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Cognitive memory effects on non-linear video-based learning

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COGNITIVE MEMORY EFFECTS ON NON-LINEAR VIDEO-BASED LEARNING

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ABSTRACT

During an informative learning process, information, material, facts and ideas are typically conveyed in a linear arrangement. Individuals are frequently distracted during this process with their attention being diverted to an interruption (Internet, phone call, etc). When presented with any new information, the mind evolves through problem solving and evaluation procedures. The way in which that information is processed and perceived depends on: (a) original presentation (b) examination of material and (c) an individualistic measurement of success. However, when faced with an interruption, the person is forced to deal with non-linear arrangement of information. This research investigates nonlinear presentation or seeking of material and the effects in optimizing memory retention.

This study (1) analyzed the cognitive consequences of non-linear forms of information paths in comparison to standard/linear paths (2) investigated the user's knowledge acquisition and control through non-linear paths during navigation while being interrupted; and, (3) determine how this non-linear presentation of instructions effect the overall learning experience. The research specifically focused on the performance levels under one of four conditions (procedural/segmented, procedural/non-segmented, non-procedural/segmented, or non-procedural/non-segmented) while interacting with a distributed web-based learning environment.

The population of this study included 62 college students taking a 20 minute web-based session. Each student completed a background questionnaire, video assessment questionnaire, working memory test, work load test, a comprehension test and a learning style test. The workload test given was the NASA-TLX which examines the "workload" experienced during the web-based session. The learning styles test was the Group Embedded Figures Test (GEFT), which classified participants as either field independent or dependent. There was no significance in user performance levels between procedural / non-procedural tasks and segmented / non-segmented video types (p=0.1224). However, when comparing the means for each task type and technology type that procedural / segmented seemed to perform much higher than that of the other groups. There was marginal significance for performance level depending on individual learning styles (p=0.0838).

Key words:

Non-linear Information, Learning Styles, Computer-based Instructions, Interruptions, Distance Learning

1 INTRODUCTION

Learning is an unlimited process of obtaining information with an undefined amount of accumulated input and output information. An active learning experience can be one of a behavioral or cognitive approach, where a small amount of input is generated into an enormous amount of output or vice versa. By repeating this process, information accrues into knowledge and becomes a combination of learning experiences to that point (Learning, 2004). However, it is not simply basic addition since one learning event plus one learning event does not yield the exact equivalent of those two learning events. Rather, joining two learning events together creates a completely new knowledge. When the learning process is engaged, an individual reflects on what have already been learned causing disorderly jumps between whole and parts or parts and whole.

Information is typically conveyed in a linear arrangement during the learning process. Hypermedia learning is quickly becoming the newest tool in educational environments by allowing the user to explore, question, invent, and discover all based on their individual needs. When presented with new information, a person evolves through problem solving and evaluation procedures by analyzing the new material based on prior material. Through cognitive and behavioral activities, the individual can then comprehend encoding characteristics connect to type and structure of information and make necessary assessments of that material (Learning Process, 1997).

However, the liberal configuration of hypermedia can become problematic for some learners and result in disrupted learning (Chen, 2001). In the recent past, researchers have found significant evidence of hypermedia learning and differences that exist within genders (Leong and Al-Hawamdeh, 1999) and cognitive styles (Shih and Gamon, 1999, and Kim, 2001). These differences are attributed to a distinct learning strategy, the way in which a person perceives and processes new information, similar to that of a cognitive style (Ford and Miller, 1996). An individual's cognitive style plays an important role when developing learning skills within hypermedia-based learning environment and refers to habits involving processing, receiving, retaining, and analyzing information (Messick, 1976).

This research explored the relationships between human controlled non-linear learning and performance. To accomplish this, it was essential to establish a comprehensive analogy of linear and non-linear information processing from an assessment of literature and development a robust cognitive flowchart illustrating how learners view and process new information.

2 USER DIFFERENCES, HYPERMEDIA, AND LEARNING

Users differ in the manner in which they go about learning new material. As well, new technologies have afforded people new methods for transmitting information to learners. In this section, individual learning styles along with the new technologies for learning are discussed.

2.1 Cognitive Styles

A learning style is an individual's preferred way of learning. It is defined as combination of cognitive, affective, and physiological traits that indicate individual learning perceptions and responses in a learning environment as predictors of behavior (Isemonger and Sheppard, 2003). The overall pattern provides direction to the learning process by creating instructional methods that are appreciated by some students and despised by others (Oxford, 2003). When the presentation of material corresponds to individual learning styles, the student experiences a higher level of understanding and a more positive attitude toward the material (Santo, 2004).

A variety of tools have been developed to detect an individual's specific learning style. One method is the "Learning Styles Inventory" (Hayden and Brown, 1985) based on Kolb's learning cycle which categorizes individuals into one of the seven groups of intelligences: body/kinesthetic, interpersonal, intra-personal, logical/mathematical, musical/rhythmic, verbal/linguistic and visual/spatial. Another method is the "Learning Styles Questionnaire" (Honey and Mumford, 1986) which was based on Kolb's learning cycle, but categorizes the learner as: activists, reflector, theorists, or pragmatists. A third method is the Group Embedded Figures Test, which has been widely used in literature. This method of classifying different learning styles into field-dependent and field-independent is a concept investigated during the Gestalt movement. It evolved into a wide range of applications within different fields of education. Extensive studies and investigations by Witkin et al (1979), Abraham (1985), and

Chapelle (1995) were conducted to formulate a distinct tendency of either external or internal frame usage in information processing. Table 1 illustrates a comprehensive listing of different attributes associated with field-independent and field-dependents groupings.

Table 1. Characteristics of field-dependent and field-independent learners

Field-Dependent	Field-Independent
Difficult to restructure new information	Easy to reorganize new information
Social orientation	Self-structure orientation
Global approach to problem solving	Analytical approach to problem solving
Prefer collaboration and group work	Prefer working alone
Weak proportional reasoning skills	Strong proportional reasoning skills
Externally directed	Internally directed
Conventional	Individualistic
Accept ideas as presented	Accept ideas once strengthened by analysis
Influenced by other opinions	Not easily influenced by others opinion
Learn material related to human content better	Learn material related to abstract concepts better
Extrinsically motivated	Inherently motivated
Passive	Competitive
Remember faces	Remember names
Have trouble understanding visual cues	Understand visual cues and are better at math
More likely to be female	More likely to be male

Adapted from Chen, 2001; Chen and Macredie, 2002; Shih and Gamon, 1999 and Santo, 2004.

The Group Embedded Figures Test (GEFT) is widely accepted within educational systems (Chen and Macredie, 2002). It measures and identifies field-dependence or field-independence by classifying each learner into a preferred learning classification (Chun-Shih and Gamon, 2002). The test evaluates cognitive functioning by exploring analytical ability, social behavior, defense mechanisms and problem solving styles. The primary goal is to diagnose an individual's ability to learn and perform on non-perceptual tasks based on performance on a perceptual task (Santo, 2004).

The classification into one of these two styles is just that, a grouping. It does not imply that one learner is better than the other; they are both equally good learners. Rather, it emphasizes that characteristics within field-dependence and field-independence affect the success of certain learning situations. Educators should be equipped and responsive to situations when presented with learning styles differences among students (Chun-Shih and Gamon, 2002).

2.2 Distance Learning

The development of hypermedia learning techniques have brought available resources into individuals' lives and created a new concept of distance learning. It is "a process that creates and provides access to learning when time and distance separate the source of information and the learners" (Zhang, 1998).

Research (Moore et al, 1990; Verduin and Clark, 1991) has compared distance learning education to traditional face-to-face instructional learning and found that teaching and studying at a distance can be as effective as traditional instruction when the methods and technologies used are appropriate for the specific task and there is a balanced interactive relationship between the teacher and the student. However, it is debatable as to whether different environments within distance learning affect an individual's comprehension when compared to a traditional circumstance. In distance learning, individuals are placed in a situation with hypermedia text formatting which is unconventional to traditional formatting. The learner is also placed in a setting more susceptible to a variety of different interruptions compared to that of a controlled class-room environment.

Distance learning has developed into an alternative form of education for those individuals seeking training and skill enhancement without leaving home. Table 2 demonstrates its acceptance throughout the educational field with a tremendous amount of expansion in the recent past.

Table 2. Four Generations of Distance Education Development

Generation	Period	Media	Primary contact	Interaction
First	1850-1960	Print, Radio, TV	One-way Interaction	Teacher-Student
Second	1960-1985	All Medias listed above plus: Audio & Video tapes, Fax	One-way Interaction	Teacher-Student
Third	1985-1995	All Medias listed above plus: E-mail, chat, bulletin boards, Computer Network & Programs Audio & Video Conferencing	Two-way Interaction	Teacher-Student All Students
Fourth	1995-Future	All Medias listed above plus: Desktop Video Conferencing	Two-way Real Time Interaction	Teacher-Student-All Students

Source from Sherron & Boettcher, 1997.

2.2.1 <u>Hypermedia Learning</u>

Hypermedia is modern educational technology with attractive interfaces and flexibility that conforms to the user's individual needs and interest. The format of this information contrasts drastically with traditional methods by an intentionally nonlinear approach to presenting material. For example, a traditional learning environment.

