THE EFFECTS OF SCAFFOLDING STUDENT'S PROBLEM-SOLVING
PROCESS VIA QUESTION PROMPTS ON PROBLEM SOLVING AND
INTRINSIC MOTIVATION IN AN ONLINE LEARNING ENVIRONMENT

A Thesis in
Instructional Systems

by
Brett Alan Bixler

© 2007 Brett Alan Bixler

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

August 2007
The thesis of Brett Alan Bixler was reviewed and approved* by the following:

Susan Land  
Associate Professor of Education  
Associate Professor of Education  
In Charge of Graduate Program in Instructional Systems  
Thesis Advisor  
Chair of Committee

Kyle Peck  
Professor of Education

Brian Smith  
Associate Professor of Information Sciences and Technology and Education

Magy Seif El-Nasr  
Assistant Professor of Information Sciences and Technology

*Signatures are on file in the Graduate School
ABSTRACT

A major concern in education is the lack of problem solving abilities in students (Hong, 1998). The importance of using ill-structured problems with students to teach problem solving is generally agreed upon by educators (Helgeson, 1992). Ill-structured problems are those that characterize the types of complex problems that we encounter in everyday life. As great deal of interest in the uses of ill-structured problems in education exists (Jonassen, 1997, 2006; de Jong and van Joolingen, 1998), more research here is needed. Furthermore, one of the critical elements required for successful problem solving is motivation (Albanese & Mitchell, 1993; Berkel & Schmidt, 2000), and the relationship between motivation and ill-structured problem solving is unclear and complex.

The purpose of the study was to investigate the effects of question prompts in scaffolding college students' problem-solving process and motivation on an ill-structured task. While scaffolding has been studied in previous research, few studies were focused on its use to support students’ problem solving on ill-structured tasks. A literature review did not identify any studies that examined motivational aspects of scaffolding. Thus, this study focused on the use of question prompts to support college students' problem-solving processes on an ill-structured task, especially in the processes of problem representation, solution, justifications, and monitoring and evaluation. Additionally, the motivational aspects of scaffolding via question prompts was investigated.

A mixed study design was used, integrating quantitative with qualitative methods. The quantitative method empirically measured individual's problem-solving outcomes on an ill-structured task. Four ill-structured problem-solving processes were measured:
problem representation, developing solutions, making justifications, and monitoring and
evaluation.

The qualitative method investigated contextual information about the individual's
problem-solving process, such as how it affected their motivation and problem
representation, solution development, making justifications, and monitoring and
evaluation of solutions. This was accomplished via observation, interviews, and think-
 aloud protocols. Through these methods, the researcher examined individuals' thoughts,
actions, decision-making, as well as their motivational states during the problem-solving
process. This was done to gain insights into student's problem-solving processes and
motivational structures on an ill-structured task.

Seventy-nine college students participated in the study; 40 in the control group
and 39 in the experimental group. The results of the experimental study showed that
students working with question prompts significantly outperformed students without
question prompts in all four problem-solving processes.

While no students in the experimental group actually claimed to be more
motivated by prompts, question prompts had a positive role in subjects' motivation as
evidenced by reduction of frustration and stress, an increase in self-efficacy, an increase
in strategic behavior, and by providing a fail-safe environment for learning.

While this study confirmed the findings of previous research on the effectiveness
of question prompts in facilitating students’ cognition and metacognition, it also showed
the motivational benefits. The study implied that, in order for students to gain full
benefits from question prompts, some teacher or peer interaction may be needed, and this interaction process itself may need to be scaffolded.

In an online learning environment, question prompts may constrain students from full exploration of the available resources, as they may be seen as overly prescriptive in nature. Finding the optimal balance between too much openness and over prescription is problematic in these environments.
TABLE OF CONTENTS

LIST OF FIGURES ................................................................................................. x
LIST OF TABLES ........................................................................................................ xi
ACKNOWLEDGEMENTS ........................................................................................... xii

CHAPTER 1 INTRODUCTION .................................................................................. 1

Problem Statement ................................................................................................. 1
The Relationship Between Online Learning Environments, Prompting, and Motivation ................................................................. 3
Purpose of the Study ................................................................................................. 6
Research Questions ................................................................................................ 7
Hypotheses ............................................................................................................... 8
Significance of the Study ......................................................................................... 9

CHAPTER 2 LITERATURE REVIEW ...................................................................... 11

Problem Solving ..................................................................................................... 11
Definition of a Problem ........................................................................................ 11
External .................................................................................................................. 12
Internal .................................................................................................................. 12
Puzzle Problems .................................................................................................. 13
Well-structured Problems ..................................................................................... 14
  Cognitive Components of Well-Structured Problems .................................. 14
  Metacognitive Components of Well-structured Problems ......................... 15
Ill-structured Problems ......................................................................................... 17
  Cognitive Components of Ill-structured Problems .................................... 20
  Metacognitive Components of Ill-structured Problems .......................... 20
Empirical Studies on Problem Solving .............................................................. 21
Scaffolding ............................................................................................................ 23
Sense Making ....................................................................................................... 24
Process Management ........................................................................................... 25
Articulation and Reflection .................................................................................. 25
Prompts ................................................................................................................ 25
Empirical Studies on Scaffolding and Prompts ................................................ 28
Motivation ............................................................................................................. 34
Definitions of Motivation ..................................................................................... 34
  Physiological .................................................................................................... 34
  Psychological .................................................................................................... 35
Importance of Motivation in Learning ............................................................... 35
Relationship Of Learners To Motivation And Learning ............................. 36
### Instructional Design Models/Frameworks That Have An Implied Motivational Component

