

THE EFFECTS OF PRIOR KNOWLEDGE ACTIVATION ON LEARNER
RETENTION OF NEW CONCEPTS IN LEARNING OBJECTS

by

KELSEY L. HENDERSON
B.A. University of West Florida, 1995
M.Ed. University of West Florida, 1997

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Major Professors:
Atsusi Hirumi
Stephen A. Sivo

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ABSTRACT

Establishing relationships between a learner's prior knowledge and any new concepts he or she will be expected to learn is an important instructional activity. Learning objects are often devoid of such activities in an attempt to maintain their conciseness and reusability in a variety of instructional contexts. The purpose of this study was to examine the efficacy of using questioning as a prior knowledge activation strategy in learning objects. Previous research on the use prior knowledge activation strategies supports their effectiveness in helping to improve learner retention. Approaches such as questioning, advance organizers, and group discussions are examples of techniques used in previous studies. Participants enrolled in a Navy engineering curriculum were randomly assigned to two groups (experimental and comparison). The experimental group was exposed to a prior knowledge activation component at the start of session I, while the comparison group received no treatment. Participants in both groups were tested at three different times during the course of the study— the pretest, at the start of session 1, posttest I, at the conclusion of session1, and posttest II, during session 2. The findings indicate that the prior knowledge activation strategy did not result in statistically significant differences between the levels of retention gained by the experimental and comparison groups. Due to administrative constraints experienced during the course of the study, statistical power was not achieved due to an insufficiently sized sample. Potential limitations and implications for future research directions are described.

This dissertation is dedicated to my wife, Sharal and my daughter, Kelsey-Lynne. I could not have accomplished this pinnacle in my academic career without their steadfast support and many sacrifices.

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CHAPTER ONE - INTRODUCTION

Each year, 20,000 young men and women voluntarily join the United States Navy in service to our country (Recruit Training Command, 2006). Upon start of their enlistments, sailors enter an 8-week basic training program at the Navy's Recruit Training Command in Great Lakes, Illinois. There they learn Navy doctrine, customs and courtesies, and a variety of other concepts to assist them with their indoctrination of becoming sailors (Recruit Training Command, 2006). Once leaving basic training, many sailors attend formal technical training schools where they receive training in their respective career fields. The U.S. makes a considerable investment in training each year. A 2002 report from the Navy Education and Training Command (NETC) estimates the Navy spends an average of \$25,000 per sailor on training before they arrive at their first duty assignment. With such high training costs, the Navy is constantly seeking ways to reduce its training budget.

One of many approaches the Navy uses to reduce its training costs is adopting best practices and new training technologies developed in private industry and academia. In 2001, one cost-saving, industry practice the Navy began to explore was learning object technology. Learning objects are "...small (relative to the size of an entire course) instructional components that can be reused a number of times in different contexts" (Wiley, 2000). Learning objects represented an attractive proposition for the Navy because of the common training requirements shared by many Navy occupations. In years past, it was common practice in computer based training development for the same content to be produced and paid for multiple times. Alternatively, learning object

technology offered a strategy whereby content could be built once and used in multiple contexts. Figure 1 illustrates the design of the Navy’s learning object in 2001.

Pretest	Overview	Lesson					Summary	Posttest
(Topics		Topic 1	Topic 2	Topic 3	Topic 4	Topic 5		(Topics
1-5)		Practice	Practice	Practice	Practice	Practice		1-5)

Figure 1. 2001 Navy learning object design

In the 2001 Navy learning object design, sailors were presented with a pretest over the topics contained in the lesson. Following the pretest, an overview of the lesson was introduced to establish context. In the lesson section, sailors were presented with one or more topics. Each topic consisted of about 10 to 15 minutes worth of instruction.

Following each topic was a practice exercise to give students an opportunity to use the information they were presented within the topic. The summary section consisted of a review of the lesson topics, provided additional resources on the lesson topics, and identified next steps to guide the sailor to the next learning object in the sequence.

Following the summary was a posttest. The posttest tested the Sailor on the topics contained in the lesson section.

While there have been minor tweaks in the strategy over time, today’s learning object strategy employed by the Navy closely resembles the strategy used in 2001.

Building upon the successes and lessons learned it has experienced over the past five years, the Navy now seeks to extend its application of learning objects by including a new approach called prescription learning. In this approach, a sailor is offered a pretest over the topics contained in the learning object. If the sailor performs well enough on all or parts of the pretest, he or she would be exempt from the corresponding topics in the

learning object. The purpose of offering this option is to give sailors, who may be familiar with the content, an opportunity to reduce their training time and thus the costs.

Problem Statement

The prescription learning approach being employed by the Navy provides sailors who may be familiar with course content an opportunity to reduce training time. There are not many that would find fault with reducing training time when feasible. However, there are two potential problems with the prescription learning approach as it is currently being employed. The prescription learning approach recognizes that students possess prior knowledge and seeks to reward them for their prior knowledge by allowing them to bypass course content for which they can demonstrate mastery. However, no interventions are put in place to establish relationships between student prior knowledge and the course content for which they are about to be presented. As a result, students are not able to use their existing knowledge to provide meaning and context to facilitate their acquisition of the new concepts. The literature is clear in defining the importance of activating prior knowledge before introducing new concepts, yet no provisions are made in prescription learning for prior knowledge activation to take place (Pressley, Wood, Woloshyn, Martin, King, & Menke, 1992).

Prescription learning also fails to identify weaknesses in prior knowledge that may be necessary for the student to be successful with the material they are about to be presented. As a result, students may needlessly struggle with the new content because they have not adequately retained the prerequisite knowledge and skills needed to acquire the new concepts.

If the prescription learning approach is modified to allow for a prior knowledge testing component, this modification would allow for activation of prior knowledge and the formation of critical linkages between prior knowledge and the present course content and thus allow for increased retention.

Purpose Statement

The purpose of this study is to examine whether adding a prior knowledge activation component to learning objects will improve the level of retention achieved by students. The outcome of this study is important to the field because if this approach can improve the level of retention then this is an approach practitioners should consider for present and future content projects. The price to modify content projects is far more expensive than including the approach in the original design. Given the large number of learning object content projects underway in various organizations and future projects planned, these findings will assist project planners with forecasting costs. Prescription learning have been discussed thus far to provide context for the problem introduced, but it is not the focus the research in this study.

Research Question

This study is designed to answer the following research question:

1. Do students retain more information from learning objects when a prior knowledge testing component is included than without the prior knowledge testing component?

Research Hypotheses

Four hypotheses are posited for this study.

Null Hypothesis I:

There is no interaction effect between group and time after repeated measure.

Null Hypothesis II:

Time has no effect on scores between the experimental and comparison groups after repeated measure.

Null Hypothesis III:

There is no mean difference in immediate retention between the experimental and comparison groups.

Null Hypothesis IV:

There would be no mean difference in the delayed retention between the experimental and comparison groups.

Significance of the Study

The use of learning objects is becoming more pervasive in the field of instructional design, yet the literature and best practices regarding their use remains sparse. Additional best practices are needed in nearly every aspect of learning object technology. This study offers empirical evidence on strategies to improve learner retention in learning objects. Most of the extant literature on using prior knowledge activation strategies was conducted using non-electronic mediums; however, researchers have written little on the use of prior knowledge activation strategies in computer based training. Computer based training is best equipped to implement prior knowledge activation strategies for a class of students because the strategies employed and follow-on learning paths can be tailored to each individual's needs. This study is one of the first

using computer based training as an environment to activate prior knowledge. The results from this study will stimulate further research in this area.

Operational Definitions

For purposes of this study, the following operational definitions are used:

Learning Objects- Learning objects are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning" (Wiley, 2000, p. 3).

Schemata (schema) – “the idea that there are mental frameworks for comprehension” (Brunning, Schraw, Norby, & Running, 2004, p. 1). “Schemata are mental frameworks we use to organize knowledge. They direct perception and attention, permit comprehension, and guide thinking” (Brunning, Schraw, Norby, & Running, 2004, p. 6).

Retention- Retention refers to the process whereby long-term memory preserves learning in such a way that it can locate, identify, and retrieve it accurately in the future (Sousa, 2001, p. 85).

Immediate Retention Testing- Testing of knowledge gained in an instructional event immediately following the learning event.

Delayed Retention Testing- Testing of knowledge gained in an instructional event after an elapsed period of time following the learning event.

Organization of the Study

The remainder of this study will use existing research literature, theory, and experimental research methods to examine the effects prior knowledge activation on learner retention of new concepts in learning objects. Chapter Two provides an overview of the history, key research studies, and relationships of the factors which are central to this study—prior knowledge, schema activation, and retention and transfer. Chapter Three provides a description of the method that will be used to answer the research question and hypotheses presented in this chapter. Chapter Four presents the results from the research. Chapter Five discusses the results and presents implications and suggestions for future research.

Chapter Summary

This chapter sought to help establish the context for the remainder of the study. The research regarding the use of learning objects is beginning to grow, but there are still many unanswered questions regarding their use. The lack of research literature addressing pedagogical considerations when designing learning objects represents several opportunities for research. This study offers empirical evidence and broadens the field's understanding of strategies to be used to facilitate learner retention in learning objects. For the field, the outcome assists practitioners with fiscal and design planning for future content development efforts. The use of prior knowledge activation strategies with learning objects is a useful study that certainly contributes to the learning objects body of knowledge.

CHAPTER TWO - LITERATURE REVIEW

Chapter Two reviews literature related to each of the major variables under study. It provides an empirically-based analysis of the influence prior knowledge activation has on learner retention. The chapter begins by presenting the theoretical foundation for the study. Following this discussion, the chapter reviews research trends related to each of the variables under study including prior knowledge, schema activation, and retention and transfer. Finally, a review of the research designs used in previous studies on related topics will be discussed to establish a methodological basis for the research design used in this study.

Theoretical Foundation

The theoretical foundation for this study is grounded in schema theory. Schema theory holds that learners have mental frameworks that they use to permit comprehension, organize knowledge, and direct their perception and attention (Brunning et al, 2004). "Schemata theorists have proposed that knowledge is organized into complex representations called schemata (sing., schema) that control the encoding, storage, and retrieval of instruction (Marshall, 1995; Rumelhart, 1984; Seifert, McKoon, Abelson, & Ratcliff, 1986)" (as cited by Brunning, Schraw, Norby, & Running, 2004, p. 48).