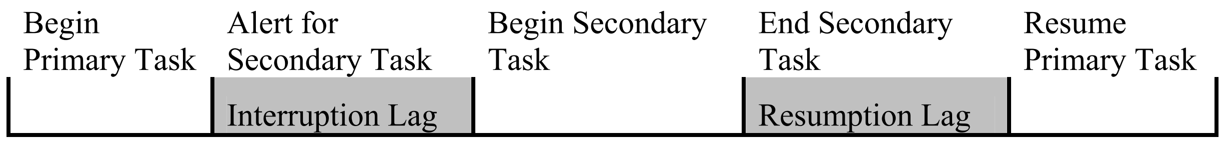
The author(s) would structure involving textbooks. They organize a logical progression of how information is acquired and comprehended by placing proceeding chapters dependent on previous chapter information. In a multimedia environment, the user has the ability to select the progression of the information having more control over the learning situation (Lawless and Brown, 1997). This formulates an exclusively unique learning experience.

There has been a profound amount of emphasis placed on the relationship between field-dependent learners and nonlinear information formatting in hypermedia settings. Some studies have found that field-dependent students took a more linear approach when dealing with computers (Reed and Oughton, 1997). They had an obvious disadvantage to field-independent learners in information seeking when material was not conveyed through interface design (Chang, 1995) and experienced prevalent problems of disorientation (Nielsen, 1995). However, other studies by Day et al (1997) and Liu and Reed (1994) have found no negative effects on students in relation to achievement within web-based instructions. In fact, they concluded positive effects on student's over-all learning experience.

2.2.2 <u>Effects of Interruptions</u>

In general, an interruption is "an externally generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task" demanding abrupt distribution of attention (Corragio, 1990 cited in Langan-Fox et al, 2002 p. 112). During a computer-aided mental task, an interruption can influence a skilled cognitive task by negatively affecting a person's performance level (Burmistrov and Leonova, 2003). Findings by Bailey et al (2003) concluded that interruptions: (1) increased a user's performance time; (2) created a level of annoyance based on content of primary material and amount of time secondary information was displayed; (3) created an increased level of anxiety when performing the task; and (4) caused users to report a higher complexity level for the task when interrupted.

As illustrated in Figure 1, when a person is presented with an interruption, that individual must divert his/her attention away from the imminent task and direct attention toward the other task.



Sourced by Trafton et. al, 2003

Figure 1. The Interruption and Resumption Process, involving a Primary (interrupted) and a Secondary (interrupting) Task.

Despite various scenarios of an interruption process or characteristics, such as content, timing, frequency, duration, and type of main task interrupted (Langan-Fox et al, 2002) the time line seems to illustrate the fundamental opportunities and constraints. A secondary task disturbs the primary task, which is the ongoing job. The interrupted lag refers to the time it takes from notification of secondary task to actual response. For example, if you were working on the computer and the phone rings, the interrupted lag time refers to the time between hearing the phone ring and answering the phone. Once the phone conversation is terminated, that person will resume back to the initial task. This is referred to as the resumption time; time from leaving the secondary task to restarting the primary task (Trafton et al, 2003).

2.2.3 Influence of Memory

Memory is a fundamental component in information-processing, which controls and maintains the learning development over time with individual differences giving some insight to retention (Langan-Fox et al, 2002). These individual differences within the working memory can set either limitations or potential knowledge capabilities (Kyllonen, 1996). Some research

(Ericsson and Chase, 1982 and Ericsson et al, 1993) has shown that memory proficiency can be learned or practiced and is often limited to a specific task or field.

3 RESEARCH GOALS

3.1 Purpose and Objectives

The goals of this research were to study the cognitive consequences of non-linear learning in comparison to that of standard/linear learning. The target of the research was to (1) investigate the knowledge acquisition and the user's control while navigating through non-linear information paths and (2) determine how this non-linear presentation of instructions affect the overall learning experience. The experiment looked at a variety of different learning conditions within a non-linear system while investigating affects on users' performance levels. By comparing these results to standard linear forms, the objective is to improve and advance technology for non-linear learning environments by enhancing student’s ability to freely explore while maximizing memory retention.

3.2 Conceptual Model

The conceptual model (Figure 2) exemplifies the literature findings that several variables including, a person's unique learning style and memory capacity along with the assigned task, technology type, and environment all share influential roles in affecting individual performance level scores.

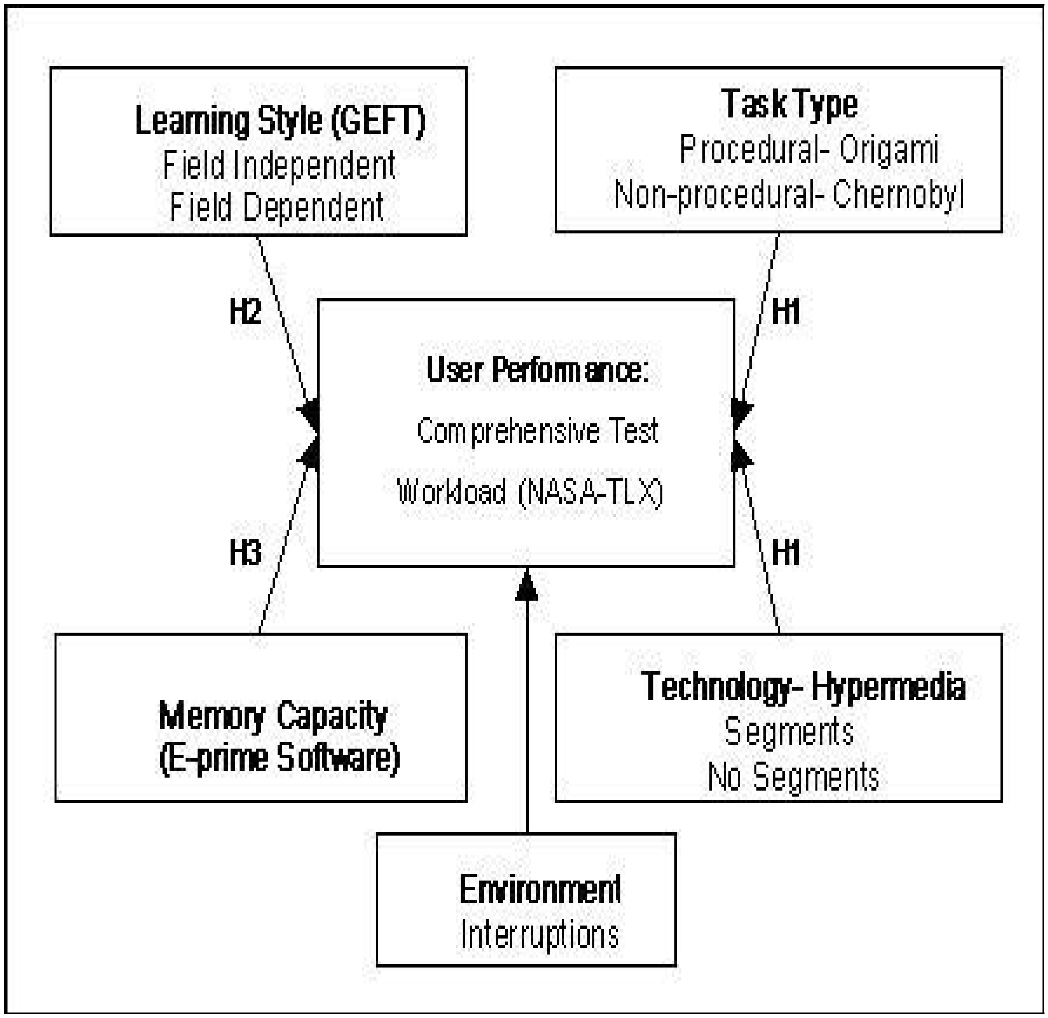


Figure 2. Conceptual Model for Research

4 METHOD

The research looked at individual cognitive perceptions and controlled performances while evaluating consequences when interacting with non-linear information formats. To complete this evaluation, a 2x2 fixed factor between subjects experiment was performed to determine direct affects of the independent variables on each of the dependent variables. In addition, analysis was performed for some variables of interest. Several variables were measured including user performance, memory capacity, learning style, and memory workload.

4.1 Hypotheses

The following list the hypotheses tested, the relationships between the independent and dependent variables, and the rationale behind testing the hypotheses:

I. No differences will exist in user performance levels between procedural or non-procedural tasks and segmented or non-segmented video types.

II. User performance level in task type and technology type will vary depending on the individual's learning style.

Investigating and predicting different learning styles, ranges of individual differences and variations within understanding (Price, 2004), forecast the performance within an activity to learn. In order to investigate the relationship between the independent or predictor variables and a dependent or criterion variable more closely, hypothesis II was tested.

III. User performance in task type and technology type will vary according to memory capacity and workload capacity.

Examining individual working memory can link deficiencies within cognitive performance level (Jefferies and Everatt, 2004).

4.2 Participants

The experiment involved 62 college students from various Psychology and Industrial Engineering courses within a one seminar time period. In all, 59 undergraduate and 3 graduate students participated. The participants vary in different areas of concentrations, physical science (engineering and natural science, 39 students) and social science (Arts and Humanities, 23 students). The mean age of the group was 21 with a standard deviation of 2 and the average ACT score was 24.82 with a standard deviation of 3.5. From the background questionnaire, 79.03% of the group reported watching entertainment type programs when watching TV roughly 6-10 hours a week. Within the group, 98.39% had a computer at home; 62.90% had access to a computer a work; everyone had access to a computer at school; and 98.39% reported using the computer everyday while using the internet 91.94% majority of the time.

4.3 Procedure

The study was conducted in the Computer Human and Machine Performance (ChaMP) Laboratory in room 3413 of the College of Engineering and Business Administration building. The experiment was composed of three parts: Orientation (~5 minutes), Data Collection (~20 minutes), and Performance Evaluation (~35 minutes).