- The ARCS Model ............................................. 40
- The Time Continuum Model of Motivation .................... 45
- The Motivational Framework for Culturally Responsive Teaching .................................................. 47
- Taxonomy of Intrinsic Motivations for Learning ............... 48

### Instructional Design Models/Frameworks That Have An Overt Motivational Component

- The Motivational Framework for Culturally Responsive Teaching .................................................. 47

### CHAPTER 3 RESEARCH METHOD ........................................... 59

- Participants .................................................................. 59
- The Context of the Study ........................................... 59
- Research Design ......................................................... 61
  - The Experimental Study ........................................... 64
  - Ill-structured Problem-solving Task .......................... 66
- Qualitative Data Collection and Analysis ....................... 69
  - Post-Experimental Data Collection and Analysis .......... 69
- Materials and Instruments .......................................... 70
  - The Ill-structured Problem-solving Task Material ....... 70
  - Treatment Material Question Prompts ....................... 71
  - Cognitive Prompts ................................................. 72
  - Metacognitive Prompts ........................................... 73
  - Scoring Rubric ....................................................... 74
  - Observation and Think-aloud Protocols ...................... 75
  - Self-report Questionnaire ....................................... 76
- Procedure ..................................................................... 76

### CHAPTER 4 RESULTS AND DISCUSSION ................................... 78

- The Experimental Study Results ................................. 78
- Statistical Data Analysis ............................................ 79
- Descriptive Statistics ................................................ 79
- Comparison of Treatment Effects for Each Dependent Variable .................. 80
- ANOVA Tests on Dependent Variables PR and DS ............. 81
- Mann-Whitney U Tests on Dependent Variables MJ and ME ...... 82
- Correlation of Treatment Effects Among the Dependent Variables ...... 82
- Comparison of Treatment Effects Among the Dependent Variable ...... 83
Findings related to the effects of question prompts on ill-structured problem-solving outcomes ................................................................. 84
Experimental Subject Main Page Description ...................................... 85
Control Subject Main Page Description ........................................... 86
Experimental Subject Justification Statement .................................... 86
Control Subject Justification Statement ........................................... 87
Summary of the Experimental Study Results .................................... 88
The Qualitative Study Results .......................................................... 89
Findings from Observations and Think Alouds .................................. 90
Interviews ....................................................................................... 94
Summary of Qualitative Findings .................................................... 104
Summary of Overall Study Findings ................................................ 105
Subject Background and Profile Information .................................... 105
Background Information .................................................................. 107
Problem Solving Skill Information .................................................... 110
Motivators Information ................................................................... 111
Mental Effort Information .................................................................. 112

CHAPTER 5 GENERAL DISCUSSION .................................................... 113

Overview of the Findings .................................................................. 113
Implications for Instructional Design ................................................ 116
  Question Prompts as a Scaffolding Strategy .................................... 116
  Question Prompts as a Motivational Strategy ................................. 119
Use of Online Learning Environments for Technological Scaffolding... 122
Implications for Future Research ..................................................... 124
Removing Scaffolding Over Time ..................................................... 124
  Prompts, Creativity, and Task Complexity ...................................... 125
Limitations of the Study ................................................................... 126

BIBLIOGRAPHY ............................................................................... 129

APPENDIX A RESEARCH CONSENT FORMS ................................. 139

APPENDIX B PROBLEM-SOLVING TASK MATERIALS ..................... 141

APPENDIX C TREATMENT MATERIAL ........................................... 159

APPENDIX D SCORING RUBRIC ..................................................... 182

APPENDIX E STRUCTURED INTERVIEW QUESTIONS .................... 186

APPENDIX F INTERVIEW TRANSCRIPTIONS .................................. 187

  Subject 1 Transcript ...................................................................... 187
<table>
<thead>
<tr>
<th>Subject 2 Transcript</th>
<th>.................................................................</th>
<th>194</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject 3 Transcript</td>
<td>..................................................................................</td>
<td>203</td>
</tr>
<tr>
<td>Subject 4 Transcript</td>
<td>..................................................................................</td>
<td>211</td>
</tr>
<tr>
<td>Subject 5 Transcript</td>
<td>..................................................................................</td>
<td>221</td>
</tr>
<tr>
<td>Subject 6 Transcript</td>
<td>..................................................................................</td>
<td>231</td>
</tr>
</tbody>
</table>