There are two concepts within schema theory that are useful in explaining the topic under study— prior knowledge and schema activation. Each will be elaborated upon in the sections to follow.

Prior Knowledge

Prior knowledge is a critical component of schema theory. "Research on human learning indicates that students will learn more if they can relate new information to what they already know (Anderson, 1977; Adams & Bruce, 1980; Rumelhart & Ortony, 1977)" (as cited in Alessi & Trollip, 1991, p. 22). When students possess relevant prior knowledge in long term memory, it is easier for them to learn related new material (Clark, 2003).

The literature identifies a number of ways to help learners establish relationships between prior knowledge and new content. Pressley, Wood, Martin, King, & Menke (1992) posit having students answer questions about new content helps them to establish relationships between prior knowledge and new content. "Attempting to generate elaborative thoughtful answers to questions accompanying meaningful content (i.e., explanatory answers going well beyond the information as presented) increases the learning of that content" (Pressley et al, 1992, p. 93).

Clark (2003) supports Pressley and his colleagues' idea of asking questions to activate prior knowledge. She also proposes that group discussions and advance organizers are additional methods to activate prior knowledge (2003, p.84).

Schema Activation

When learners receive new information and are able to associate "meaning" or a relationship to something they already know, schemata helps to organize and integrate the new information with their existing information (Torney-Purta, 1991). The schemata also help to control the encoding, storage, and retrieval of information (Marshall, 1995;

Rumelhart, 1984; Seifert, McKoon, Abelson, & Ratcliff, 1986) (as cited by Brunning, Schraw, Norby, & Running, 2004, p. 48).

Establishing connections between prior knowledge and new content requires the activation of learner's schema. "Schema activation refers to various methods designed to activate students' relevant knowledge prior to a learning activity" (Brunning, Schraw, Norby, & Running, 2004, p. 75). "The central idea underlying schema activation is that new knowledge always builds on prior knowledge; that is, a foundation of well-understood information will help students comprehend new information and will guide their thinking about the new topic" (Brunning, Schraw, Norby, & Running, 2004, p. 75).

One schema activation method introduced in the literature is questioning. Asking students questions about previously learned material can promote both review and further elaboration (Ormrod, 2004). When learners are asked questions and provide responses, it helps them to improve their cognitive processing. It is through this processing that learners solidify their "mental representations", thus making comprehension and recall easier (King & Rosenshine, 1993) (as cited by Brunning, Schraw, Norby, & Running, 2004).

Empirical Evidence

This section of the chapter reviews the empirical evidence on prior knowledge, schema activation, and retention and transfer. The trends found in previous research on these areas are analyzed.

Criteria

The following criteria were used in selecting the empirical evidence reviewed in this chapter:

1. Describes research studies which support or negate prior knowledge as a contributing factor to learner retention
2. Describes the origin and history of retention research and barriers the literature mentions regarding retention
3. Describes research studies which support or negate schema activation as a contributing factor to learner retention
4. Describes research studies identifying factors which contribute to learner retention and transfer

Prior Knowledge

For learners to leverage their prior knowledge, some event or stimuli needs to activate their prior knowledge. While advanced students may be able to identify these relationships themselves, less advanced students may not be able to draw the same connections and will require additional support. Instructional designers employ different tactics to activate the prior knowledge of learners when they are equipped with the appropriate knowledge about the learners and the subject matter. Researchers who have studied the influence of prior knowledge suggest that strategies, such as asking students prequestions, allowing for group discussions, or providing advance organizers, are valuable tools for activating prior knowledge (Pressley et al, 1992, p. 93; Clark, 2003, p. 84).

Fifteen studies, published between 1975 and 2005, were reviewed examining the influence of prior knowledge on learning. When reviewing these studies, trends were noted in the focus and findings. Figure 3 illustrates these trends and their relationships.

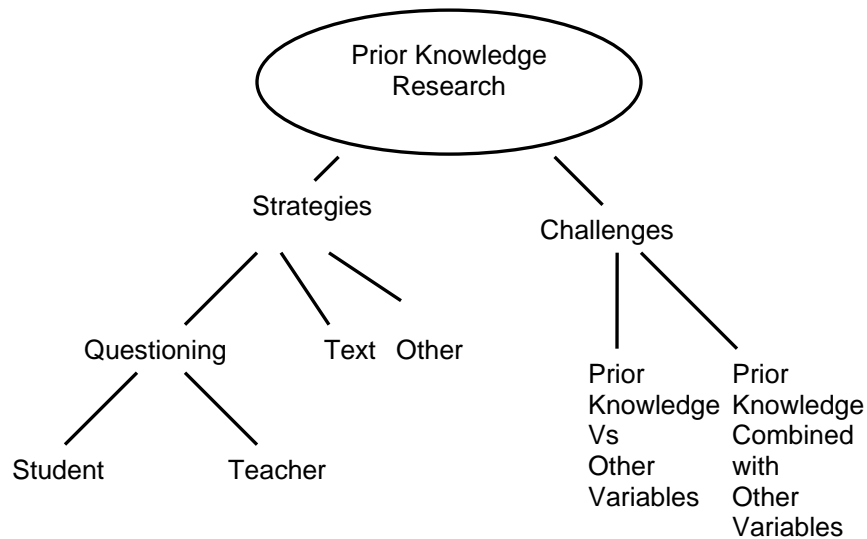


Figure 2. Prior knowledge research trends

Two major trends can be identified in previous prior knowledge research—strategies and challenges. The strategies trend refers to studies which used a particular prior knowledge activation method with a group of participants and compared the effects of the method with another group who did not receive the same treatment. The challenges trend refers to studies where researchers were interested in testing the influence of prior knowledge by either comparing prior knowledge with some other variable or observing the interaction of prior knowledge with other variables. The sections to follow review the strategies and challenges trends in further detail and identify their associated studies.

Strategies

Two major threads were noted in the strategies employed in prior knowledge research studies—questioning and relating text to previously learned material. As reflected in Table 1, three studies are highlighted as having used questioning as a strategy to activate prior knowledge (Andersen & Biddle, 1975; Frase & Schwartz, 1975; Osman & Hannafin, 1994). It should be noted that while there is only one entry for the Anderson & Biddle study in Table 1, this study is a review of the findings of fourteen other studies where experimental research designs and questioning groups were utilized.

Table 1

Prior Knowledge Activation Strategies Used in Previous Studies

Study	Questioning	Text-Relation	Other
Anderson & Biddle (1975) x 14	X	X	
Frase & Schwartz (1975)	X		
Gay (1986)			X
Woloshyn, Pressley, & Schneider (1992)			X
Osman & Hannafin (1994)	X		
Spires & Donley (1998)		X	
Kaplan & Murphy (2000)		X	
Muller-Kalthoff & Jens (2003)			X
Thompson & Zamboanga (2004)			X
Mitchell, Chen, & Macredie (2005)			X
Tsai & Tsai (2005)			X
Clarke, Ayers, and Sweller (2005)		X	

In 10 of 14 studies reviewed in the Anderson and Biddle study, questioning groups outperformed groups where no questioning treatment was used. The Frase and Schartz and Osman and Hannafin study both found that questioning was an effective strategy in improving learner retention or recall.

Table 1 also reflects three studies that utilized text as a method to relate new information to previously learned information (Anderson & Briddle, 1975; Spires & Donnelly, 1998; Kaplan & Murphy, 2000).

The findings from all of the text relation studies concluded that when text-based approaches were used to activate prior knowledge, participants outperformed students who had not received same treatment.

Figure 3 further subdivides the questioning thread into student and teacher. Student refers to studies in which the researchers tested the effectiveness of having students generate questions to activate prior knowledge. Teacher refers to studies where there questions were either provided by the teacher orally or provided in the teacher prepared materials. Table 2 shows the breakdown of studies which used the student-generated or teacher-generated questions.

Table 2

Student-Generated Questions Versus Teacher-Generated Questions

Study	Student	Teacher
Anderson & Biddle (1975) x 14		X
Frase & Schwartz (1975)	X	X
Osman & Hannafin (1994)		X

Teacher-generated questions have been used most frequently in previous research (Anderson & Biddle, 1975; Frase & Schwartz, 1975; Osman & Hannafin, 1994). The Frase & Schwartz study also appears under the student column because it compared the effectiveness of student-generated versus teacher-generated questions. It should be noted that the data from the Frase and Schwartz study suggests that it is more effective to have the students generate questions versus using teacher prepared questions.

Challenges

Research studies that challenge the influence of prior knowledge on learner retention or recall are few in number, but two threads are noted in the focus of these studies. The first thread focuses on the effectiveness of prior knowledge compared to some other variable. The second thread focuses on the interaction between prior knowledge and other variables. Table 3 summarizes which of the previously described studies fall under each category.

Table 3

Challenge Studies in Prior Knowledge Research

Study	Comparison	Interaction
Gay (1986)		X
Woloshyn, Pressley, & Schneider (1992)	X	
Muller-Kalthoff & Jens (2003)		X
Thompson & Zamboanga (2004)	X	
Mitchell, Chen, & Macredie (2005)		X

The findings from the comparison studies are mixed. In the Thompson & Zamboanga study, they concluded that prior knowledge was a greater predictor of student performance than academic ability. However, in the Woloshyn et al. study, they found that prior knowledge only made a difference in the performance of their participants in the reading-to-understand experiment.

The findings from the interaction studies are also mixed. The Gay study looked at the interaction between prior knowledge and learner control. The study found that participants with high prior knowledge could be given more learner control than students with low prior knowledge. The Muller-Kalthoff study also had a positive finding in that the interaction of high prior knowledge, high self-concept, and graphical organizers was shown to increase the rate of learner retention. Conversely, in the Mitchell study, a finding was introduced that students with high prior knowledge actually performed worse than students with low prior knowledge. Of note with the Mitchell study is that high prior

knowledge caused the participants to be more self-sufficient and they did not attend to the instruction as well as they ought to have, which caused them to miss critical details.