Components of the experimental procedure are described below:

1. Orientation (~5 minutes)

A. Brief introduction-

Explains the purpose, goals, procedures, consent form (Appendix A) and web-site components within the experiment.

B. Background Information-

Questionnaire format compiled by the research team with questions related to computer skills and other technical knowledge, gender, ACT/SAT score, field of study, etc. (Appendix B).

2. Data Collection (~20 minutes)

Each participant was randomly selected to participant under one of the four operating conditions. During data collection, each participant was given a set of simple math problem (Appendix C) as interruption, which they were asked to perform. All of the participants received the same mathematical problems, however, order and timing was randomized for each. Figure 3 illustrates the time line of interruptions throughout the experiment. They then completed a series of assessment tasks and questionnaires in order to get a complete evaluation of their performance levels.

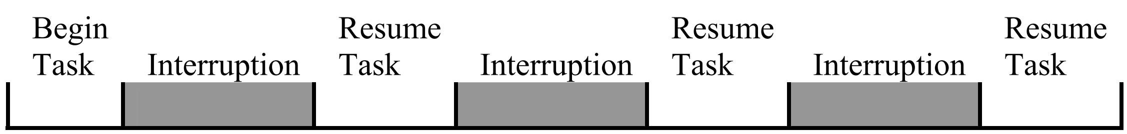


Figure 3. Time Line for Interruptions in Experiment

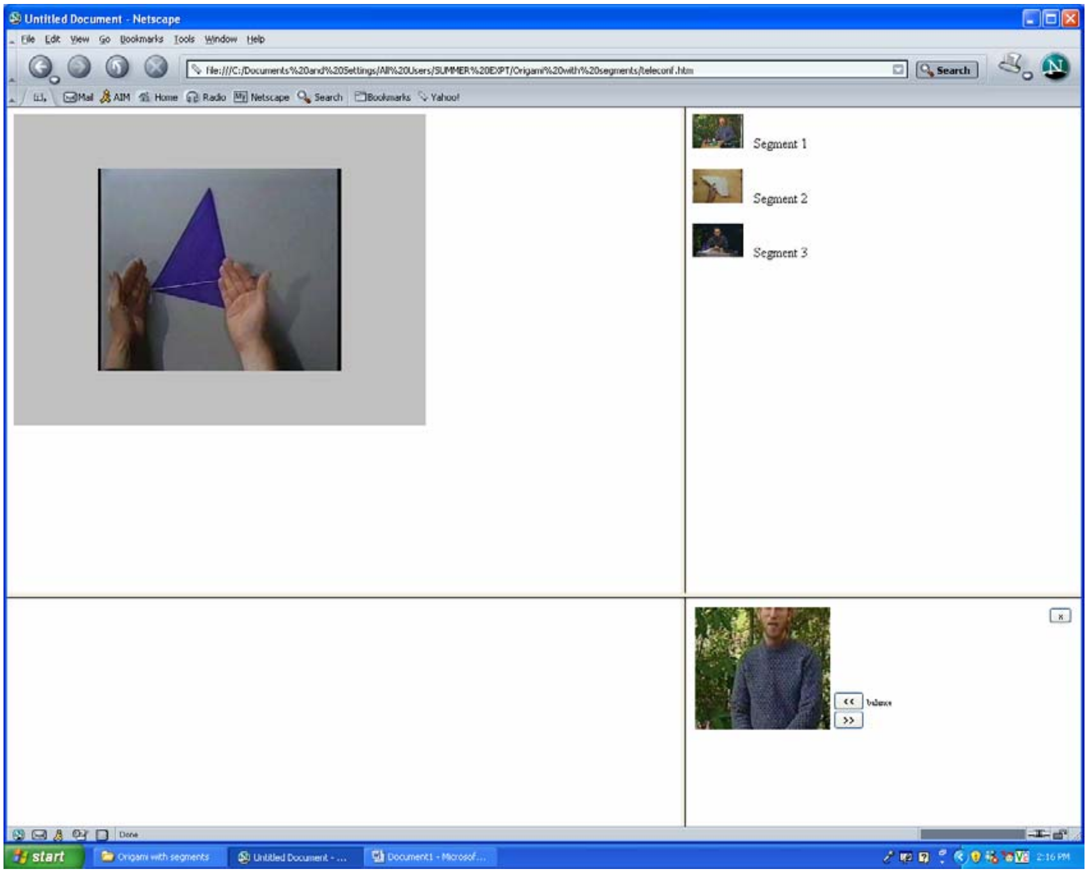


Figure 4. Screen Display

The system operates on a simple point and click interface and includes a 30 minute pre-recorded video intended to generate a learning process. Figure 4 is a screen shot of the experimental display. The upper left hand corner is the main video with segment markers placed in the upper right hand corner. When a segment is selected, that portion of the video is replayed in the lower corner.

The system operates under combinations of technology type and task type conditions as listed below:

A. Technology Type

- Segmented video-

  Time frame references are placed on the screen every 30 seconds while video is being played to indicate the video's progress. Each frame is represented by a still-shoot image corresponding to the beginning of that 30 second time frame. The user has the ability to click on any image in any sequence to playback the video accordingly.

- Non-segmented video-

This video is viewed without the option of time frame intervals being displayed on the screen. Therefore, the user does not have the ability to review any information.

B. Task Type

- Procedural video-

An instructional step-by-step video introducing the art origami and demonstrating the construction of three entry-level figures: a sail boat, a snake, and a bird.

- Non-procedural video-

An informative video highlighting the actual occurrence and the events following the Chernobyl Accident.

3. Evaluation (~35 minutes)

Several evaluation methods were used to investigate several different measures.

a. Working memory test by E-prime Software (~5 minutes)-

Measures an individual's limited processing capacity space (attention span) by asking them to retain one set of information while processing another set of material (Appendix D).

b. NASA-TLX Work load test (~5 minutes)-

Evaluates the participant's perception of performing a task in relation to mental demand, effort, and frustration level based on High to Low rating scale (Appendix E).

c. Video assessment (~5 minutes)-

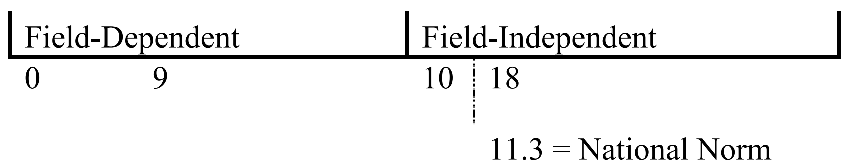
Questionnaire modeled after Lewis (1995) IBM computer usability satisfaction questionnaire (Appendix F).

d. Task Assessment (~5 minutes)-

- Comprehension test for Non-procedural Video Information- Multiple choice test format used to evaluate the amount of information obtained through the video (Appendix G).
- Task Completion test for Procedural Video Information-Application based task used to assess the amount of retained information from viewing the video (Appendix H). A post-hoc analysis of the participant's recorded procedural task will be evaluated for completion of task.

e. Witkin's Group Embedded Figure Test (~15 minutes)-

Measured individual cognitive style (Appendix I). The number of shapes correctly identified within the figures places an individual on the scale of field dependency as illustrated in Figure 5.



Adapted by O'Brien et al, 2001 & Dyer and Osborne, 2004

Figure 5. Field Dependency Scale

5 ANALYSIS METHODS, MODELS, AND RESULTS

To evaluate the three hypotheses, ANOVA and correlation analyses were performed as described below. The following tables (table 3-5) are descriptive statistical analysis of the populations scoring on task performance, Ospan memory test, and Nasa TLX workload test.

Table 3. Descriptive Statistics for Task Performance

*Note- Maximum score for Task performance was a 100%.

	Performance					
Technology/Task	**Procedural**			**NonProcedural**		
Without Segments	Male	Female	Total	Male	Female	Total
MEAN	90	60.77	66.25	66.67	68.75	67.65
STDEV	10	29.85	29.41	16.33	18.85	22.25
TOTAL	3	13	16	9	8	17
With Segments						
MEAN	88	81	83.33	76	64.44	68.57
STDEV	19.39	22.1	17.51	4.9	17.07	15.62
TOTAL	5	10	15	5	9	14

Table 4. Descriptive Statistics for Ospan Memory

*Note- Maximum score for Task performance was a 42%.

	Ospan (Memory)					
Technology/Task	**Procedural**			**NonProcedural**		
Without Segments	Male	Female	Total	Male	Female	Total
MEAN	32.67	25.46	26.81	31.33	30.12	30.76
STDEV	3.21	8.14	7.93	8.14	5.72	6.99
TOTAL	3	13	16	9	8	17
With Segments						
MEAN	31.8	28.5	29.6	18	26.22	23.29
STDEV	5.56	9.63	8.93	11.95	10.48	12.15
TOTAL	5	10	15	5	9	14

Table 5. Descriptive Statistics for Workload

*Note- Maximum score for Workload was a 100%.

	Workload					
Technology/Task	**Procedural**			**NonProcedural**		
Without Segments	Male	Female	Total	Male	Female	Total
MEAN	61.56	58.26	58.88	41.19	55.20	47.78
STDEV	18.36	18.66	18.03	13.63	19.10	17.25
TOTAL	3	13	16	9	8	17
With Segments						
MEAN	45.8	57.57	53.64	25.13	58.44	46.55
STDEV	16.87	18.9	19.74	16.44	15.12	23.17
TOTAL	5	10	15	5	9	14

5.1 Hypothesis I

A 2x2 analysis of variance was performed to determine the effects of the independent variables (technology/task) on the dependent variable. The ANOVA model below describes the statistical method used for evaluation with α=0.05 level of significance.