**APPENDIX G SELF-REPORT QUESTIONNAIRE** ........................................... 241
LIST OF FIGURES

Figure 2.1. The Motivational Framework for Culturally Responsive Teaching . 47
Figure 3.1. Treatments................................................................. 65
Figure 4.1. Histograms of distribution of the four dependent variables......... 80
LIST OF TABLES

Table 2.1. Comparison of four models concerning motivation .......................... 53
Table 2.2. Elements of flow ............................................................................. 55
Table 3.1. Overall study questions, data collection techniques, instruments, and data sources ................................................................................. 63
Table 4.1. Summary of descriptive statistics and effect sizes ......................... 80
Table 4.2. ANOVA effect for dependent variables PR and DS ....................... 81
Table 4.3. Mann-Whitney U effect for dependent variables MJ and ME ......... 82
Table 4.4. Correlations between all dependent variables ............................... 83
Table 4.5. Comparison of treatment effects among all dependent variables ..... 84
Table 4.6. Selected question means, standard deviation, and F ratio .............. 106
ACKNOWLEDGEMENTS

My extreme gratitude goes to my thesis advisor and mentor, Dr. Susan Land, for her unwavering dedication, steady encouragement, and support. Dr. Land represents the best of what academia offers to the world, and I wish her all the best in whatever paths she pursues.

I'd also like to thank my committee members. Dr. Kyle Peck, thank you for agreeing to serve on my committee despite your heavy workload. You taught me many things throughout the years that I use every day. To Dr. Brian Smith and Dr. Magy Seif El-Nasr, thank you both for taking on an unknown and assisting me through this process.

To Marilynne Stout and Cole Campese, my thanks for allowing me to pursue my doctorate while working full time for you. Without your support, I simply could never have finished this.

To Gerry Santoro, Jane Noel, and Jan Mahar, thank you for allowing me to use your students and your class time to gather my research data. Without that, none of this would have been possible. I know that your curriculums are full to bursting. Allowing me time and access had to be a burden.

Finally, I must thank my wife and children. Family is my top priority in life, and I sacrificed more time with you in pursuit of my doctorate than I care to admit. Yet through it all you were kind, understanding, and patient. I only hope I can live up to the high standards you set, and be worthy of the love you've given to me.
Chapter 1

INTRODUCTION

Problem Statement

A major concern in education is the lack of problem solving abilities in students (Hong, 1998). Ideally, students acquire problem-solving skills by solving real-world problems. The importance of using ill-structured problems with students to teach problem solving is generally agreed upon by educators (Helgeson, 1992). Ill-structured problems are those that characterize the types of complex problems that we encounter in everyday life. As great deal of interest in the uses of ill-structured problems in education exists (Jonassen, 1997, 2006; de Jong and van Joolingen, 1998), more research here is needed. Furthermore, one of the critical elements required for successful problem solving is motivation (Albanese & Mitchell, 1993; Berkel & Schmidt, 2000), and the relationship between motivation and ill-structured problem solving is unclear and complex. Research suggests that students exhibit several deficiencies in problem-solving skills, including hypothesis formation, systematic approaches to problem solving, and evaluation of efforts (de Jong and van Joolingen, 1998). Continuing research in this area must investigate not only what the learner brings to the task, but also the environments in which problem solving occurs (Hong, 1998).

Online learning environments are generally rich, complex environments that invoke problem solving. When viewed as a problem or series of problems to be solved,
many online learning environments may be considered ill-structured. Ill-structured problems are the types of everyday problems that possess unknown elements, multiple solutions, multiple evaluation criteria, and require judgments and justification (Jonassen, 2000). The information needed to solve the problem is not provided in the problem statement (Chi & Glaser, 1985; Jonassen, 1997). Previous research indicates that many students are lacking in problem-solving skills (de Jong & van Joolingen, 1998), and traditional curricula rarely asks them to solve problems (Jonassen, 2000). They may be lacking in domain knowledge, metacognitive strategies, or both (Feltovich, Spiro, Coulson, & Feltovich, 1996; Brown, 1987). Students may have difficulty with one or more of the following:

- defining the problem
- planning and monitoring their efforts
- searching for information
- interpreting available information
- deciding what available information is relevant
- generating potential solutions

In order to help students mitigate some of these difficulties in solving ill-structured problems, instructional support mechanisms are needed. Previous research in problem solving indicates that embedding various types of cognitive and metacognitive prompts in the learning environment has yielded positive results (Palincsar & Brown, 1984, King, 1991; Ge, 2002). To date, within an online learning environment, little to no
research has investigated simultaneously the relationship of the strategic use of cognitive and metacognitive prompts to assist learners with problem solving and also the effects on learner motivation.