Prior Knowledge Trend Summary

The overwhelming majority of the studies reviewed provide strong empirical evidence that prior knowledge when properly activated can be used to help improve student acquisition of new information. Both comprehension and retention are improved when new information can be related to the learners existing knowledge base.

The literature also indicates that learning is not a series of isolated events. Instead, each learning event is related to another learning event. If links can be made evident to learners, tremendous pedagogical dividends can be gained. Approaches such as prescription learning recognize these dividends and attempt to reward students for their prior knowledge by allowing them to bypass content. However, in the process of rewarding students, these approaches also deny learners of an opportunity to make critical cognitive links between new knowledge and prior knowledge.

The empirical evidence supports the study's claim that prior knowledge suggests for this study that prior knowledge is a significant contributor to student acquisition of new information.

Schema Research

Schema research, like prior knowledge research, seeks to investigate the relationship between what learners already know and their comprehension, retention, and recall of their new information. "New knowledge always builds on prior knowledge..." (Brunning et al, 2004, p. 75).

Nine studies, published between 1975 and 2005, are reviewed examining the role of schema activation in learning. When reviewing these studies, trends were noted in their focus and findings. Figure 3 illustrates these trends and their relationships.

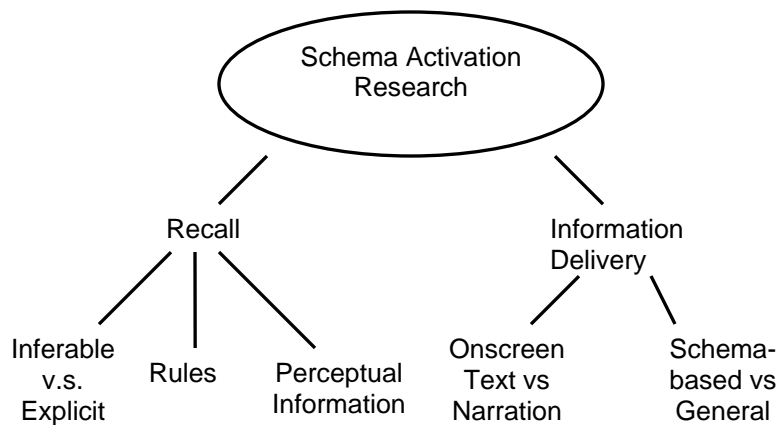


Figure 3. Schema activation research trends

Two major trends appear in the extant schema activation research—recall and information delivery. The recall trend refers to studies which examine the role of schema activation in the recall of specific types of information. The information delivery trend refers to patterns in the research where the focus is placed on schema activation strategies which occur during the delivery of information. Table 4 shows the breakdown of which studies fall into each trend area.

Table 4

Schema Activation Strategies Used in Previous Studies

Study	Recall	Information Delivery
Pearson, Hansen, & Gordon (1979)	X	
Thorndyke & Hayes-Roth (1979)	X	
Landis (1982)	X	
Cooper & Sweller (1987)	X	
vonHippel, Jonides, Hilton, & Narayan (1993)	X	
Harp & Mayer (1998)	X	
Hoz, Bowman, & Koyminsky (2001)	X	
Mayer, Heiser, & Lonn (2001)		X
Xin, Jitendra, and Deatline-Buckman		X

The sections to follow review the recall and information delivery trends in further detail.

Recall

Two major threads were noted in the recall studies reviewed—perceptual information and rules. As indicated in Table 1, seven studies are highlighted as being focused on schema activation and its role in recall (Pearson, Hansen, & Gordon, 1979; Thorndyke & Hayes-Roth, 1979; Landis, 1982; Cooper & Sweller, 1987; vonHippel, Jonides, Hilton, & Narayan, 1993; Harp & Mayer, 1998; Hoz, Bowman, & Koyminsky; 2001). The findings from six of the seven studies show strong support for the positive effects of schema activation in recall. The Hoz, Bowman, and Koxminsky study (2001) was the only study where the findings did not provide strong empirical support.

Information Delivery

There were two studies found in the literature that employed schema activation techniques during the delivery of information to participants (Mayer, Heiser, and Lonn, 2001); Xin, Jitendra, & Deatline-Buckman, 2005). In the Mayer study, researchers were interested in observing whether on-screen text or narration was more effective at facilitating recall. The findings from the Mayer study concluded that when text was presented with narration, participants were not able to recall information as well as participants who either received the text only or narration only treatments. In the Xin study, researchers investigated the effects of schema-based instruction (utilize schema activation strategies) versus general strategy instruction (no schema activation technique employed). The findings from the Xin study concluded that participants in the schema-based instruction group significantly outperformed the general strategy group on immediate and delayed posttests.

Schema Activation Trend Summary

With the exception of the Hoz, Bowman, & Koxminsky study (2001), schema or schema activation was shown to be an important factor in retention (Landis, 1982) and recall of information (Thorndyke & Hayes-Roth, 1979). Establishing relationships between learning events, concepts, and experiences is supported by the literature. Methods such as offering questions on prerequisite concepts enable learners to create linkages between their existing knowledge base and new concepts.

The empirical evidence on schema activation supports the use of questions as a means to activate the schema prior to introducing new information, as proposed in this study.

Retention and Transfer

Application of schema theory and prior knowledge improves learner retention and transfer. When learners learn something new, they transfer their prior knowledge from memory to assist with acquiring the new knowledge (Bransford, Brown, & Cocking, 2000, p. 53). " Without an adequate level of initial learning, transfer cannot be expected" (Bransford, Brown, & Cocking, 2000, p. 53). "...Students may have knowledge that is relevant to a learning situation that is not activated. By helping activate this knowledge, teachers can build on student's strengths" (Bransford, Brown, & Cocking, 2000, p. ?).

Questioning helps learners in the retention process. "Providing students with opportunities to first grapple with specific information relevant to a topic has been shown to create a 'time for telling' that enables them to learn much more from an organizing lecture (as measured by subsequent abilities to transfer) than students who do not first have these specific opportunities" (Bransford, Brown, & Cocking, 2000, p. 58). When learners find sense and meaning with learning content and can relate the learning experience to something they have learned before, retention is easier (Sousa, 2001, p. 84).

Eight research studies, published between 1970 and 2006, investigating the role of retention and transfer to the learning process are reviewed. Figure 4 illustrates their trends and relationships.

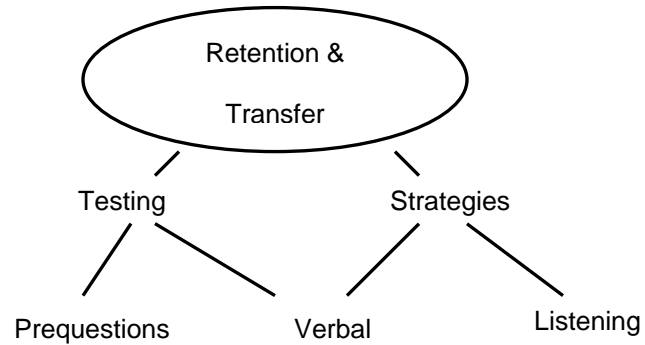


Figure 4. Retention and transfer research trends

Two major trends appear in the extant retention and transfer research—testing and strategies. The testing trend refers to a pattern of research focused on the use of tests or questions to improve retention and transfer. The strategies trend refers to research whose primary focus is in the effectiveness of different strategies in promoting retention. Table 5 shows the breakdown of which studies fall into each trend area.

Table 5

Retention and Transfer Threads in Previous Research

Study	Testing	Strategies
Peeck (1970)	X	
Boker (1974)	X	
Laporte & Ross (1975)	X	
Dwyer and deMelo (1984)		X
Brown, Dunne, & Cooper (1996)		X
Labant (2001)		X
Yan (2006)	X	
Rittle-Johson (2006)		X

The sections to follow review the testing and strategies trends in further detail.

Testing

Two major threads were noted in the testing studies reviewed – prequestions and verbal strategies. As reflected in Table 5, four studies are highlighted as being focused on testing and its relationship to retention and transfer (Peeck, 1970; Boker, 1974; Laporte & Ross, 1975; Dwyer and deMelo, 1984). Three of the four studies were prequestion studies under the testing thread (Peeck, 1970; Boker, 1974; Yan, 2006). In each study, the findings were conclusive that when groups were introduced to prequestions, they outperformed students who were not exposed to the prequestion treatment. There was also one verbal study under the testing thread (Laporte & Ross, 1975). In the Laporte & Ross study, researchers examined the effect knowing pretest results would have on

immediate and delayed retention. They found that knowledge of results had no impact on participant performance.

Strategies

The strategies trend was subdivided into two other threads – verbal and listening. There were four studies which examined strategies to help improve learner retention (Dwyer and deMelo, 1984; Brown, Dunne, & Cooper, 1996; Labant, 2001; Rittle-Johnson, 2006). There were three research studies reviewed under the verbal thread (Dwyer and deMelo, 1984; Labant, 2001; Rittle-Johnson). Dwyer and deMelo investigated the effects of visual versus verbal testing. Their research concluded that verbal testing was more effective on comprehension and immediate and delayed retention. Labant was interested in examining the effects of verbal strategies on immediate and delayed retention of information. He found that time-on-task and rehearsal had no effect on learner performance. Rittle-Johnson evaluated whether self-explanation leads to lasting improvements in transfer success. Her findings were conclusive that self-explanation was helpful in promoting transfer regardless of the instructional conditions.

There was one research study under the listening thread (Brown, Dunne, & Cooper, 1996). In the Brown, Dunne, and Cooper study, researchers were interested in the effects of listening and immediate retelling of information versus listening and delaying the retell of information. The findings concluded that it was more effective to have students listen and do immediate retells than to listen and have them do delayed retells.

Retention and Transfer Trend Summary

The common themes running throughout this section related to testing and strategies to improve learner retention. The Peeck study (1970) and the Boker study (1974) support the use of questioning as a means to improve learner retention. The research studies on retention and transfer provide a sound research basis for the research question and hypotheses presented in Chapter One.