H1: No differences will exist in user performance levels between procedural or non-procedural tasks and segmented or non-segmented video types.

ANOVA Equation: $Y= \mu_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_{12} (X_1 * X_2) + \varepsilon$

Variables defined where:

Y= Performance Level

X_1= Task Type (Procedural/Non-procedural)

X_2= Technology Type (with Segments/without Segments)

$X_1 * X_2$= Interaction (Task type, Technology type)

The independent and dependent variables are defined for the hypothesis as:

<u>Independent Variables:</u>

1. Randomized

    System video type consisting one of the following conditions:

    a. Procedural Video without segments

    b. Procedural Video with segments

    c. Non-procedural Video with segments

    d. Non-procedural Video without segments

2. Controlled

    Interruptions

<u>Dependent Variables:</u>

3. Performance Level- Comprehension or Task Accomplishment

The following are the findings from the ANOVA analysis:

Table 6. Analysis of Variance Results for Hypothesis I

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Ratio**	**Prob > F**
Model	3	2911.13	970.377	2.0111	0.1224
Error	58	27985.644	482.511		
C. Total	61	30896.774			

Table 7. Effects Test Results for Hypothesis I

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F	Power	LSN
Procedural (P)/Nonprocedural (NP)	1	1	688.5358	1.427	0.2371	0.2171	169.374
Segment (S)/Non-segment (NS)	1	1	1250.015	2.5906	0.1129	0.3533	94.445
Procedural/Nonprocedural*Segment/ Non-segment	1	1	1006.527	2.086	0.154	0.2951	116.667

There is no significant evidence by which to reject H_I (p=0.1224) which could be accounted for in Table 7 in the power test where the LSN (less significant number) is higher than that of the sample size. However, Table 3 shows that when comparing the means for each task type and technology type that procedural/segmented seemed to perform much higher than that of the other groups.

5.2 Hypothesis II

A 2x2 analysis of variance was performed to determine the affects of the independent variables (technology, task and learning style) on the dependent variable. The ANOVA model below describes the statistical method used for evaluation with α=0.05 level of significance.

H2: User performance level in task type and technology type will vary depending on the individual's learning style.

ANOVA Equation**:** $Y= \mu_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_{12} (X_1 * X_2) + \varepsilon$

Variables defined where:

Y= Performance Level

X_1= Task Type (Procedural/Non-procedural)

X_2= Technology Type (with Segments/without Segments)

$X_1 * X_2$= Interaction (Task type, Technology type)

A stepwise selection was performed to determine which factors above should be included in the analysis model. At a reduced α=0.1 level of significance, where the model accepted a variable, it was concluded that only the three main effect variables (e.g., task type, technology types, and learning style) should be included in the model, thus all other interactions were excluded as a variable and the data collapsed to those effects (see Appendix J).

ANOVA Equation: $Y= \mu_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 +\beta_{123} (X_1{*} X_2{*} X_3) + \varepsilon$

Variables defined where:

Y= Performance Level

X_1= Task Type (Procedural / Non-procedural)

X_2= Technology Type (with Segments / without Segments)

X_3= Learning Style (Field Independent / Dependent)

$X_1{*}X_2{*}X_3$ = Interaction between task type, technology type, and learning style

To determine direct affects of the independent variables on the dependent variable within the equation the variables are defined for the hypothesis as:

<u>Independent Variables:</u>

1. Randomized

   System video type consisting one of the following conditions:

   a. Procedural Video without segments
   b. Procedural Video with segments
   c. Non-procedural Video with segments
   d. Non-procedural Video without segments

   Learning Style

   a. Field Independent

b. Field Dependent

2. Controlled

Interruptions

<u>Dependent Variables:</u>

3. Performance Level- Comprehension or Task Accomplishment

The following are the findings from the ANOVA analysis:

Table 8. Analysis of Variance Results for Hypothesis II

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	3	3322.119	1107.37	2.3292	0.0838
Error	58	27574.656	475.43		
C. Total	61	30896.774			

Table 9. Effects Test Results for Hypothesis II

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F	Power	LSN
Procedure/Non-Procedure	1	1	733.2062	1.5422	0.2193	0.231	156.91
NS/S	1	1	1091.034	2.2949	0.1352	0.319	106.28
I/D	1	1	1417.516	2.9816	0.0895	0.397	82.404

There is marginal significant evidence against H_{II} (p=0.0838). This could be contributed to the power test in Table 9 were the LSN is higher than that of the sample size also showing that only learning style (e. g, field dependency) is marginally significant as a main effect.

5.3 Hypothesis III

A Pearson r-value matrix was performed to establish relationships with a 0.05 level of significance between performance, memory capacity, and workload. The correlation matrix below describes the statistical method used for evaluation.

H3: User performance in task type and technology type will vary recording to Memory capacity and workload assessment.

Table 10. Correlation Matrix between Performance, Memory Capacity and Workload

Performance	Memory	Workload
Non-Procedural / Segment	0.1320	-0.3655
Non-Procedural / Non-Segment	0.0003	-0.0125
Procedural / Non-Segment	0.0225	0.1469
Procedural / Segment	0.0180	-0.1218

There is significant evidence against H_{III}. Table 8 correlation matrixes show no relationship between performance and memory nor performance and workload in any of the four conditions.

5.4 Post-Hoc Analysis

Some studies concluded spatial ability skills difference within gender (McGee, 1979); while other studies concluded that the differences were minor or non-existent (Tukey and Sclvaratnam, 1991). Therefore, an additional post-hoc analysis was performed to see if this variable of gender could explain performance differences. A total of 22 males performed on average a 76.81 as compared to a total 40 females with an average performance of 68.25.

A 2x2 analysis of variance was performed to determine the affects of the independent variables (technology, task and gender) on the dependent variable. The ANOVA model below describes the statistical method used for evaluation with α=0.05 level of significance.

ANOVA Equation**:** $Y= \mu_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_{12} (X_1 * X_2) + \varepsilon$

Variables defined where:

Y= Performance Level

X_1= Task Type (Procedural/Non-procedural)

X_2= Technology Type (with Segments/without Segments)

X_1*X_2= Interaction (Task type, Technology type)

A stepwise selection was performed to determine which factors above should be included in the analysis model. At a reduced α=0.1 level of significance, where the model accepted a variable, it was concluded that only the three main effect variables (e.g., task type, technology types, and gender) should be included in the model, thus all other interactions were excluded as a variable and the data collapsed to those effects (see Appendix K).

ANOVA Equation*:* $Y= \mu_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_{123} (X_1 * X_2 * X_3) + \varepsilon$

Variables defined where:

Y= Performance Level

X_1= Task Type (Procedural / Non-procedural)

X_2= Technology Type (with segments / without segments)

X_3= Gender (male / female)

$X_1*X_2*X_3$ = Interaction between task type, technology type, and gender

<u>Independent Variables:</u>

2. Randomized

   System video type consisting one of the following conditions:

   a. Procedural Video without segments
   b. Procedural Video with segments
   c. Non-procedural Video with segments

d. Non-procedural Video without segments

Gender

a. Male

b. Female

2. Controlled

Interruptions

<u>Dependent Variables:</u>

3. Performance Level- Comprehension or Task Accomplishment

The following are the findings from the ANOVA analysis:

Table 11. Analysis of Variance Results for Post Hoc Analysis

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	4	4053.686	1013.42	2.152	0.0861
Error	57	26843.088	470.93		
C. Total	61	30896.774			

Table 12. Effects Test Results for Post Hoc Analysis

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F	Power	LSN
Procedure	1	1	1042.7436	2.2142	0.1423	0.309	110.085
NS/S	1	1	1284.1049	2.7267	0.1042	0.368	89.89
Procedure*NS/S	1	1	652.5793	1.3857	0.244	0.212	174.36
Gender	1	1	1142.5561	2.4262	0.1249	0.334	100.693

There is marginally significant evidence (p=0.0838) for support of the model. However, table 10 shows that are no main effect variables and the LSNs are higher than that of the sample size.

A complete list of all participants' data and results can be found in Appendix L.

6 DISCUSSION

This research was originally initiated to increase online learning opportunities with the objective of relating it to real-life applications. Interruptions are encountered daily and break the learning process causing attention to be diverted to a secondary source. This study addressed the issue of interruptions by periodically presenting participants with mathematical problems. Due to the interruptions the participants could then use the segments to re-gain any information lose during this transfer. However, during the course of the research the issue of interruption variety (all math problems) and the difficulty of interruptions came into question. Researchers also examined the procedural set-up of the experiment in that all participants received interruptions, but only two of the four groups received the segmented features as aids to re-gain lose information. When participants were asked about the segmented feature, some reported that the segments only added more confusion to the learning process with all the distractions from interruptions.

Another area of interest during the analysis was the large amounts of standard deviations on performance between participants. This is due to the grading scale for both the procedural and non-procedural task. For the non-procedural, a ten question multiple choice test was distributed with each question being worth ten points. If the participant answered the question wrong, they received a minus ten points with no partial credit given. Trying to keep consistent with this grading scale from non-procedural to procedural, the procedural task was broken down into ten main steps each being worth ten points. If the participant performed a step incorrectly or skipped a step, they received minus ten points. This ten point grading systems created large gaps between participant's final scores.