Many types of cognitive and metacognitive prompts can be modified in an online learning environment that is ill structured to help students to engage in more effective problem solving. One of the most promising approaches to prompting involves the use of questioning strategies. These strategies have been used in well-structured contexts effectively (King, 1991; 1992; Scardamalia, Bereiter, and Steinbach, 1984), and some evidence has shown their effectiveness in ill-structured problems (Ge & Land, 2003). Question prompts help the learner focus attention and monitor their progress (Rosenshine, Meister, & Chapman, 1996; Wager & Mory, 1993). Questioning strategies have been found to foster the following important functions: focusing attention, stimulating prior knowledge, enhancing comprehension, monitoring thinking and learning processes, and facilitating problem-solving processes (Ge, 2001).

The Relationship Between Online Learning Environments, Prompting, and Motivation

The features of a learning environment and a learner's initial motivation level are linked (Howell & Cannon-Bowers, 2003). Yet, it is unclear what factors intrinsically motivate people in these environments. Can educators isolate these factors, verify their effectiveness, and utilize them in future developmental efforts in online learning environments and perhaps other forms of instruction? It is possible that the nature of an online learning environment containing an ill-structured task has a differential impact on
students’ motivation. This is one major area where research can play an important role – determining the most probable key factors that influence intrinsic motivation in an individual utilizing an online learning environment containing an ill-structured task.

There is no direct research on the relationship between scaffolding of ill-structured problems via prompts and intrinsic motivation. However, Keller (1999) posits that learner support is important for motivating learners in instruction, and cognitive and metacognitive prompts may serve a motivational scaffolding role in online learning environments as well. They may serve to:

- reduce frustration and stress,
- increase self-efficacy and encourage metacognition,
- encourage strategic behavior that leads to increased motivation, and
- provide a fail-safe environment for learning.

As Bos (2005) writes, “There is now a need for research on scaffolding of engagement to supplement scaffolding of cognition.” (p. 1).

Frustration can be defined as a blocking of a goal-directing activity (Beck, 1983). Frustration occurs when learners are uncertain of goals or how to accomplish them. Related to this concept is the Yerkes-Dodson Law (Beck, 1983; Broadhurst, 1957) that states that the more difficult the problem the lower the level of motivation – it is perceived as too difficult to solve without assistance. Prompting in an environment containing an ill-structured task may lead to a reduction of stress and an increased belief that the problem is easier to solve.

Similarly, self-efficacy and metacognitive strategy use are also related to motivation. Many studies of motivation use self-efficacy measures as an indicator of
motivational states. Similarly, students who behave strategically have increased levels of motivation for a task (Bruning & Horn, 2000, Kauffman, 2004). Prompts may provide learners with a sense of control over their environment, thus increasing their intrinsic motivation (Pintrich & Schunk, 1996). Prompts may reduce cognitive overhead, making it easier for students to make connections in a learning environment (Hmelo & Day, 1999). Song (2004) found a relationship between prompting in an electronic environment containing an ill-structured task and motivation (via self-efficacy measures), but it is unclear what role these prompts played.

Online learning environments may provide the opportunity for learners to enact misconceptions, make mistakes, and learn from them. These fail-safe environments may stimulate learners’ interest more than traditional ones (Smith & Ragan, 1993). Computer games used as an online learning environment have been found to include the use of metacognitive strategies, including “expert” behaviors such as self-monitoring, pattern recognition, principled decision making, and superior short and long-term memory (Pillay, Brownlee, and Wilss, 1999; VanDeventer & White, 2002). Prior research indicates that these environments may be improved by the use of guidance derived from the instructor (de Jong & van Joolingen, 1998, Moreno & Mayer, 2005). Online learning environments may provide built-in mechanisms for reflection in the form of journals (both automatically generated and user created), recorded conversations, and “reminder” prompts. These mechanisms may assist a learner’s self-regulation processes while providing a form of guidance. In addition, these mechanisms may increase motivation and self-efficacy (Garris, Ahlers, & Driskell, 2002).
Purpose of the Study

Despite prior research on the use of question prompts to facilitate problem-solving activities, the relationship between questioning strategies and ill-structured problem solving in an online learning environment has been insufficiently studied. While several studies (Ge, 2001; King, 1991, 1992) represent a solid beginning, the extension of this research into college-level online learning environments is needed. As Howell and Cannon-Bowers (2003) state, "Further research is needed to better understand the nature of tutorial dialog and which strategies are best for various learning tasks and/or subject matter." (p. 30).

Will the use of cognitive and metacognitive prompts as a scaffolding mechanism in an online learning environment produce a significant difference in problem-solving outcomes and motivation? What effect will these prompts have on an individual's problem-solving processes (problem representation, solution development, making justifications, monitoring and evaluation of solutions) and motivation?

By developing a treatment within an online learning environment, question prompts can be manipulated in relation to an individual's problem solving skills to determine the effect on the problem solving effectiveness of the individual. This can be measured quantitatively.