Research Designs

The research design selection for a study was made based on several factors; e.g. research questions, research traditions, availability of subjects, etc. The studies examined in this chapter utilized a variety of research designs; posttest only (Fraser & Schwartz, 1975), pretest-posttest control group (Hall & Edmondson, 1992), and factorial designs (Shapiro, 2004).

The Hall and Edmondson study (1992) most closely represents the research design used in this study. Their study utilized a pretest-posttest control group design. There were two experimental groups and one control group. Group 1 completed a pretest, read a passage, completed an immediate posttest, and completed a delayed posttest one week following the immediate posttest. Group 2 completed the pretest, read the passage, and completed the delayed posttest one week later. The control group completed the pretest and the posttest without reading the passage.

Chapter Summary

The purpose of this literature review was to establish a theoretical foundation for the study and to review the empirical evidence on prior knowledge, schema theory, and

retention and transfer. The prior knowledge section provided strong empirical evidence that prior knowledge when properly activated can be used to help improve student acquisition of new information. The schema theory section described the importance of schema activation to learner retention. The retention and transfer section identified strategies related to improving comprehension such as using questions and offered support for establishing relationships between learning events, concepts, and experiences. The research design section describes the range of research designs used in the studies discussed in this chapter and the design of a study which is similar to the approach proposed in this study.

CHAPTER THREE - METHOD

Chapter Three describes the method used to answer the research question and hypotheses presented in Chapter One, investigating the effects of prior knowledge activation on learner retention of new concepts in learning objects. This chapter provides a description of the participants, research design, intervention, instruments, procedures, data analysis, and limitations.

Participants

The participants for this study were selected from a population of enlisted Navy sailors who were enrolled in the Basic Engineering Common Core (BECC) course at the Engineering “A” school in Great Lakes, Illinois. The BECC course is an introductory course required by all enlisted sailors entering one of the Navy’s fourteen engineering occupations. The participants were selected from this population because the BECC course is one of the few Navy training curricula with core introductory and follow-on course materials developed using the Navy’s learning object strategy.

The number of sailors who complete the BECC course at any one time varies because the course is online and self-paced. Consequently, sailors also complete the course at different times. The request made to the Engineering school was to identify students who had completed Module 1 of the BECC course and were awaiting the start of Module 2 for participation in the study. Engineering “A” school personnel were responsible for selecting the participants meeting these criteria. There were 46 students identified; however, 12 of the 46 were unable to participate in the study because they

were receiving remediation training. The study was conducted with remaining 32 participants.

The sailors who attend Engineering “A” school come from various ethnic and socio-economic backgrounds. Both male and female sailors may serve in any of the engineering occupations. Engineering students typically possess above-average Armed Services Vocational Aptitude Battery (ASVAB) scores.

All participants were randomly assigned to either the experimental or comparison group. Prior to the start of the experiment, Engineering “A” school personnel provided the researcher with a list of the students who were available to participate in the study. Upon arrival of the participants at the first session, the researcher read the verbatim identified in Appendix G. Participants were notified that their participation in the study was voluntary and all agreed to continue with the study. The researcher then placed the names of the participants in a spreadsheet in ascending order. The names were then numbered from 1 to n. The researcher then used the randomizing tool, Randomizer.org, to select a randomized list of numbers. The amount of numbers requested was one-half the total number of participants. The numbers returned were used to identify the participants who were assigned to the experimental group. The other half of the participants were assigned to the comparison group.

Research Design

This study used an experimental research design. A pretest/posttest control group design was used to examine the research question as illustrated in Figure 5. Participants were randomly assigned to one of two groups—prior knowledge activation treatment group or comparison group. Both groups were administered a pretest. The experimental

group was administered a prior knowledge activation treatment at the beginning of their pretest. Both groups were then presented with a lesson and retention test. One week following the initial retention test, a delayed retention test was administered to both groups.

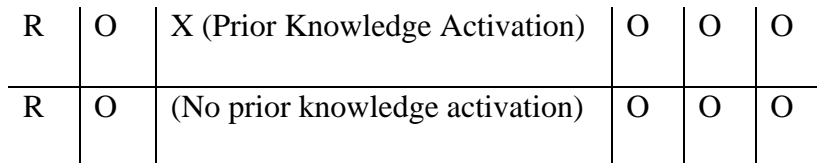


Figure 5. Research design diagram

The level of statistical significance for the study was set at the conventional value = .05 (two-tailed). The observed statistical power was .498.

Interventions

There were two interventions used in this study—a prior knowledge activation strategy and a lesson. The sections to follow provide a description of each intervention.

Prior Knowledge Activation Strategy

The prior knowledge activation strategy utilizes prior knowledge questions as a means to stimulate student thinking about concepts. The strategy requires participants to think about concepts they learned in Module 1 of the BECC course and confirms their understanding of concepts before being presented with related concepts in the follow-on module. Following the pretest and before the lesson, participants in the experimental

group were presented with a series of questions. The questions were related to concepts participants would have learned in Module 1 of the BECC course. Each question elicited prerequisite knowledge necessary to understand the concepts presented in Module 2. Following each question, participants were provided with feedback related to the question and identified the correct response. Participants were then prompted to attempt answering the next question. Participants did not receive a score on the questions. The intervention merely served to confirm the participants' understanding of material learned in Module 1 of the BECC course prior to introducing new content from Module 2.

Lesson

The lesson used in this study was Module 2 of the BECC course. In Module 2, students were asked to complete seven topics. Each topic was in a computer-based format. The topics consisted of an overview, content, practice questions, and a summary. The Overview provided an introduction to the topic, a list of the objectives, and a description of the information to follow. The Topics section is where the objectives of the lesson were taught. Each topic required approximately ten minutes to complete. Following each topic, practice questions were provided to allow students to apply the information presented in the preceding topic. The Summary section reviewed the information presented in the Topics section by discussing the main ideas. Also, it presented additional resources the student may utilize to learn more about the lesson material, and identified next steps after completing the lesson.

Instruments

This study used three measurement instruments: pretest, posttest I, and posttest II. The pre and posttests were selected from existing item banks being administered to sailors at the Engineering “A” school. The purpose in using their test banks was that the items had been used with previous engineering students and the school had historical test item statistics to confirm the quality of the items. Further, the items contained in the test bank have been evaluated for content validity with subject matter experts (SME) and instructional systems specialists. To thwart cheating, the school offers randomized tests to each student, so reliability coefficients for particular tests were not available. Instead, the p-values for the individual items were used to rate the quality of the items selected to create the tests used in this study. The p-value range of the items selected was .55 to .75. No randomization was used in the administration of the tests for this study as to allow for identical measures for all participants.

Pretest

The pretest was administered to both the experimental and comparison groups prior to the lesson being assigned. The test consisted of ten multiple-choice questions. Each question was worth ten points. Four answer choices were presented for each question. The pretest was worth 100 points. Each question on the pretest was aligned to an objective in the lesson that followed. Participants were given twenty minutes to complete the pretest. With each administration, questions and answer choices were presented in the same order. Following the pretest, participants were advised to begin the lesson.

Posttest I

Posttest I was administered to both the experimental and comparison groups following the lesson. The test consisted of ten multiple-choice questions. Four answer choices were presented for each question. Each question had four choices. Posttest I was worth 100 points. Each question on posttest I was aligned to an objective introduced in the lesson. Participants were given twenty minutes to complete posttest I. With each administration, questions and answer choices were presented in the same order. Following posttest I, participants were not advised of their scores.

Posttest II

Posttest II was administered to both the experimental and comparison groups one week following the administration of posttest I. The test consisted of ten multiple-choice questions. The questions presented on Posttest II were identical to the questions presented on Posttest I. Each question was worth five points. Four choices was presented for each question. Posttest II was worth 100 points. Each question on posttest II was aligned to an objective introduced in the lesson. Participants were given twenty minutes to complete posttest II, though most completed the test in less time. With each administration, questions and answer choices were presented in the same order. Following posttest II, participants were not advised of their scores.

Procedures

The study was conducted in two two-hour sessions over a one week period. During the first session, the participants were read a verbatim (see Appendix G) identifying the purpose of the study, advising them of their voluntary participation in the

study, and describing what they were going to be asked to do as a participant. Following the reading of the verbatim, each participant was given an informed consent form and asked to sign the form if they were willing to participate in the study. If participants did not wish to participate, they would have been excused from the session and their names would have been removed from the list of participants. None of the participants requested to discontinue the study. All of the participants were randomly assigned to either the experimental or comparison group.

After participants were randomly assigned to their groups, they were administered the pretest. Participants were given twenty minutes to complete the pretest. The version of the pretest given to the experimental group presented the prior knowledge activation treatment followed by the pretest items, while the version of the pretest administered to the comparison group did not include the prior knowledge activation treatment. When both groups completed their pretests, they were advised to begin completing the lesson. When both groups completed the lesson, they were administered posttest I. Upon completion of posttest I, participants were advised to return in one week to be administered posttest II. After the week had elapsed, participants returned to be administered posttest II. Following posttest II, participants were advised of their scores and excused from the session.

Data Analysis

Following the data collection, the pretest and posttest scores from the experiment were entered into the Statistical Package for the Social Sciences (SPSS) software. The statistical procedures, One-Way Analysis of Variance (ANOVA) and Repeated Measures Analysis of Variance (ANOVA), were used to analyze the data. The one-way ANOVA

was used to test hypotheses III and IV because in both cases the hypothesis required the examination of differences in mean scores between two independent groups. The Repeated Measures ANOVA was selected to answer hypotheses I and II, and in both cases, examined the difference in performance after repeated measure.

To assure the data being collected was not compromised, all of the test materials were assigned a number and after each test administration, the tests were inventoried to ensure all tests were present. During the test administration, students were proctored by the researcher and an engineering school instructor. To protect against data corruption or loss, data were stored on multiple password-protected storage devices.

Limitations and Assumptions

There were a few limitations identified at the start of the study. First, gaining access to the same participants for posttest I and posttest II was difficult. In order to ensure the same participants were used for both sessions, posttest II had to be administered no more than one week following posttest I. As a result, the time proximity of the posttest II may not reduce the testing and recency effect to the extent necessary to show differences in the control and experimental groups. This limitation restricts the generalizability of this study's findings to other populations for periods of one week or less.