7 CONCLUSION

As online learning opportunities increase, distance learning through hypermedia technologies stand to offer a significant contribution to the world of education by providing unique information layout. Teachers need to recognize eLearning outlets as an effective instructional design and understand that the format can deliver information which can be controlled and explored freely by the user in non-linear path offering an unmanaged flow in the learning process. This allows the user to branch out based on individual needs and styles. Messick (1976) established that an individual's cognitive style plays an important role when developing learning skills within hypermedia-based learning environment and transfers habits into processing, receiving, retaining, and analyzing information.

However, the unconventional configuration of hypermedia has been reported as being problematic for some learners (Chen, 2001). Developing the strategies necessary to teach and/or learn online successfully requires looking at the benefits, as well as, the limitations of cognitive perception and learning styles in a real world setting. This type of environment involves interruptions which are generally frequent in variety and form and are perceived as detracting from an individual’s performance success rating (Jett and George, 2003).

Though this research found no conclusive results to link performance results to learning styles, gender, task or technology type or segmentation, it explored new techniques afforded by the world of technology by utilizing concepts from distance learning (eLearning) and TiVo. It found an interesting bridge between procedural / segmented and the rest of the systems working conditions illustrated through the differing mean performance values (table 3) and relationship between performance and learning styles ($p=0.0838$). The computer and television have been a channel for millions of people and by combining these different elements from the two outlets the process could provide a prime source of information for training and educating in a school, work, or home environment.

Based on the findings of this research, future research should explore further the relationship between procedural tasks and segmented video. Hypothesis I illuminated that there may ultimately be a relationship between these two elements although not conclusive in this research. To further study the relationship between procedural segmented and non-segmented conditions would be beneficial in guiding the types of courses offered through distance learning. In addition, Hypothesis II found that learning style as an important variable in performance as has been reported in previous research and more experiments should be conducted to strengthen the power analysis. More exploration into interruptions would also be beneficial and add to validation of the research by conducting a group which encounters no interruptions. Thus as we developed eLearning applications, learning style must still remain at the forefront of our design considerations. Future research in eLearning must continue to stretch our imagination on the potential technology applications available to support learning in the cyberspace.

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APPENDIX A:

CONSENT FORM

Louisiana State University
Industrial and Manufacturing Systems Engineering (IMSE)
3413 CEBA, CHaMP Lab
(Please read the form carefully and ask questions about the purpose of the research, procedures, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear.)

CONSENT FORM

Cognitive and Affective Consequences of Nonlinear Information Seeking

PURPOSE AND BENEFITS

The focus of the study is to look at learning through video media. The purpose is to explore human controls on nonlinear information processing (Computer Based Tutorial) and its effects on the learning experience. Through participation, all students will receive class credit.

PROCEDURES

The experiment will take approximately 65 minutes. It consist of a working memory test (10 minutes), a background questionnaire on computer knowledge, gender, ACT/SAT score, etc. (5 minutes), a work load test (10 minutes), a video (25 minutes), a video assessment questionnaire on satisfaction, etc. (5 minutes), and a test based on information obtained through that video (10 minutes). Visual and audio recordings of the video pre-viewing segment will be captured for each experiment. You may refuse to answer any question in any test or questionnaire.

RISKS, STRESS, OR DISCOMFORT

The amount of stress and discomfort will be no different then that experienced in a class room setting working with computers.

OTHER INFORMATION

All data will remain in records as property of IMSE for the duration of 24 months. You have the opportunity to review any of your raw experimental data results within this period. All data will be kept confidential in a locked cabin within the IMSE department at Louisiana State University, whom is the only agency that has access to identifiable data. This data will be used to study correlation and variance between nonlinear learning methods and learning retention in memory.

RESEARCHERS AND CONTACT INFORMATION

Name	Title	E-mail	Phone #
Craig Harvey	Assistant Professor	Harvey@lsu.edu	578-5364
Larry Nabatilan	PhD Student	lnabat1@lsu.edu	
Katherine Comeaux	Graduate Student	kcomea1@lsu.edu	

SUBJECT'S STATEMENT

The study has been discussed with me and all my questions have been answered. I have read and understand the conditions above, and I consent to voluntarily participate in this research study. I realize I am free to withdraw from this study at any time or refuse my experimental data submission without penalty. I consent to the use of visual images (photos, videos, etc.) involving my participation in this research. If I have questions later about the research, I can ask one of the researchers listed above between 9am-4pm Monday-Friday. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Chairman, LSU Institutional Review Board, (225)578-8692. I agree to participate in the study described above and acknowledge the researchers' obligation to provide me with a copy of this consent form if signed by me.'

____________________ ______________________________

Printed name of subject   Signature of subject   Date

APPENDIX B:

BACKGROUND QUESTIONNAIRE

Background Questionnaire

Part A: Personal Information

Gender: ____________

Age: ____________

ACT/SAT Score: ____________

GRE Score (if graduate student): ____________

Degree(s) pursuing and/or complete: ________________________________

Type of Degree currently pursuing: Undergraduate Graduate PhD

Year of Study: First Second Third Fourth Fifth

Part B: Basic Exposure and Knowledge

Please circle one response that best represents your opinion to the following questions.

The average amount of time total spent watching TV each week?

0-5 Hours 6-10 Hours 11-15 Hours 16-20 Hours 20 or more

Content of material being viewed the **majority** of the time in TV programs is:

History based Entertainment Scientific Current Events Other:________

Portion of total time spent watching sitcoms?

1	2	3	4	5
None	Very Little	Moderate	Majority	All

Portion of total time spent watching movies?

1	2	3	4	5
None	Very Little	Moderate	Majority	All

Do you have access to a computer at home?

Yes No

Do you have access to a computer at work?

Yes	No

Do you have access to a computer at school?

Yes	No

How often do you use a computer?

Daily	2-3 a Week	Once a Week	Once a Month	Rarely Ever

The **majority** of the time when you work on the computer is mostly with:

The Internet	Word Processing Documents	Spreadsheet Documents	Other

APPENDIX C:

MATHEMATICAL PROBLEMS

1.) $\sqrt{625}$ =

2.) (32/4) - 3 =

3.) 3.07- 1.98 =

4.) 28 + 67 =

5.) (6*3) -5 =

APPENDIX D:

WORKING MEMORY TEST

In this experiment you will try to memorize words you see on the screen. This is very similar to the word memory task you did in the previous session of this study. However, to make it more difficult, you will have to do a second task between the presentation of each word. Specifically, you will have to solve simple math problems.

Here is an answer sheet that you will use to write down the words you remember.

You will see an equation and a word appear on the screen. Your job is to read the equation OUT LOUD, then verify if the answer provided is correct or not by saying "yes" or "no," and then immediately read the word that follows the equation OUT LOUD.

Let's take a look at an example, to make your task clearer. If I pressed the space bar and you saw the following:

IS 2 + 1 = 3 ? DOG

You would read the equation out loud, "Is 2 plus 1 equal to 3?" then you would say "yes," because 2 plus 1 DOES equal 3, and then you would immediately say "dog." When you say "dog" you should try to remember it for a later test.

After you say the word aloud, such as "dog," I will hit the space bar again, and you will see a new equation and word appear on the screen, for example:

IS 3 + 4 = 5 ? SNOW

Here, you would say, out loud: "Is 3 plus 4 equal to 5?... no.. snow." Here you would say "no" because 3 + 4 = 7, not 5. Don't forget to then always read the word that follows the equation out loud.

After some number of these equations and words, you will see three question marks appear in the center of the screen like this:

???

This is your cue to write down all the words that you saw in that set, in the same order you saw them in.

So, for this example, you would write "dog" in the first blank on your answer sheet, and "snow" in the second blank, going from left to right.

APPENDIX E:

WORK LOAD TEST

Task Load Index (NASA-TLX)

Subject RATING Instructions

In the most general sense, we are examining the "workload" that you estimate you experienced during the session today. Workload is a difficult concept to define precisely, but a simple one to understand generally. The factors that influence your experience of workload may come from the task itself, your feelings about your own performance, how much effort you put in, or the stress and frustration you felt.

Since workload is something that is experienced individually by each person, there are no effective "rulers" that can be used to estimate the workload of different activities. One way to find out about workload is to ask people to describe the feelings they experienced. Because workload may be caused by many factors, we would like you to evaluate several of them individually rather than lumping them into a single global evaluation of overall workload. This set of six rating scales was developed for you to use in evaluating your perceptions of performing different tasks. Please read the descriptions of the scales carefully. If you have a question about any of the scales in the table, please ask me about it. It is extremely important that they be clear to you. You may keep the description with you for reference during the experiment.

At the end of each session, you asked to rate the workload using the scales provided on the following pages. You will evaluate each session by putting an "|" on each of the six scales at the point that matches your perception by clicking the mouse. Each line has two endpoint descriptors that describe the scale. Notice that "PERFORMANCE" goes from "Good" to "Poor" whereas all other scales go from "Low" to "High". Consider each scale individually. Your ratings play an important role in the evaluation of this experiment and your active participation is essential to the success of this experiment.