The use of observation, interviews, and think-aloud protocols will allow the researcher to qualitatively ascertain contextual information about the individual's problem-solving process, such as how it affected their motivation and thinking during the process.
Question prompts are defined as static questions that are presented to the individual within the online learning environment. Both cognitive and metacognitive prompts are used to guide the individual through the problem-solving process. Cognitive prompts assist the learner in deciding what to do next (Davis & Linn, 2000), how to globally proceed, and provide exemplars (Ge & Land, 2004). Metacognitive prompts help learners understand what they've done up to a point in a process, call attention to a learner's process as it occurs, model processes, and provide multiple perspectives on a problem (Lin, Hmelo, Kinzer, & Secules, 1999).

The online learning environment will consist of a web site containing a series of web pages that describe an ill-structured problem. Control and experimental groups will be employed. Both cognitive and metacognitive prompts will be embedded in the experimental group for this study, to investigate the effects of these prompts on an individual's problem-solving processes and outcomes (problem representation, solution development, making justifications, and monitoring and evaluation of solutions), and motivation in the ill-structured task.

Research Questions

This study concentrates on the effect of using question prompts to scaffold student's problem-solving processes in an ill-structured task in:

1. Problem representation
2. Developing solutions
3. Making justifications
4. Monitoring and evaluating solutions

This study examines both problem-solving processes and outcomes, and is focused on the following questions:

1. Does the use of cognitive and metacognitive prompts have an effect on an individual's problem-solving outcomes (problem representation, solution development, making justifications, and monitoring and evaluation of solutions) in an ill-structured task?

2. How does the use of cognitive and metacognitive prompts influence an individual's problem-solving processes (problem representation, solution development, making justifications, and monitoring and evaluation of solutions) and motivation in an ill-structured task?

Hypotheses

Based on the research questions, the following hypotheses was generated:

**Hypothesis 1.** Individuals receiving question prompts will demonstrate better problem-solving outcomes on an ill-structured task than their counterparts who did not receive the question prompts on (a) problem representation, (b) solution development, (c) making justifications, and (d) monitoring and evaluation of solutions.

**Hypothesis 2.** Individuals receiving question prompts will demonstrate better problem-solving processes on an ill-structured task than their counterparts who did not receive the question prompts on (a) problem representation, (b) solution development, (c) making justifications, and (d) monitoring and evaluation of solutions.
**Hypothesis 3.** Individuals receiving question prompts will demonstrate better motivation on an ill-structured task than their counterparts who did not receive the question prompts on (a) problem representation, (b) solution development, (c) making justifications, and (d) monitoring and evaluation of solutions. This will be measured by students’ verbal self-reporting during a structured post-intervention interview.

**Significance of the Study**

This study will yield several pieces of information that can be applied to future development of online learning environments. Previous research investigating the use of prompting mechanisms in well-structured and ill-structured problems has generally yielded positive results – prompting can produce a significant positive effect. However, the numbers of investigations are low. To build a robust nomological net (Cronback, 1955), more studies are needed.

Why and when online learning environments are motivating is unclear. Most research on the subject mention this as a given, or list strategies to increase motivation for all users. Without research on motivation, such assumptions and strategies are suspect. Research on motivational aspects in online learning environments is important for another reason – development economics. The time and resources need to develop these environments can be far greater than that of other forms of instruction. Educators simply cannot afford to invest in the development of these environments without ensuring the environment will appeal to as wide an audience as possible and also lead to superior learning gains.
This study will serve as a basis for future related studies that provide empirical evidence designers of online learning environments can utilize to improve online learning environments. Finally, findings from this study may be applicable to other forms of instruction, providing ways to increase the intrinsic motivation of learners who use that instruction. This may be especially useful with novice learners.
Chapter 2
LITERATURE REVIEW

Problem Solving

Definition of a Problem

When a person needs to obtain a goal and there are unknown factors that affect obtaining that goal, a problem exists (Jonassen, 1997).

According to Smith (1991):

A problem is a task that requires analysis and reasoning toward a goal (the "solution"); must be based on an understanding of the domain from which the task is drawn; cannot be solved by recall, recognition, reproduction, or application of an algorithm alone; and is not determined by how difficult or by how perplexing the task is for the intended solver. (p. 14)

According to Jonassen (1997), problems consist of the following: (a) a problem domain, consisting of concepts, rules, and principles that define the problem elements; (b) a problem type, which is a combination of concepts, rules, and procedures used to act upon it; (c) a problem-solving process, which depends on the person's understanding of the problem and their expertise in this type of problem; and (d) a solution.

Both external and internal factors affect problem solving (Smith, 1991). These factors are outlined as follows:
**External**

1. Problem context.
2. Problem structure – semantics, novelty, complexity, etc.
3. Social factors – the surrounding environment.

**Internal**

1. Affect – self-confidence, perseverance, enjoyment, positive self-talk, motivation, beliefs, and values.
2. Experience – prior successful problem-solving experiences
3. Domain-specific knowledge – factual, conceptual, procedural
5. Organizational – accessible, integrated, accurate
6. Miscellaneous personality characteristics – field dependence, personality, etc.