The study also has the limitation of detecting the level of prior knowledge of participants prior to the start of the study. Some sailors enter the Navy with college degrees in the occupation for which they are being trained. The engineering school personnel may not be privy to transcripts for any training Sailors completed prior to entering the Navy. As a result, selection of participants who had no prior knowledge on

topics in Module 2 of the BECC course was difficult to ensure prior to the start of the study. However, after reviewing participant pretest scores, no participants appeared to have high prior knowledge of the Module 2 content. Thus, no additional sampling was required.

With these limitations, a few assumptions were made that when sailors were administered their tests, no cheating and test compromises occurred. Every effort was made to protect against sailors compromising the tests and to monitor participants during the test administrations.

Another assumption made was that sailors took the tests seriously and completed them earnestly. If sailors did not see the value in participating in the study, it would have affected their attitudes and caused them not to try as hard to perform well. Clearly communicating the purpose of the study was an important factor in getting sailors to put forth an earnest effort.

Chapter Summary

This chapter describes the method that was used in this study. Navy engineering students were the participants. They were sampled from a population of students who recently completed Module 1 of the BECC course. The experimental research design, pretest/posttest control group was selected. Data collection was conducted in two sessions over a one-week period. The statistical procedures one-way ANOVA and repeated measures analysis of variance (ANOVA) were used to analyze scores. In Chapter Four, the results are presented.

CHAPTER FOUR - RESULTS

Chapter Four presents an analysis of the data that were collected from the research described in Chapter Three. The purpose of this analysis is to summarize the efficacy of using questioning as a prior knowledge activation strategy in learning objects. To test each hypothesis, the participants in both groups were tested at three different times during the course of the study– the pretest, at the start of session 1, posttest I, at the conclusion of session1, and posttest II, during session 2. All of the data were input and analyzed using SPSS Version 13 for Windows - Graduate Edition. This chapter begins by reviewing the hypotheses first introduced in Chapter One. Following the hypotheses review, the findings for each hypothesis will be described. The last section of the chapter presents a reexamination of the results after reliability analyses on the instruments. It should be noted that due to administrative constraints experienced during the course of the study, sufficient statistical power could not be achieved. Therefore, the results provided and conclusions drawn are limited in scope and future application.

Hypotheses

The following null hypotheses were posited in Chapter One:

1. There is no interaction effect between group and time after repeated measure.
2. Time has no effect on scores between the experimental and comparison groups after repeated measure.
3. There is no mean difference in immediate retention between the experimental and comparison groups.

4. There would be no mean difference in the delayed retention between the experimental and comparison groups.

Findings

This section describes the statistical procedure used to test each hypothesis and the associated findings.

Null Hypothesis I

To examine the effect of the interaction between time and group after repeated measure, a Repeated Measures Analysis of Variance (ANOVA) was performed on the pretest, posttest I, and posttest II scores for the experimental and comparison groups.

Table 6 shows the results from this procedure.

Table 6

Multivariate Tests of the Time and Group Interaction Effect

Effect		Value	F	Hypothesis df	Error df	Sig.
Time * group	Wilk's Lambda	.964	.544	2.000	29.000	.586

The interaction between time and group did not have a statistically significant effect on participant scores ($F=.544, p>.05$). Thus, Null Hypothesis I is accepted.

Null Hypothesis II

To examine the effect of time after repeated measure, a Repeated Measures Analysis of Variance (ANOVA) was performed on the pretest, posttest I, and posttest II scores for the experimental and comparison groups. Tables 7 and 8 show the results from

this procedure. First, sphericity is determined. In Table 7, a review Box's test for equality of covariances indicates the two groups were not different to a statistically significant degree ($p > .05$), so sphericity was assumed.

Table 7

Box's Test of Equality of Covariance Matrices

Box's M	2.171
F	.322
df1	6
df2	6520.755
Sig.	.926

Table 8

Multivariate Tests of the Time Effect

Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Wilks' Lambda	.498	14.617	2.000	29.000	.000

Once sphericity was confirmed, the focus of the analysis was shifted to the effect of time on scores. Table 8 indicates that time had a statistically significant effect on participant scores after repeated measure ($F=14.617$, $p < .01$). To confirm the direction of the mean scores, Table 9 was examined. The mean scores on pretest I ($M=49.69$), posttest I ($M=56.56$), and posttest II ($M=66.25$) increase for both groups with each exposure. Thus, Null Hypothesis III is rejected.

Table 9

Descriptive Statistics on Pretest I, Posttest I, and Posttest II

	Group	Mean	Std. Deviation	N
Pretest	Experimental	50.00	20.331	16
	Comparison	49.38	15.262	16
	Total	49.69	17.686	32
Posttest1	Experimental	57.50	19.149	16
	Comparison	55.63	16.721	16
	Total	56.56	17.709	32
Posttest2	Experimental	63.75	22.17356	16
	Control	68.75	19.27	16
	Total	66.25	20.59596	32

The plotted means in Figure 6 demonstrates visually what is seen numerically above.

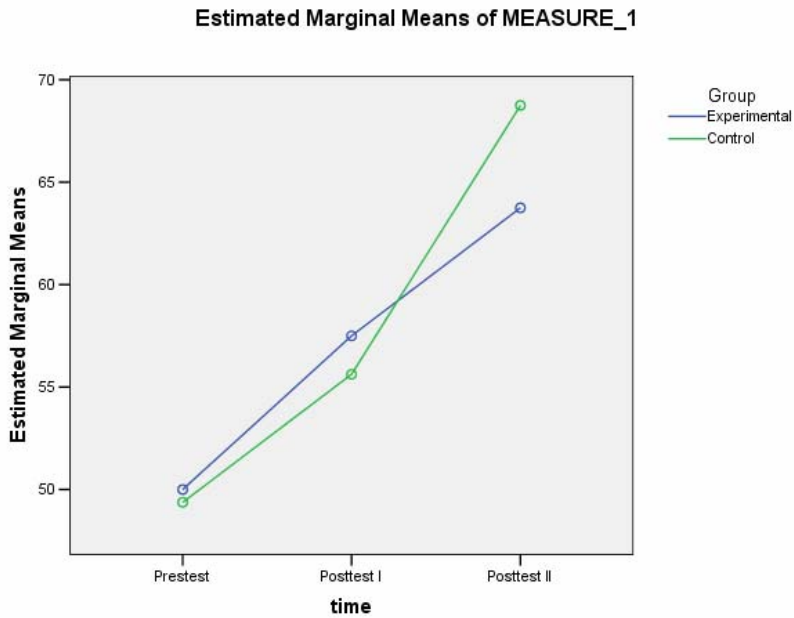


Figure 6. Plotted means of groups on pretest, posttest1, and posttest2

Null Hypothesis III

To test Null Hypothesis III, a one-way analysis of variance (ANOVA) was performed on the mean scores on Posttest I for the experimental and comparison groups. A review of Table 10 indicates that the experimental group (M=57.50) outscored the comparison group (M=55.63), as had been predicted.

Table 10

Descriptive Statistics for Posttest I

	Group	Mean	Std. Deviation	N
Posttest I	Experimental	57.50	19.149	16
	Control	55.63	16.721	16
	Total	56.56	17.709	32

To assess the significance of the differences between the two groups, Table 11 was examined.

Table 11

Summary of Analysis of Variance Results from Posttest I

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	28.125	1	28.125	.087	.770	.003
Intercept	102378.125	1	102378.125	316.838	.000	.914
Group	28.125	1	28.125	.087	.770	.003
Error	9693.750	30	323.125			
Total	112100.000	32				
Corrected Total	9721.875	31				

The mean differences between the two groups are not statistically significant ($F=.087$, $df=1,30$, $p>.05$). Thus, Null Hypothesis III is accepted.

Null Hypothesis IV

To test Null Hypothesis II, a one-way analysis of variance (ANOVA) was performed on the mean scores on Posttest II for the experimental and comparison groups. Table 12 indicates that the comparison group ($M=68.75$) outscored the experimental group ($M=63.75$), which contradicts earlier predictions.

Table 12

Descriptive Statistics for Posttest II

	Group	Mean	Std. Deviation	N
Posttest1	Experimental	63.75	22.17356	16
	Comparison	68.75	19.27866	16
	Total	66.25	20.59596	32

To assess whether the differences were significant, Table 13 was examined.

Table 13

Summary of Analysis of Variance Results from Posttest II

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	200.000	1	200.000	.463	.501	.015
Intercept	140450.00	1	140450.00	316.838	.000	.916
Group	200.000	1	200.000	.087	.501	.015
Error	12950.000	30	431.667			
Total	153600.000	32				
Corrected Total	13150.000	31				

The mean differences between the two groups are not statistically significant ($F=.463$, $df=1,30$, $p>.05$). Thus, Null Hypothesis IV is also accepted.

Reliability Analyses

After the hypothesis testing was conducted, reliability analyses were conducted on the student responses collected on the pretest, posttest I, and posttest II. Individual analyses were conducted on each test using the SPSS statistical procedure, Reliability Analysis. The purpose of these analyses was to identify any items negatively correlated with the corrected total. Items negatively correlated with the corrected total were eliminated from the analysis and participant scores adjusted. Their elimination was warranted on the basis that reducing the scale to only relevant items would make for a better, more parsimonious scale. To examine the impact of removing each item, items were removed one at a time. This approach was necessary because the impact of removing one item changes the relationship of the other items with the changing total. Participant scores were then adjusted based on the removal of poor performing items.

Pretest

A reliability analysis was performed on the Pretest, but the procedure indicated that all of the items were negatively correlated with the item totals. As a result of this finding, none of the items were removed. Thus, no adjustments were made to participant scores on the pretest.

Posttest I

Upon conducting the reliability analysis on posttest I, participant responses during Session I of this study were judged to be poor. The initial reliability coefficient was $-.044$.