Task Load Index (NASA-TLX)

Subject RATING Instructions

NASA-TLX RATING SCALE DEFINITIONS		
Title	Endpoints	Descriptions
MENTAL DEMAND	*Low/High*	How much mental and perceptual activity was required (e.g., thinking, deciding, calculating, remembering, looking, searching, etc.)? Was the task easy or demanding, simple or complex, exacting or forgiving?
PHYSICAL DEMAND	*Low/High*	How much physical activity was required (e.g., pushing, pulling, turning, controlling, activating, etc.)? Was the task easy or demanding, slow or brisk, slack or strenuous, restful or laborious?
TEMPORAL DEMAND	*Low/High*	How much time pressure did you feel due to the rate or pace at which the tasks or task elements occurred? Was the pace slow and leisurely or rapid and frantic?
PERFORMANCE	*Good/Poor*	How successful do you think you were in accomplishing the goals of the task set by the experimenter (or yourself)? How satisfied were you with your performance in accomplishing these goals?
EFFORT	*Low/High*	How hard did you have to work (mentally and physically) to accomplish your level of performance?
FRUSTRATION LEVEL	*Low/High*	How insecure, discouraged, irritated, stressed and annoyed versus secure, gratified, content, relaxed and complacent did you feel during the task?

Task Load Index (NASA-TLX)

Subject Weighting Instructions

Sources of Workload Evaluation

The evaluation you are about to perform is a technique that has been developed by NASA to assess the relative importance of six factors in determining how much workload you perceive for each task. The procedure is simple: You will be presented with a series of pairs of rating scales titles (for example, Effort vs. Mental Demands) and asked to choose which of the items was more important to your perception of workload in the session. See the description of each of the items on the following page.

<u>Indicate the Scale Title that represents the more important contributor to workload for the specific task under consideration by selecting the number next to the workload factor using the keyboard.</u>

After you have finished the entire series we will be able to use the pattern of your choices to create a weighted combination of the ratings from that session into a summary workload scale. Please consider your choices carefully and make them consistent with how you used the rating scales for evaluating the task. You will be given this tool after each session and each session should be evaluated independent of any other session. Don't think there is a correct pattern; we are only interested in your opinions.

If you have any questions, please ask them now. Otherwise, start whenever you are ready. Thank you for your participation.

APPENDIX F:

ASSESSMENT QUESTIONNAIRE

There were four different sets of assessment questionnaire based on experiment task type and technology type to which the participant was randomly assigned. The words highlighted in bold were subject to change depending on the experiment set.

Video Assessment Questionnaire

Please circle the response that best represents your opinion to the following questions.

Had you ever heard of the **Chernobyl / Origami** disaster prior to this video?

1	2
Yes	No

If yes to question #1, how would you rate your knowledge level?

1	2	3
Minimal	Average	Extensive

Was it easy to learn the current video-based process?

1	2	3	4	5
Very Easy	Easy	Borderline	Hard	Very Hard

Was the amount of time it took to learn the process acceptable?

1	2	3	4	5
Very Acceptable	Acceptable	Borderline	Unacceptable	Very Unacceptable

Was it easy to remember how to perform the current process?

1	2	3	4	5
Very Easy	Easy	Borderline	Hard	Very Hard

Was the amount of effort required to learn the current process acceptable?

1	2	3	4	5
Very Acceptable	Acceptable	Borderline	Unacceptable	Very Unacceptable

How effective was the current process for your learning needs?

1	2	3	4	5
Very Effective	Effective	Borderline	Ineffective	Very Ineffective

How would you rate the effort to perform this process compared to similar processes you may have used in the past?

1	2	3	4	5
A Lot Less Effort	Slightly Less Effort	Same Amount Of Effort	Slightly More Effort	A Lot More Effort

Did you find it easy to avoid making mistakes with the current process?

1	2	3	4	5
Very Easy	Easy	Borderline	Hard	Very Hard

If you make a mistake or encounter an error, is it easy to recover?

1	2	3	4	5
Very Easy	Easy	Borderline	Hard	Very Hard

Was the process easy for the task performed?

1	2	3	4	5
Very Easy	Easy	Borderline	Hard	Very Hard

How satisfied were you with your performance in learning the information?

1	2	3	4	5
Very Satisfied	Satisfied	Borderline	Unsatisfied	Very Unsatisfied

How useful was the process in helping you learn to information?

1	2	3	4	5
Very Useful	Useful	Borderline	Useless	Very Useless

Were you satisfied with the process in terms of amount of time to complete the task?

1	2	3	4	5
Very Satisfied	Satisfied	Borderline	Unsatisfied	Very Unsatisfied

Were you satisfied with this process in terms of effectiveness in learning the material?

1	2	3	4	5
Very Satisfied	Satisfied	Borderline	Unsatisfied	Very Unsatisfied

Were you satisfied with this process in terms of quality with which the tasks are performed?

1	2	3	4	5
Very Satisfied	Satisfied	Borderline	Unsatisfied	Very Unsatisfied

How effective does the current process of segmented videos seem to be?

1	2	3	4	5
Very Effective	Effective	Borderline	Ineffective	Very Ineffective

Comments on Effectiveness of Segments:

APPENDIX G:

NON-PROCEDURAL COMPREHENSION TEST

Please answer all questions based on the information provided in the Night-Line broadcast.

All of the following were likely hazards of the Chernobyl accident **EXCEPT:**

A. The contamination of the Kiev Water supply.

B. Many deaths in the United States.

C. Death of those living near Chernobyl.

D. A total melt-down of the nuclear reactor.

How did the Chernobyl accident compare to the Three Mile Island accident?

A. There were more deaths at the Three Mile Island plant.

B. The two disasters were about the same in their level of severity.

C. The accident at Three Mile Island was mild compare to the one at Chernobyl.

D. There was more of a cover-up of the Three Mile Island accident.

Which of the following is **NOT** a negative health effect of radiation?

A. Damage to many vital organs.

B. Death from thyroid cancer.

C. Risk of mutation

D. Abnormal growth in body size.

Which statement is true regarding the Soviet Union's dependence on nuclear energy, at the time of the Chernobyl accident?

A. Nearly 100% of the Soviet Union's energy was from nuclear power.

B. The Soviet Union was in the process of trying to lessen its dependence on nuclear power.

C. There was an abundance of coal and oil in the western part of the Soviet Union, so nuclear energy was not greatly needed.

D. The Soviet Union was in the process of increasing its reliance on nuclear energy.

Why were Western experts monitoring Soviet weather data in the days following the Chernobyl disaster?

A. Given the Soviet government's secrecy, it was the only way to measure of the spread of radiation away from Chernobyl

B. To provide corroborating evidence of the effect of the Chernobyl accident with official reports from the Soviet government.

C. To help warn the Soviet Union of an impending large thunderstorm that was heading toward Chernobyl.

D. To see if radiation could be spread by storm clouds.

What specific effect on the food-chain could a nuclear power plant disaster have?

A. Its effects would be very harmful at first, but would dissipate quickly.

B. The release of iodine into the environment could lead to thyroid cancer.

C. While the effect of the nuclear accident would kill many animals, a person could not get sick from eating an infected animal.

D. Animals would be affected but not plants.

According to the broadcast

A. Chernobyl was the most severe of two or three nuclear accidents to occur in the former Soviet Union.

B. Chernobyl was the only nuclear accident to occur in the former Soviet Union.

C. The Chernobyl accident resulted in a worst-case scenario, in terms of nuclear accidents. A complete melt-down.

D. The radiation from the Chernobyl accident would not spread to other countries.

The NightLine broadcast mentioned several examples of instances of the secrecy of the Soviet Union with regard to internal tragedies. Which one of these was **<u>NOT</u>** mentioned?

A. The accident at Kystym near the Ural Mountains.

B. The infrequent reporting of airplane crashes.

C. The report of the Chernobyl accident was buried in the later part of the official newscast, after awards and credits were listed.

D. The Soviet news broadcast did not report that a government commission would need to be set.

Which of the following statements was made about the Chernobyl nuclear power plant?

A. The reactor must have had a containment vessel to help protect against nuclear melt down.

B. It is about sixty miles south of the city of Kiev.

C. The reactor was originally built in the 1960's.

D. All of the above were stated in the NightLine broadcast.

Near the end of the broadcast the Soviet expert was asked what the economic fallout of the Chernobyl accident would be for the Soviet Union. Which of the following was his response?

A. He believed that there would be very little economic fallout.

B. He predicted that it would eventually lead to the fall of the Soviet Union.

C. He stated that the Soviet Union would suffer a major recession because of the accident.

D. He thought that the Soviet Union would find some way to profit from the negative effects of the accident.

APPENDIX H:

PROCEDURAL APPLICATION TASK

Origami- Paper Folding Evaluation
Subject ID _-_________-_______________ Date

Asked to please form the SNAKE from the best of their memory.