Good problem solvers:

1. Adapt their knowledge and organization of knowledge to the domain.
2. Apply their knowledge and organization of knowledge to the problem.
3. Use both general problem-solving techniques for problems outside their domain, and domain-specific problem-solving techniques for problems inside their domain.
4. Create an internal "problem space" that incorporates a qualitative redescription of the problem – they put it in their own words and schema.
5. Plan a general strategy or approach to take.
6. Break problems apart and use multi-step procedures when necessary. (Scaffolding does this for the person.)

7. Monitor and evaluate their solutions.

8. Identify patterns in their own performance and identify critical similarities among problems.

Thus, problem solving consists of guided searches of solution possibilities within a cognitive space. Searches are guided by learned rules of thumb, or heuristics (Ge, 2001).

Jonassen (1997) identifies three types of problems:

- Puzzle Problems
- Well-structured Problems
- Ill-Structured Problems

**Puzzle Problems**

This type of problem is content-neutral, belonging to no specific domain. They are also named logical problems (Jonassen, 2006). Sudoku is a current example of a puzzle problem. The Towers of Hanoi is another. In both cases, there is no specific content domain attached to the problem. These problems usually lack relevance to the "real" world. They have a specific most-effective solution.
Well-structured Problems

These are problems with a defined method of solving and a definitive answer. Simple math problems are an example. Well-structured problems have the following elements in common (Jonassen, 1997):

- All parts of the problem are apparent
- The problem is presented to the person with a probable solution
- There are a limited and usually known number of rules and principles that exist within narrow parameters that can be applied to the problem
- There is a known way to apply these rules and principles.

Well-structured problems are more domain-specific than puzzle problems.

Cognitive Components of Well-Structured Problems

Solving well-structured problems requires domain-specific structural knowledge (Jonassen, 1997). Structural knowledge is the knowledge of how concepts in a domain relate to each other (Jonassen, 2006). Ryle (as cited in Hong, 1998) writes that domain-specific knowledge includes declarative and procedural knowledge. Declarative knowledge includes the facts, concepts and principles of a specific subject matter domain. Procedural knowledge includes the steps needed to solve the problem. These steps are closely tied to the domain itself and resist transfer to other domains (Smith, 1991; Mayer, 1992).
Because the goal of a well-defined problem is itself clearly defined, one can focus on decomposing and classifying the problem, using a means-end analysis (Ge, 2001). Decomposition is fairly easy if one possesses the appropriate domain knowledge (Hong, 1998). Then the appropriate steps and the order of the steps to solve the can be readily determined. The structure of the given problem can be compared and linked to previous problems.

The solution to a well-defined problem is usually singular. The solver considers possible solutions until one is found (Jonassen 2006). The solution is correct in that it solves the problem in the best way possible and alternative solutions (if they exist) simply do not compare in terms of efficiency or effectiveness.

After a solution is given to a well-defined problem, the solver must implement the solution, then monitor and evaluate the result (Smith, 1991). The problem ends when the solution is successful (Ge, 2001).

Metacognitive Components of Well-structured Problems

Metacognition may occur in a well-structured problem during the problem representation phase, the generation of solutions, and the monitoring and evaluation of the implemented solution.

If solvers do not have domain-specific knowledge or adequate structure (integration) of knowledge in the given domain, they must turn to general strategies. Analogy is one such strategy (Jonassen, 1997), where the solver takes a situation from
another domain and applies it via analogy to the given problem. Gick and Holyoak (1980) investigated the use of analogy in problem solving with positive results.

During the generation of solutions, the solver may use a means-end analysis. A means-end analysis combines aspects of both forward and backward reasoning by focusing the problem solving on the actual differences between the current state and that of the goal (Newell & Simon, 1963). The General Problem Solver (GPS) was an artificial intelligence program developed by Ernst and Newell (1969). The GPS used means-end analysis to plan backwards from the goal to be achieved. Differences between the current and goal states are used to propose operators which reduce the differences. During a means-end analysis, each proposed solution step must be analyzed by the solver, which should invoke metacognitive processes. This type of problem solving works best in well-structured or "closed" systems with clearly defined goals that fixed means can reach (Weinert & Kluwe, 1987). However, research indicates that solvers using a means-end analysis may only concentrate on reducing the gap between the current state and the goal state without much thought (de Jong & van Joolingen, 1998; Owen & Sweller, 1985). In addition, this type of reasoning may lead to blind ends. For example, consider the problem of crossing a stream to reach the other side. The most obvious path is to wade across the stream. However, the stream may be too deep, contain crocodiles, etc. In this case, it may better to look for a bridge. Means-end analysis may not reveal the relevant issues that one must consider in constructing a step-by-step problem solution.

Monitoring and evaluation actually begins when the problem is approached (Sinnott, 1989). The solver must look back at the strategies used and evaluate them (Bransford, Sherwood, & Sturdevant, 1987). Monitoring and evaluation of the implemented solution
implies that metacognition must occur. However, this is not always the case. de Jong &
vvan Joolingen (1998) report that in numerous studies of learners using computer
simulations, when learners fail to solve the given problem they do not stop to reflect on
the failure but simply proceed to change various aspects of the simulation without much
thought.