Items 3, 6, and 9 were found to be negatively correlated with the corrected total. The resultant reliability coefficient after their removal was .34. Participant scores were adjusted based on the removal of these items. After making the adjustment in participant scores, the mean score for participants in the experimental and comparison groups increased to M=63.55 and M=58.34 respectively (see Table 14).

Table 14

Descriptive Statistics on Pretest I, Posttest II, and Posttest II After Item Removal

	Group	Mean	Std. Deviation	N
Pretest	Experimental	50.00	20.331	16
	Comparison	49.38	15.262	16
	Total	49.69	17.686	32
Posttest1	Experimental	63.5544	20.38812	16
	Comparison	58.3450	20.18837	16
	Total	60.9497	20.13326	32
Posttest2	Experimental	71.4275	24.46628	16
	Comparison	76.6050	23.54120	16
	Total	74.0163	23.76379	32

The plotted means in Figure 7 demonstrates visually what is seen numerically above.

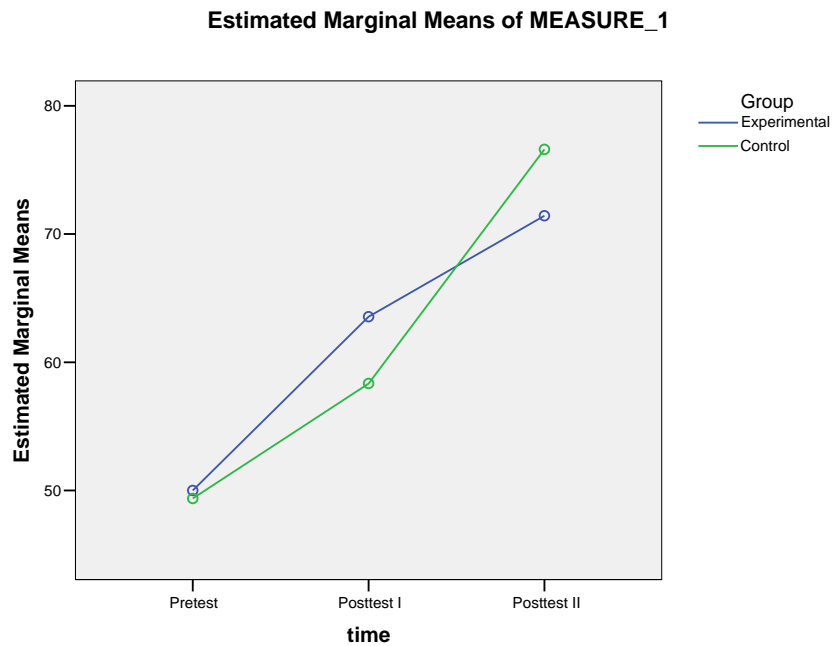


Figure 7. Plotted means of groups on after item removal

Posttest II

The same analysis was conducted on Posttest II. Participant responses during Session II of this study were also judged to be poor. The initial reliability coefficient was .176. Items 4, 5, and 6 were found to be negatively correlated with the corrected total. The resultant reliability coefficient after their removal was .407. Participant scores were adjusted based on the removal of these items. After making the adjustments to participant scores, the mean scores for experimental and comparison groups increased to $M=71.43$ and $M=76.61$ respectively.

When Null Hypothesis I was examined in light of the item removal, the results did not change to a statistically significant degree. As indicated in Table 15, the interaction between time and group did not have a statistically significant effect on participant scores ($F=1.037$, $p>.05$).

Table 15

Multivariate Tests of the Time and Group Interaction Effect After Item Removal

Effect		Value	F	Hypothesis df	Error df	Sig.
Time * group	Wilks' Lambda	.933	1.037	2.000	29.000	.367

When Null Hypothesis II was examined in light of the item removal, the results did not change to a statistically significant degree. As indicated in Table 16, time still had a statistically significant effect on participant scores ($F=27.432$, $p<.01$)

Table 16

Multivariate Tests of the Time Effect After Item Removal

Effect		Value	F	Hypothesis df	Error df	Sig.
Time	Wilks' Lambda	.346	27.432	2.000	29.000	.000

Null Hypothesis III was examined in light of the item removal. While slight increases were noted, the increases did not change to a statistically significant degree. As described in Table 12, there were not statistically significant mean differences in immediate retention between the experimental and comparison groups ($F=.527$, $df=1,30$, $p>.05$).

Table 17

Summary of Analysis of Variance from Posttest I After Item Removal

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	217.101	1	217.101	.527	.473	.017
Intercept	118875.661	1	118875.661	288.797	.000	.906
Group	217.101	1	217.101	.527	.473	.017
Error	12348.688	30	411.623			
Total	131441.450	32				
Corrected Total	12565.789	31				

Null Hypothesis IV was examined in light of the item removal. Slight differences were noted; however, the increases did not result in statistically significant differences in delayed retention between the experimental and comparison groups ($F=.372$, $df=1,30$, $p>.05$) (see Table 18).

Table 18

Summary of Analysis of Variance from Posttest II After Item Removal

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	214.452	1	214.452	.372	.546	.012
Intercept	175308.968	1	175308.968	304.148	.000	.910
Group	214.452	1	214.452	.372	.546	.012
Error	17291.804	30	576.393			
Total	192815.225	32				
Corrected Total	17506.256	31				

Chapter Summary

This chapter presented an analysis of the data that were collected. The results from the data served as a basis to accept or reject the hypotheses posited earlier in this study. Null Hypotheses I, III, and IV were accepted, while Hypotheses II was rejected. After removing poor performing items from the analysis, the results were reexamined to noted any differences in findings. None of the hypothesis results changed to statistically significant degrees. In Chapter Five, the results will be interpreted more fully identifying what these results suggest for schema theory and provide recommendations for future studies.

CHAPTER FIVE - DISCUSSION

The purpose of this study was to examine whether adding a prior knowledge activation component to learning objects would help to improve the level of retention achieved by students. Learning objects are designed to be free of unnecessary instructional context to promote greater reuse. This lack of context provides a learning environment where students are unable to establish critical relationships between concepts introduced throughout a course of instruction (Pressley, Wood, Woloshyn, Martin, King, & Menke, 1992). This study sought to examine whether adding a series of questions on relevant prior knowledge at the beginning of learning objects could be used to establish relationships between the learner's prior knowledge and new concepts introduced in the learning object.

To examine the research question posed in this study, a pretest/posttest control group design was utilized. Participants currently enrolled in a Navy engineering curriculum were randomly assigned to two groups—an experimental group and a comparison group. The experimental group received a prior knowledge activation component which consisted of questions from an earlier module deemed to be relevant to the concepts in the learning object; whereas, the comparison group received no treatment.

Four hypotheses were tested. The hypotheses were tested using the method described in Chapter Three. The results indicated that the prior knowledge activation strategy did not result in statistically significant differences between the levels of retention gained by the experimental and comparison groups. This chapter explains the results presented in Chapter Four in light of prior research, discusses the limitations of this study and provides implications and suggestions for future research.

Interpretation of Hypotheses

Null Hypothesis I

Null Hypothesis I examined the interaction effect between time and group on participant scores. The data from this testing indicated that there was not a statistically significant interaction effect between time and group. This finding suggests that the treatment did not significantly affect the participants' level of retention between session I and session II. The purpose in looking at this hypothesis was to examine whether a combination of the time variable and the treatment would affect any statistically significant differences in scores. The data suggests that it did not. While the finding does contradict earlier research (Xin, Jitendra, and Deatline-Buckman, 2005), it does not suggest a need to modify the theory or that methodological error occurred. The testing conditions in this study differed from the Xin study in that the participants in their study were in a far more controlled environment; whereas in this study, the participants were not in as controlled an environment in that they continued with training between session I and II. The differences in testing conditions provide a realistic explanation for the differences in each study's findings.

Null Hypothesis II

Null Hypothesis II examined the effect of the treatment over time on the scores of participants in the experimental and comparison groups. The data from this test indicated that the treatment did have a statistically significant effect on student scores over time. This finding suggests that participants performed significantly better on posttest II than they did on the pretest and posttest I. The mean scores for both groups increased between

session I and session II. This finding does contradict findings from previous research where delayed retention tests were conducted after prior knowledge strategies had been employed (Hall & Edmondson, 1992), but it does not suggest a need to modify the theory or that methodological error occurred. Three explanations were considered in analyzing this finding. The first explanation considered was that retention improved between session I and session II. However, participants did not review or retake the lessons between session I and session II, so this conclusion was dismissed. A second explanation examined was that students experienced testing effect. This explanation was viewed as being possible, but unlikely given that students did not receive their scores or feedback on the correctness of their answers until the conclusion of session II. The third explanation considered was that the training topics participants were exposed to between session I and session II helped them to better understand the topics on which they were tested during posttest I. Initially when participants were exposed to material in the lesson, participants may not have been clear on the information presented. However, some of the follow-on topics may have provided additional context or meaning of the material participants were testing on during session I. The follow-on topics may have been able to prime or activate the schemata needed to better understand the material they were tested on previously. This explanation was accepted as the most likely cause for the increase in scores over time.

Null Hypothesis III

Null Hypothesis III posited that there would be no mean difference between the experimental and comparison groups. When this hypothesis was tested, the data indicated that there were no statistically significant differences in mean scores between the two

groups. This finding suggests the prior knowledge activation treatment did not affect statistically detectable differences in immediate recall between students who received a prior knowledge activation component and those who did not. This finding does contradict the findings in some of the earlier studies (Dwyer & deMelo, 1984; Brown et al, 1996) where students had shown statistically significant differences in their recall, but differences in instructional formats between the current study and prior studies may offer an explanation for the contradiction in findings. It should be noted that the time proximity of testing and instruction with learning objects differs from the forms of instruction used in earlier studies. Because Navy learning objects are typically about an hour's worth of instruction and students complete the posttest immediately following the content, the time gap between instruction and testing is relatively short. With students recently being exposed to the learning content, it is difficult to determine whether the posttest is actually measuring retention or recency effect. While this finding does not support schema theory or the trends of earlier studies, additional studies with similar findings would be required before a modification to the theory could be suggested. However, this finding does highlight time proximity as one of the limitations with assessing learner retention in learning objects.