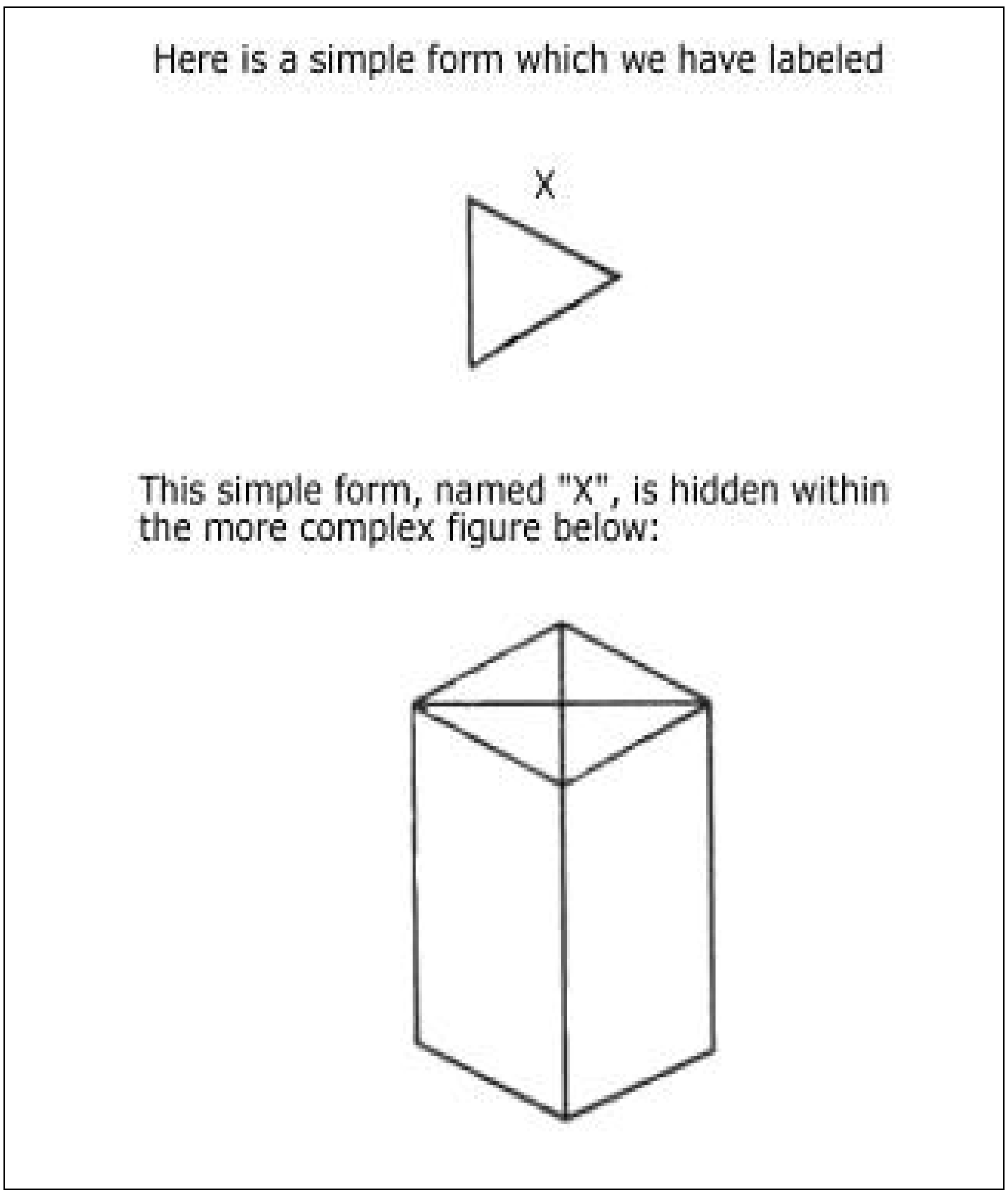
Fold Number	Rating	Comments
1- Diagonal Fold		
2- Top Fold		
3- Bottom Fold		
4- 2nd Top Fold		
5- 2nd Bottom Fold		
6- 3rd Top Fold		
7- 3rd Bottom Fold		
8- Fold Over		
9- Tail Fold		
10- Head Fold		
Over All Rating		

APPENDIX I:

GROUP EMBEDDED FIGURES TEST

The Group Embedded Figures Test (GEFT) has been used in research as a recognized tool for exploring analytical ability and testing cognitive functioning. The GEFT is a twenty-five item assessment used to measure an individual's field dependence / independence level. The objective was to find common geometric shapes positioned within a larger design illustrated in Figure 12 below.

Figure 6: Illustration of GEFT Sample Test Figure



APPENDIX J:

HYPOTHESIS II STEPWISE TABLES

Stepwise Fit / Stepwise Regression Control

Response: Performance

Probably to Enter = 0.250

Probably to Leave = 0.100

Table 13. Hypothesis II Stepwise Current Estimates

SSE	DFE	MSE	RSquare	RSquare Adj	Cp	AIC
26843.088	57	470.9314	0.1312	0.0702	5.3116023	386.379

Lock	Entered	Parameter	Estimate	nDF	SS	"F Ratio"	"Prob>F"
X	X	Intercept	72.82775	1	0	0	1
	X	Procedure{NP-P}	-4.19119	2	1647.76	1.749	0.1831
	X	NS/S{NS-S}	-4.56336	2	1948.74	2.069	0.1357
	X	Procedure{NP-P}*NS/S{NS-S}	3.300437	1	652.579	1.386	0.244
	X	Gender{F-M}	-4.64822	1	1142.56	2.426	0.1249
		Procedure{NP-P}*Gender{F-M}	0	1	515.309	1.096	0.2996
		NS/S{NS-S}*Gender{F-M}	0	1	0.04681	0	0.9922
		Procedure{NP-P}*NS/S{NS-S}*Gender{F-M}	0	3	1551.06	1.104	0.3556

Table 14. Hypothesis II Stepwise Step History

Step		Parameter	Action	"Sig Prob"	RSquare	Cp	p
1		I/D{D-I}	Entered	0.0932	0.0463	4.49	2
2		NS/S{NS-S}	Entered	0.1253	0.0838	4.03	3
3		Procedure{NP-P}	Entered	0.2193	0.1075	4.47	4

APPENDIX K:

POST HOC STEPWISE TABLES

Stepwise Fit / Stepwise Regression Control

Response: Performance

Probably to Enter = 0.250

Probably to Leave = 0.100

Table 15. Post Hoc Stepwise Current Estimates

SSE	DFE	MSE	RSquare	RSquare Adj	Cp	AIC
26843.088	57	470.9314	0.1312	0.0702	5.3116023	386.379

Lock	Entered	Parameter	Estimate	nDF	SS	"F Ratio"	"Prob>F"
X	X	Intercept	72.82775	1	0	0	1
	X	Procedure{NP-P}	-4.19119	2	1647.757	1.749	0.1831
	X	NS/S{NS-S}	-4.56336	2	1948.74	2.069	0.1357
	X	Procedure{NP-P}*NS/S{NS-S}	3.300437	1	652.5793	1.386	0.244
	X	Gender{F-M}	-4.64822	1	1142.556	2.426	0.1249
		Procedure{NP-P}*Gender{F-M}	0	1	515.3094	1.096	0.2996
		NS/S{NS-S}*Gender{F-M}	0	1	0.046806	0	0.9922
		Procedure{NP-P}*NS/S{NS-S}*Gender{F-M}	0	3	1551.058	1.104	0.3556

Table 16. Post Hoc Stepwise Step History

Step	Parameter	"Sig Prob"	Seq SS	RSquare	Cp	p
1	NS/S{NS-S}	0.1074	1317.046	0.0426		2
2	Gender{F-M}	0.1385	1088.883	0.0779		3
3	Procedure{NP-P}	0.1528	995.1781	0.1101		4
4	Procedure{NP-P}*NS/S{NS-S}	0.244	652.5793	0.1312		5

APPENDIX L:

PARTICIPANTS' RAW DATA

Table 17. Participant's Raw Data Information and Scores

Subject	Treatment	Gender	Age	ACT/SAT Score	Degree	Weekly TV	Type TV
ANS-001	ABC-NS	F	19	26	Mass Comm	2	E
ANS-002	ABC-NS	M	21	21	IE	1	E
ANS-003	ABC-NS	M	22	22	ME	2	O
ANS-004	ABC-NS	M	25		IE	2	O
ANS-005	ABC-NS	M	20	24	IE	2	E
ANS-006	ABC-NS	F	19	990	Psychology	1	E
ANS-007	ABC-NS	F	21	27	Psychology	1	C
ANS-008	ABC-NS	F	21	27	Biological Sci	2	E
ANS-009	ABC-NS	M	23		IE	3	E
ANS-010	ABC-NS	F	18	24	Undecided	2	E
ANS-011	ABC-NS	M	23	25	ME	3	E
ANS-012	ABC-NS	F	21	1100	IE	2	E
ANS-013	ABC-NS	M	22	1210	General Studies	3	E
ANS-014	ABC-NS	M	24	28	ME	2	S
ANS-015	ABC-NS	F	19	23	Biological Sci	1	E
ANS-016	ABC-NS	F	20	23	Mass Comm	1	E
ANS-017	ABC-NS	M	19	30	Business	4	E
AS-001	ABC-S	M	20	29	Mass Comm	1	E
AS-002	ABC-S	F	18	24	Microbiology	2	E
AS-003	ABC-S	F	18	30	IE	3	E
AS-004	ABC-S	M	23	19	General Studies	2	E
AS-005	ABC-S	F	18	21	Nursing	1	E
AS-006	ABC-S	M	21	26	CHE	2	E
AS-007	ABC-S	M	21	30	IE	1	C
AS-008	ABC-S	F	18	27	Architecture	2	E
AS-009	ABC-S	M	22	29	ME	1	C
AS-010	ABC-S	F	23	1230	IE	1	C
AS-011	ABC-S	F	18	30	IE	1	E
AS-012	ABC-S	F	19	1280	IE	1	E
AS-013	ABC-S	F	21	33	Psychology	3	E
AS-014	ABC-S	F	20	26	Psychology	3	E
OS-001	Origami-S	F	22	28	Mass Comm	2	E
OS-002	Origami-S	M	21	24	BA	1	C
OS-003	Origami-S	M	21	21	Marketing	3	E
OS-004	Origami-S	F	19	31	Bio Sciences	1	E
OS-005	Origami-S	M	21	28	PE	1	O
OS-006	Origami-S	M	21	24	ME	1	E
OS-007	Origami-S	F	22	1170	General Studies	3	E
OS-008	Origami-S	F	20	23	Education	1	E
OS-009	Origami-S	F	20	27	Biology	1	E
OS-010	Origami-S	F	21	1080	Mass Comm	3	E