**Ill-structured Problems**

Ill-structured problems are situated in a domain or environment, and emerge from
a specific context (Jonassen, 1997). Ill-structured problems are the types of everyday
problems that possess unknown elements, multiple solutions, multiple evaluation criteria,
and require judgements and justification (Jonassen, 2000; Sinnott, 1989). The
information needed to solve the problem is not provided in the problem statement (Chi &

Related to ill-structured problems are "wicked" problems (Ritchie, 2005). Wicked
problems are "messy" and resist structuring. Ritchey defines ten criteria for wicked
problems:

1. There is no definite formulation of a wicked problem.
   It is difficult to have all the needed information at hand, or even know what that
   information might be.
2. Wicked problems have no stopping rules.
   You can't tell when the problem is solved completely, or if the solution is
   completely correct.
3. Solutions to wicked problems are not true-or-false, but better or worse.

Solutions are multiple, and the relative worth of a solution is dependent on the stakeholder.

4. There is no immediate and no ultimate test of a solution to a wicked problem.

The effectiveness of the solution cannot be easily measured. Also, the effectiveness of the solution depends on many ever-changing external factors that continually impact the effectiveness of the solution.

5. Every solution to a wicked problem is a “one-shot operation”; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.

It is impossible to step back through the solution after a step is implemented, as each step taken changes the nature of the problem.

6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.

It is impossible to list all the potential solutions to the problem.

7. Every wicked problem is essentially unique.

Wicked problems defy classification, rules, and procedures to follow.

8. Every wicked problem can be considered to be a symptom of another [wicked] problem.

Aspects internal to the problem are interrelated and constantly changing. They are problems in and of themselves. Defining an appropriate level of problem abstracting is critical or you will become mired in detail.

9. The causes of a wicked problem can be explained in numerous ways. The choice
of explanation determines the nature of the problem’s resolution.

With no rules for defining the problem, the way you impose structure on the problem determines the causes.

10. The planner has no right to be wrong.

Unlike hard sciences where a researcher may make hypotheses that are later rejected, solvers of wicked problems are held liable for their conjectures, processes, and rationales.

Sinnott (1989) developed a model for solving ill-structured problems consisting of five parts and processes:

1. Constructing the problem space.
   The essence of a problem is identified and selected.

2. Choosing and generating solutions.
   One must have methods for doing this, including:

3. Monitoring of the problem space and solutions.


Similarly, Voss and Post (1988) postulate that ill-structured problem solving consists of:

1. Problem representation.
   One must examine the concepts and relationships in the problem.

2. Stating a solution.
   How do you eliminate the problem? Defining this allows one to develop solutions.
3. Evaluation.

Will the solutions work? Are the solutions justified?

Because the number of stakeholders may be significant, the problem keeps shifting, and aspects that affect the problem are in flux, there is no definitive problem. Thus, there is no definitive solution. Herb Simon, a Nobel-prize winning economist, terms the process "satisficing" (Simon 1969). Simon states that it is virtually impossible to find the best solution as the number of possible solutions is so large. Instead, you find a solution that is "good enough."

Cognitive Components of Ill-structured Problems

Solving ill-structured problems share many cognitive elements with well-structured problems, but have several unique elements. Due to the "uncertain" nature of the problem, determining the appropriate problem space among all competing options is the most important cognitive process in ill-structured problems (Jonassen, 1997). Solving ill-structured problems may require domain-specific structural knowledge in several different domains (Jonassen, 2006).

Metacognitive Components of Ill-structured Problems

Monitoring and evaluation of ill-structured problems is necessary to ensure the solution is justified (Ge, 2001). The ability to develop a justification or argument for the proposed solution is also a critical cognitive element in ill-structured problem solving
(Cho & Jonassen, 2002; Voss & Post, 1988). The solver must examine and evaluate the proposed solution, compare it to other potential solutions, and decide if it is the best solution (Jonassen, 1997; Voss & Post, 1998).

**Empirical Studies on Problem Solving**

A significant body of research in problem solving examines the differences between experts and novices. Chi, Feltovich, and Glaser (1981) conducted four experiments to examine these differences: (a) the existence of problem categories as a basis for representation, (b) differences in the categories used by experts and novices, (c) differences in the knowledge associated with the categories, and (d) features in the problems that contribute to problem categorization and representation. They concluded that novices, lacking structural knowledge in a particular domain, will rely on the problem's literal features. Experts, on the other hand, have a mental structure or schema of similar problems in place that allow them to move toward a goal quickly.

Sinnott (1989) conducted a longitudinal study on ill-structured problems with 150 respondents. Her model postulates two basic sets of thinking processes in solving ill-structured problems: processes to construct problem space, and processes to choose and generate solutions. A problem solver chooses the critical aspects of the problem, selects a goal or goals, selects possible solutions and chooses a final solution. In ill-structured problems where many possible solutions exist, a problem solver must have a method for selecting the best solution.