Null Hypothesis IV

Null Hypothesis IV posited that there would be no mean difference in the delayed retention between the experimental and comparison groups. The results indicated that there were no statistically significant differences in the mean scores between the two groups. This finding suggests the prior knowledge activation treatment did not affect statistically detectable differences in delayed recall between students who received the

prior knowledge activation component and those who did not. It was expected that scores would have decreased for both groups, but the opposite occurred. The mean scores increased for both groups; however, what should be noted is the mean score for participants in the comparison group was higher than participants in the experimental group. This finding suggests that participants in both groups gained a better understanding of the material between posttest I and posttest II. For the students whose scores either remained the same or decreased, this either indicates either a decay in retention or that students did not try as hard on posttest II as they had on posttest I. groups. This finding does contradict findings from previous research where delayed retention tests were conducted after prior knowledge strategies had been employed (Fraser & Schwartz, 1975), but it does not suggest a need to modify the theory or that methodological error occurred.

Limitations

This study attempted to address all of the threats to internal and external validity commonly associated with educational research. Limitations were however noted in the internal validity of the study. The internal validity of this study was limited due to sample size, maturation, and testing effect.

Sample Size

Originally, there were seventy-five participants planned and confirmed with the Engineering school where the study was conducted. Unfortunately, due to administrative constraints discovered in the middle of the study, the availability of students meeting the criteria established for the sample was not able to be supported. The Engineering school

could only support 32 participants. As a result, the effect size and statistical significance of the results were likely affected by the small sample size.

Maturation

During the course of the study, participants continued with their Engineering training between session I and session II. Because of the costs associated with students being in training each day, it was fiscally unfeasible to stop participants from their Engineering training to support the study.

As students progress through their training, they typically gain a better understanding of some of the earlier topics because they have greater context of which the information applies (Clark, 2003). Substantial increases in scores were noted on posttest II which suggests that participants somehow increased their understanding of the material between sessions.

Testing Effect

Participants were exposed to the same questions on all three instruments. It is possible that their score improvements may have been due to testing effect. The procedure in this study attempted to control for testing effect by not providing feedback or scores until the conclusion on session II. However, according to Gall, Borg, and Gall (1996), testing effect can occur simply by users experience taking the test.

Implications and Suggestions for Future Research

The findings from this study hold implications for the method in which assessments are designed in learning objects and the types of assumptions that can be made about what students actually gain. The time proximity of the instruction and

assessments makes it difficult to determine whether student performance can be attributed to retention or testing effect. Alternate assessment approaches need to be explored in order to reduce the threat of testing effect. The current model places severe limitations on the assumptions that can be made about what students have actually learn in learning objects. These implications hold true for future research in which learning objects and assessments are utilized.

Additional research is needed in this area to determine the efficacy of using questioning as a prior knowledge activation strategy in learning objects. One area that instructional design practice could benefit from additional research is the use of multimedia-based coaches to administer the questioning and feedback. This study utilized text exclusively to administer its prior knowledge activation component. In the previous research studies utilizing prior knowledge questioning, instructors were used to administer this strategy.

Research is also needed on utilizing other prior knowledge activation strategies in learning objects. Strategies such as using advance organizers or comparing the effectiveness of advance organizers to questioning would also offer the practice greater insight into what are the best approaches to activate prior knowledge.

The field would also benefit from a study identical to this one with another population where maturation could be better controlled, such as an academic setting. The previous research introduced in Chapter Two presents compelling evidence on the effectiveness of prior knowledge activation strategies, but this study was unable to produce similar results likely due to the limitations described earlier in the chapter.

Chapter Summary

Prior knowledge activation is an important part of the learning process. Before students are exposed to new material, effort should be placed in activating what students already know about relevant prior knowledge. There are many approaches that can be employed to activate prior knowledge; i.e. advance organizers, group discussions, etc. This study examined the use of questioning as a means to activate prior knowledge; the other approaches should be researched as well. This chapter provided an explanation of the findings described in Chapter Four, a discussion on the limitations of this study, and a description of the implications and suggestions for future research studies.

APPENDIX A: HUMAN SUBJECTS APPROVAL LETTER



February 9, 2007

Atsusi Hirumi, Ph.D. and
Kelsey Henderson
University of Central Florida
Department of Educational Research, Technology & Leadership
ED 320C
Orlando, FL 32816-1250

Dear Dr. Hirumi and Mr. Henderson:

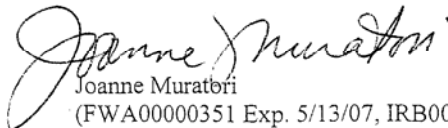
With reference to your protocol #07-4141 entitled, "The Effects of Prior Knowledge Activation on Learner Retention of New Concepts in Learning Objects," I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved on 2/7/2007. The expiration date for this study will be 2/6/2008.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,


Joanne Muratori
(FWA00000351 Exp. 5/13/07, IRB00001138)

Copies: IRB File

JM;jm

APPENDIX B: INFORMED CONSENT FORM

INFORMED CONSENT TO PARTICIPATE

"The Effects of Prior Knowledge Activation on Learner Retention of New Concepts in Learning Objects"

A research project is being conducted by Dr. Atsusi Hirumi and Mr. Kelsey Henderson to examine whether adding a prior knowledge activation component to learning objects will improve the level of retention achieved by students.

You are being asked to take part in this study by participating in two two-hour sessions over this week. During the first session, you will be asked to complete a short pretest, a lesson, a posttest. In the second session, you will be asked to complete another posttest. Please be aware that you are not required to participate in this research and you may discontinue your participation at any time without penalty. You may also omit any items on any items on the tests you prefer not to answer.

There are no risks associated with participation in this study. If you have further questions about your rights, information is available from the contact person listed at the end of this consent form.

Your responses will be analyzed and reported anonymously to protect your privacy. Potential benefits associated with the study include being able to improve online training courses. You must be 18 years of age or older to participate. If you agree to voluntarily participate in this research project as described, please indicate your agreement by printing and signing the second page of the consent form. Please retain this consent cover form for your reference, and thank you for your participation in this research.

If you have any questions regarding your participation in the study, please feel free to contact Dr. Hirumi using one of the following methods: email: hirumi@mail.ucf.edu; phone: 407.823.1760 or Mr. Henderson using of the following methods: email: kelsey@hendersoncts.com; phone: 850-384-3435.

If you believe you have been injured during participation in this research project, you may file a claim with UCF Environmental Health & Safety, Risk and Insurance Office, P.O. Box 163500, Orlando, FL 32816-3500 (407) 823-6300. The University of Central Florida is an agency of the State of Florida for purposes of sovereign immunity and the university's and the state's liability for personal injury or property damage is extremely limited under Florida law. Accordingly, the university's and the state's ability to compensate you for any personal injury or property damage suffered during this research project is very limited.

Information regarding your rights as a research volunteer may be obtained from:

Institutional Review Board (IRB)
University of Central Florida
Office of Research & Commercialization
12201 Research Parkway, Suite 501 - Orlando, FL 32826-3246
Telephone: (407) 823-2901

INFORMED CONSENT TO PARTICIPATE

"The Effects of Prior Knowledge Activation on Learner Retention of New Concepts in Learning Objects"

Print Name: _____

I have read the "Informed Consent to Participate" and agree to allow Dr. Atsusi Hirumi and Mr. Kelsey Henderson to use the information I provide to conduct their research.

Signature

Date

APPENDIX C: PRETEST (EXPERIMENTAL)

START HERE



INSTRUCTIONS: Circle the number corresponding to the correct answer for each question below.

Some of the topics learned in Module 1 are related to topics which will be presented in Module 2. So, before getting started, let's review a few things from Module 1.

The first topic we'll look at is Personnel Qualifications Standards (PQS). Try answering Question 1.

1. In the PQS book, where would you find line items requiring you to demonstrate knowledge of how to respond to an emergency, abnormal conditions or infrequent tasks?

1. Section 100
2. Section 200
3. Section 300
4. Feedback Report Form

The correct answer to Question 1 is Section 300. I hope that was one that you remember.

Next, let's think for a minute about Power Tools. Try answering Question 2.

2. If any doubt exists about the condition of any power tool, you should notify and show it to your _____.

1. Division Officer.
2. Supervisor.
3. Assistant.
4. Electrical Officer.

The correct answer to Question 2 is Supervisor. How did you do this time?

In Module 1, you also learned about emergency breathing equipment. Let's see how much you remember about this topic. Try answering Question 3.

3. Which Emergency Escape Breathing Device will operate for approximately fifteen minutes?

1. SEEDS
2. Ocenco
3. Scott
4. Jordan

GO TO NEXT PAGE

PRETEST – Module 2

Participant # ___

The correct answer to Question 3 is Scott. Did you remember learning this one in Module 1?

Okay, let's try one more. This time let's look at the topic, Repair Locket Equipment. Try answering question 4.

4. Which of the following tags/labels prohibits operation of equipment that could endanger personnel or equipment?

1. Out of Commission Label
2. Danger Tag
3. Out of Calibration Label
4. Caution Tag

The correct answer to Question 4 is Danger tag. Great job!

The next set of questions will test you to see how much you know about the information you will be presented in Module 2. Try your best to answer each of the questions below.

5. What fitting must have the Commanding Officers permission to open?

1. Circle Zebra
2. X-ray
3. Circle Yoke
4. Zebra

6. Piping, throughout the drainage system, is made up of

1. Aluminum.
2. PVC.
3. Iron.
4. Copper-nickel or galvanized.

7. The following are the Fire Watch' s duties and responsibilities EXCEPT:

1. inspect all sides of the bulkhead or deck, ensuring safe distance of combustibles.
2. signal the hot worker in the event of fire.
3. certify the space as Gas Free.
4. know the designation and location of the compartment where he is standing watch.