OS-011	Origami-S	F	21	25	Environment Eng.	2	C
OS-012	Origami-S	F	21	20	General Studies	2	E
OS-013	Origami-S	F	21	22	Psychology	1	E
OS-014	Origami-S	M	29		EE	1	H
OS-015	Origami-S	F	20	27	CHE	3	E
ONS-001	Origami-NS	F	21	24	Mass Comm	4	E
ONS-002	Origami-NS	F	21	20	Psychology	1	E
ONS-003	Origami-NS	M	21	27	Psychology	2	E
ONS-004	Origami-NS	F	19	22	Kinesiology	2	E
ONS-005	Origami-NS	F	19	20	Psychology	5	E
ONS-006	Origami-NS	F	18	21	Psychology	3	E
ONS-007	Origami-NS	F	21	20	Psychology	1	E
ONS-008	Origami-NS	F	17	1390	CE	1	E
ONS-009	Origami-NS	F	20	20	Pharamacy	1	E
ONS-010	Origami-NS	F	22	23	Psychology	1	E
ONS-011	Origami-NS	F	20	24	Nursing	2	E
ONS-012	Origami-NS	F	21	29	IE	3	E
ONS-013	Origami-NS	F	18	24	Nursing	4	E
ONS-014	Origami-NS	F	22	21	Business	1	E
ONS-015	Origami-NS	M	25	22	IE	3	C
ONS-016	Origami-NS	M	21	1050	IE	2	O

Table 18. Continued Participant's Raw Data Information and Scores

Subject	Sitcoms	Movies	Hm Comp	WK Comp	Schl Comp	Often use	Maj. Comp use
ANS-001	3	3	1	1	1	1	1
ANS-002	2	2	1	N/A	1	1	1
ANS-003	2	3	1	1	1	1	1
ANS-004	2	3	1	1	1	1	3
ANS-005	2	3	1	1	1	1	1
ANS-006	2	4	1	1	1	1	1
ANS-007	1	4	1	2	1	1	1
ANS-008	2	2	1	0	1	1	1
ANS-009	4	3	1	1	1	1	1
ANS-010	3	4	1	1	1	1	1
ANS-011	3	3	1	1	1	1	3
ANS-012	3	2	1	1	1	1	1
ANS-013	4	2	1	1	1	1	1
ANS-014	2	2	1	1	1	1	2
ANS-015	1	2	1	N/A	1	1	1
ANS-016	2	2	1	1	1	1	1
ANS-017	2	4	1	1	1	1	4

AS-001	2	4	1	1	1	1	1
AS-002	2	3	1	1	1	1	1
AS-003	3	4	1	N/A	1	1	1
AS-004	2	4	1	0	1	1	1
AS-005	2	3	1	2	1	2	2
AS-006	2	1	1	1	1	1	1
AS-007	2	2	1	2	1	1	1
AS-008	4	2	1	N/A	1	1	1
AS-009	2	2	1	1	1	1	1
AS-010	1	1	1	1	1	1	1
AS-011	3	2	1	1	1	1	1
AS-012	3	3	1	1	1	1	1
AS-013	3	2	1	1	1	1	1
AS-014	3	1	1	2	1	1	1
OS-001	4	3	1	1	1	1	1
OS-002	2	1	1	1	1	1	1
OS-003	2	2	1	1	1	1	1
OS-004	3	2	1	1	1	1	1
OS-005	1	3	1	1	1	1	1
OS-006	2	2	1	1	1	1	1
OS-007	4	3	1	1	1	1	1
OS-008	2	4	1	2	1	1	1
OS-009	1	2	1	1	1	1	1
OS-010	3	3	1	1	1	1	1
OS-011	2	2	1	1	1	1	1
OS-012	4	2	1	2	1	1	1
OS-013	3	2	1	2	1	1	1
OS-014	2	3	1	2	1	1	1
OS-015	2	4	1	2	1	1	1
ONS-001	3	4	1	2	1	1	1
ONS-002	4	2	1	2	1	1	1
ONS-003	2	2	1	1	1	1	1
ONS-004	3	3	1	1	1	1	1
ONS-005	4	3	1	1	1	1	1
ONS-006	4	2	1	2	1	1	1
ONS-007	4	3	1	2	1	1	1
ONS-008	3	3	1	2	1	1	1
ONS-009	2	3	1	1	1	1	1
ONS-010	4	4	1	1	1	1	1
ONS-011	4	2	1	2	1	1	1
ONS-012	3	2	1	1	1	1	1
ONS-013	5	5	2	2	1	1	1
ONS-014	3	2	1	2	1	1	1
ONS-015	2	3	1	2	1	1	1
ONS-016	2	1	1	1	1	1	1

Table 19. Continued Participant's Raw Data Information and Scores

Subject	Nasa TLX	Sat	Knowledge	Level	Performance	Ospan	GEFT-W	GEFT-C	Field (I/D)
ANS-001	72.33	1.8125	2	0	100	41	11	14	I
ANS-002	56.67	2.3125	2	0	90	12	14	11	I
ANS-003	41.33	2.1176	1	1	40	30	6	19	I
ANS-004	62.67	1.9375	1	1	70	26	5	20	I
ANS-005	22	1.6875	1	1	50	33	8	17	I
ANS-006	59.33	1.58823	2	0	70	27	4	21	I
ANS-007	19.33	1.9375	1	2	80	22	0	25	I
ANS-008	39.33	2.0625	1	1	70	26	0	25	I
ANS-009	34	1.6875	2	0	80	37	7	18	I
ANS-010	62	2.125	1	1	60	30	6	19	I
ANS-011	28.67	2.0625	1	2	50	29	6	19	I
ANS-012	45.67	2.2625	2	2	80	33	1	24	I
ANS-013	48.33	1.9375	1	2	80	40	7	18	I
ANS-014	25.67	1.75	1	2	80	37	5	20	I
ANS-015	69	6.333	2	0	50	29	3	22	I
ANS-016	74.67	2	1	2	40	33	1	24	I
ANS-017	51.33	1.5	1	2	60	38	2	23	I
AS-001	31	1.1875	1	1	80	23	3	22	I
AS-002	72.67	1.875	2	0	70	35	17	8	D
AS-003	43.67	1.58823	2	0	80	34	2	23	I
AS-004	12.67	1.5294	1	2	80	8	1	24	I
AS-005	76.33	1.41176	1	1	80	7	9	16	I
AS-006	54.67	2	2	0	70	0	11	14	I
AS-007	10	1	1	1	80	29	3	22	I
AS-008	55	2.05882	2	0	80	42	0	25	I

AS-009	17.33	2	1	2	70	30	0	25	I
AS-010	77	1.764705	1	2	40	29	15	10	N
AS-011	47.67	2	2	0	30	12	0	25	I
AS-012	36.33	2.0588	1	2	70	28	4	21	I
AS-013	45.33	1.82352	1	1	70	27	1	24	I
AS-014	72	2.41176	1	2	60	22	12	13	I
OS-001	74	3.05882	2	0	90	41	11	14	I
OS-002	38	2.64705	1	1	50	36	8	17	I
OS-003	55.33	2.29411	2	0	100	25	12	13	I
OS-004	33.33	1.7647	1	1	90	28	2	23	I
OS-005	46.67	1.47058	2	0	90	27	1	24	I
OS-006	19.33	1.8125	1	1	100	31	5	20	I
OS-007	56.33	1.35294	1	2	20	24	2	23	I
OS-008	43.33	1.47058	1	1	100	24	13	12	I
OS-009	70.67	2.7647	1	1	70	42	1	24	I
OS-010	74	2.17647	1	1	80	9	3	22	I
OS-011	56.67	1.8235	1	1	80	33	4	21	I
OS-012	68.33	1.7647	1	1	90	20	6	19	I
OS-013	79.67	2.529411	1	1	90	37	7	18	I
OS-014	69.67	2.11764	1	2	100	40	2	23	I
OS-015	19.33	1.82352	1	1	100	27	3	22	I
ONS-001	68.33	1.875	2	0	70	26	5	20	I
ONS-002	32	1.8125	2	0	80	10	11	14	I
ONS-003	49.33	1.875	1	1	80	34	2	23	I
ONS-004	69	2.125	1	1	30	31	8	17	I
ONS-005	84.67	3.25	1	1	100	33	14	11	I
ONS-006	66	2.0625	1	1	80	13	13	12	I
ONS-007	53.67	1.5	1	1	10	23	12	13	I
ONS-008	51	2.4375	2	0	30	41	2	23	I
ONS-009	64	2.625	2	0	70	25	7	18	I
ONS-010	52.67	3.25	1	1	10	21	16	9	D
ONS-011	85.33	3.375	1	1	80	22	9	16	I
ONS-012	18	2.375	1	1	80	28	5	20	I

ONS-013	59	2.4375	2	0	70	28	18	7	D
ONS-014	53.67	2.375	1	1	80	30	4	21	I
ONS-015	52.67	2	1	2	100	35	6	19	I
ONS-016	82.67	2.125	1	2	90	29	8	17	I

VITA

Katherine Comeaux was born on August 12, 1980, in Baton Rouge, Louisiana, and raised in New Roads, Louisiana, where she attended Catholic High School of Pointe Coupee finishing in the top twenty percent of her class. She joined Louisiana State University in 1998 for a Bachelor of Science degree in industrial engineering and continued to enroll in a master's degree program in industrial engineering. She has recently been working in the area of occupational health/ergonomics focusing on human computer interaction under the leadership of Dr. Craig Harvey, Assistant Professor, Department of Industrial Engineering.