8. What is the first step in securing the Portable Exothermic Cutting Unit (PECU) in an emergency?

1. Close the oxygen cylinder valve
2. Adjust the oxygen regulator
3. Release the torch oxygen lever
4. Remove torch quick disconnect from battery assembly

GO TO NEXT PAGE

9. Who is responsible for organizing and personally directing training of repair five?

1. Commanding Officer
2. Damage Control Assistant
3. Chief Engineer
4. Executive Officer

10. Who sets and maintains the boundaries, and removes and relocates flammables?

1. Messenger
2. Boundary man
3. Investigator
4. Access man

11. The team responsible for exposed ordinance is the _____ team.

1. Munitions Disposal
2. Weapons Recovery
3. Ordinance Disposal
4. Crash and Salvage

12. Removal of water from flooded compartments, is the responsibility of the _____ team.

1. De-watering
2. Rescue and Assistance
3. Emergency Hull Repair
4. At-sea Fire Party

13. What is the minimum time that a Fire Watch needs to remain on station after a completion of hot work operation?

1. 5 minutes
2. 30 minutes
3. 1 hour
4. 8 hours

14. Main Drainage systems on smaller ships usually _____.

1. run fore and aft on the centerline.
2. run forward on the DC deck.
3. forms a loop within engineering compartments.
4. are not used on smaller ships.



INSTRUCTIONS: This ends your Pretest. Please raise your hand to let the Proctor know that you have completed the Pretest.

APPENDIX D: PRETEST (COMPARISON)

START HERE



INSTRUCTIONS: Circle the number corresponding to the correct answer for each question below.

1. What fitting must have the Commanding Officers permission to open?

1. Circle Zebra
2. X-ray
3. Circle Yoke
4. Zebra

2. Piping, throughout the drainage system, is made up of

1. Aluminum.
2. PVC.
3. Iron.
4. Copper-nickel or galvanized.

3. The following are the Fire Watch' s duties and responsibilities EXCEPT:

1. inspect all sides of the bulkhead or deck, ensuring safe distance of combustibles.
2. signal the hot worker in the event of fire.
3. certify the space as Gas Free.
4. know the designation and location of the compartment where he is standing watch.

4. What is the first step in securing the Portable Exothermic Cutting Unit (PECU) in an emergency?

1. Close the oxygen cylinder valve
2. Adjust the oxygen regulator
3. Release the torch oxygen lever
4. Remove torch quick disconnect from battery assembly

5. Who is responsible for organizing and personally directing training of repair five?

1. Commanding Officer
2. Damage Control Assistant
3. Chief Engineer
4. Executive Officer

GO TO NEXT PAGE

6 Who sets and maintains the boundaries, and removes and relocates flammables?

1. Messenger
2. Boundary man
3. Investigator
4. Access man

7. The team responsible for exposed ordinance is the _____ team.

1. Munitions Disposal
2. Weapons Recovery
3. Ordinance Disposal
4. Crash and Salvage

8. Removal of water from flooded compartments, is the responsibility of the _____ team.

1. De-watering
2. Rescue and Assistance
3. Emergency Hull Repair
4. At-sea Fire Party

9. What is the minimum time that a Fire Watch needs to remain on station after a completion of hot work operation?

1. 5 minutes
2. 30 minutes
3. 1 hour
4. 8 hours

10. Main Drainage systems on smaller ships usually _____.

1. run fore and aft on the centerline.
2. run forward on the DC deck.
3. forms a loop within engineering compartments.
4. are not used on smaller ships.



INSTRUCTIONS: This ends your Pretest. Please raise your hand to let the Proctor know that you have completed the Pretest.

APPENDIX E: POSTTEST I

START HERE



INSTRUCTIONS: Circle the number corresponding to the correct answer for each question below.

1. What fitting must have the Commanding Officers permission to open?

1. Circle Zebra
2. X-ray
3. Circle Yoke
4. Zebra

2. Piping, throughout the drainage system, is made up of

1. Aluminum.
2. PVC.
3. Iron.
4. Copper-nickel or galvanized.

3. The following are the Fire Watch' s duties and responsibilities EXCEPT:

1. inspect all sides of the bulkhead or deck, ensuring safe distance of combustibles.
2. signal the hot worker in the event of fire.
3. certify the space as Gas Free.
4. know the designation and location of the compartment where he is standing watch.

4. What is the first step in securing the Portable Exothermic Cutting Unit (PECU) in an emergency?

1. Close the oxygen cylinder valve
2. Adjust the oxygen regulator
3. Release the torch oxygen lever
4. Remove torch quick disconnect from battery assembly

5. Who is responsible for organizing and personally directing training of repair five?

1. Commanding Officer
2. Damage Control Assistant
3. Chief Engineer
4. Executive Officer

GO TO NEXT PAGE

6 Who sets and maintains the boundaries, and removes and relocates flammables?

1. Messenger
2. Boundary man
3. Investigator
4. Access man

7. The team responsible for exposed ordinance is the _____ team.

1. Munitions Disposal
2. Weapons Recovery
3. Ordinance Disposal
4. Crash and Salvage

8. Removal of water from flooded compartments, is the responsibility of the _____ team.

1. De-watering
2. Rescue and Assistance
3. Emergency Hull Repair
4. At-sea Fire Party

9. What is the minimum time that a Fire Watch needs to remain on station after a completion of hot work operation?

1. 5 minutes
2. 30 minutes
3. 1 hour
4. 8 hours

10. Main Drainage systems on smaller ships usually _____.

1. run fore and aft on the centerline.
2. run forward on the DC deck.
3. forms a loop within engineering compartments.
4. are not used on smaller ships.



INSTRUCTIONS: This ends your Post test. Please raise your hand to let the Proctor know that you have completed the Posttest.

APPENDIX F: POSTTEST II

START HERE



INSTRUCTIONS: Circle the number corresponding to the correct answer for each question below.

1. What fitting must have the Commanding Officers permission to open?

1. Circle Zebra
2. X-ray
3. Circle Yoke
4. Zebra

2. Piping, throughout the drainage system, is made up of

1. Aluminum.
2. PVC.
3. Iron.
4. Copper-nickel or galvanized.

3. The following are the Fire Watch' s duties and responsibilities EXCEPT:

1. inspect all sides of the bulkhead or deck, ensuring safe distance of combustibles.
2. signal the hot worker in the event of fire.
3. certify the space as Gas Free.
4. know the designation and location of the compartment where he is standing watch.

4. What is the first step in securing the Portable Exothermic Cutting Unit (PECU) in an emergency?

1. Close the oxygen cylinder valve
2. Adjust the oxygen regulator
3. Release the torch oxygen lever
4. Remove torch quick disconnect from battery assembly

5. Who is responsible for organizing and personally directing training of repair five?

1. Commanding Officer
2. Damage Control Assistant
3. Chief Engineer
4. Executive Officer

GO TO NEXT PAGE

POST TEST – Module 2

Participant # _____

6 Who sets and maintains the boundaries, and removes and relocates flammables?

1. Messenger
2. Boundary man
3. Investigator
4. Access man

7. The team responsible for exposed ordinance is the _____ team.

1. Munitions Disposal
2. Weapons Recovery
3. Ordinance Disposal
4. Crash and Salvage

8. Removal of water from flooded compartments, is the responsibility of the _____ team.

1. De-watering
2. Rescue and Assistance
3. Emergency Hull Repair
4. At-sea Fire Party

9. What is the minimum time that a Fire Watch needs to remain on station after a completion of hot work operation?

1. 5 minutes
2. 30 minutes
3. 1 hour
4. 8 hours

10. Main Drainage systems on smaller ships usually _____.

1. run fore and aft on the centerline.
2. run forward on the DC deck.
3. forms a loop within engineering compartments.
4. are not used on smaller ships.



INSTRUCTIONS: This ends your Post test. Please raise your hand to let the Proctor know that you have completed the Posttest.

APPENDIX G: STUDY VERBATIM

STUDY VERBATIM

My name is Kelsey Henderson and I am a doctoral student at the University of Central Florida. I am working with my professor, Dr. Atsusi Hirumi, to examine what effects asking students questions on information they already know has on them learning new information in computer based training

You were selected to participate in this study because each of you is currently enrolled in the Basic Engineering Common Core (BECC) course. We are interested in seeing how some of the information you learned in Module 1 of BECC can assist you in learning information in the later Modules in BECC.

Your participation in the study will help to improve your learning experiences in future training courses.

We will be meeting for two sessions this week. Today's session will last for about two hours. During the session, you will be given a pretest, lessons, and a posttest. After completing the posttest, you are dismissed. On Friday, you will return for session two. Session Two will last for about an hour. During session two, you will take another posttest. Following the posttest, you will receive your scores and be excused from the session.

You will not be penalized for the scores you receive this week, but any lessons you complete this week do not have to be completed again.

//Your participation in this week's study is voluntary. If you do not wish to participate in //the study, please raise your hand and you will be excused from the study.

[Pause]

If any students leave, remove their names from the list and re-run Randomizer.com numbers.

To indicate your agreement with participating in the study, please print and sign your names on page 2 of the form titled, INFORMED CONSENT TO PARTICIPATE, provided to you when you entered the room. After you print and sign the form, please look at me so that I know you are done. Keep the top page for your records, but I will need the second page.

[Pause]

Please pass the forms to your left and I will collect them from the person on the end.

[Pause]

Okay, let's begin. When you came in, you were given a number. If you have forgotten that number, please refer to the right corner of your copy of the consent form. If I call your number, please stand.

2,8,9,10,12, 16,17,18,22,24,25,26,28,31,32,33,34,37,38,39,41,42,43,47

[Hand out Exp. Copy of Pretest to these students.]

Does everyone whose number I called have a Pretest?

For everyone whose number I did not call, please stand.

[Hand out other version of Pretest to the remaining students.]

Does everyone in the room have a Pretest?

Be sure to place the number I gave you in the Participant ID # field on your test.

Complete the Pretest. Once you are done, please raise your hand and I will come by to pick up your Pretest.

Are there any questions?

If you have any questions while you're going through the materials, please raise your hand and I will come to you.

You are going to complete lessons 18, 20, 21, 22, 24, 33, & 34. After you complete these lessons, please raise your hand and I will bring you a copy of the Posttest. If you have already completed any of these lessons, you may either review them or skip them during this session.

At 8:30, if anyone is still working on the lessons, I am going to ask that you stop working on the lessons and begin taking the posttest.

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