Based on observations in her study, Sinnott wrote that problem solvers do engage in metacognitive activities, such a monitoring thoughts and looking back to initial states and data to guide their processes. She found that emotions and outside, non-task thoughts guided the choice of critical aspects of the problem and goal choices.
Marakas and Elam (1997) investigated how creativity in the problem-solving process can be influenced by decision support systems. Subjects were divided into two groups, a no software and a software group. Each of these groups was further divided into non-instruction (on the creativity-enhancing process) and instruction subgroups. A Kruskal-Wallis one-way ANOVA test indicated highly significant differences between subgroups ($x^2=22.8160$, df=3, $p=0.0001$), where the no software/process only, and software and process subgroups showed the greatest creativity. The authors caution that the problem used was well-structured and similar results should not be inferred for a typical (ill structured) business problem.

Shin, Jonassen, and McGee (2003) investigated predictors of performance in both well-structured and ill-structured problems in a ninth grade science curriculum. The multimedia program Astronomy Village was used in the study. Two well-structured problems and two ill-structured problems (ill-structured, familiar context and ill-structured, unfamiliar context) were presented to all subjects.

For well-structured problems, well-integrated domain knowledge is essential. The problem solver must be able to provide a rational argument for his/her solution, for this may be an indicator of well-integrated domain knowledge. Knowledge of cognition (general strategies) is not a strong predictor of success in well-structured problem solving, nor is attitude, motivation, nor regulation of cognition.

For ill-structured problems, well-integrated domain knowledge is also essential. Ill-structured problems rely more on case-based reasoning and prior experiences. Providing a rational argument for the solution to the problem is also critical to successful ill-structured problem solving. Neither knowledge of cognition (general strategies) nor
regulation of cognition is a strong predictor of success in ill-structured problem solving in familiar situations. The authors contend that regulation of cognition is only required when problems are sufficiently complicated and unpredictable enough to challenge the problem solver.

**Scaffolding**

Scaffolded instruction is a concept based on research on how individuals learn (Collins, Brown, & Newman, 1986; Vygotsky, 1978; Wood, Bruner, & Ross, 1976). Wood et. al. described scaffolding as adult assistance that allowed a child or novice to solve a problem normally beyond his or her stand-alone capabilities. Scaffolding suggests that at the beginning of learning, students need a great deal of support; then this support is gradually removed to allow students to work things independently. Pearson (1985) called this the gradual release of responsibility. Guzdial (2006) names this process "fading." If students are unable to achieve independence, the teacher brings back the support system to help students experience success until they are able to achieve independence (Cooper, 1993). Thus, scaffolding is a temporary support, removed when no longer needed, but reintroduced when necessary.

While originally scaffolding was viewed as an interaction between teacher and student, it is now increasingly viewed as any support provided (human or otherwise) to help students learn successfully (Puntambekar & Hübscher, 2005).

Scaffolding is tied conceptually to Vygotsky's Zone of Proximal Development (1978). Scaffolds allow an individual to attain a goal or engage in a practice otherwise
out of reach (Davis & Miyake, 2004).

Guzdial (2006) lists three critical types of support that are combined to provide scaffolding: communicating process, coaching, and eliciting articulation. Process is communicated in a variety of methods, including simple contextualized lectures. Key points are highlighted, and concepts may be simplified initially. Coaching occurs as the learner attempts a process. Hints and guides are given at this time. When the learner is asked to justify an action, name a procedure or part, etc., articulation is elicited. This encourages reflection.

Stone (1998) identifies four features of scaffolding in a face-to-face environment where an adult is working with a child.

- An adult involves a child in a task in a meaningful and culturally desirable way that is beyond the child's understanding or current control.
- The "titration" or careful addition of just the necessary amount of assistance by the adult.
- A range of types of support is provided by the adult.
- The support is temporary and is gradually withdrawn.

Quintata, et al. (2004) define a scaffolding design framework to support science inquiry. The framework includes seven guidelines divided into three categories:

**Sense Making**

Generating hypotheses and comparisons, observing, analyzing data, and constructing interpretations.
1. Use representations and language that bridge learner's understanding

2. Organize tools and artifacts and the semantics of the discipline

3. Use representations that learners can inspect in different ways to reveal important properties of underlying data

**Process Management**

Knowledge and strategies needed to steer the ill-structured problem to a successful conclusion.

4. Provide structure for complex tasks and functionality

5. Embed expert guidance about scientific practices

6. Automatically handle nonsalient, routine tasks

**Articulation and Reflection**

Making thinking visible to improve understanding of content and theory, to discover weaknesses in approaches, and to promote knowledge building.

7. Facilitate ongoing articulation and reflection during the investigation

**Prompts**

Prompts are a type of scaffolding (Rosenshine & Meister, 1992). Prompts may be procedural, stating what to do at a given time (Palinscar, 1987). Prompts may also appear in the form of a question (King, 1991). Prompts may be cognitive or metacognitive in
nature (Ge & Land, 2004). Cognitive prompts include procedural and elaboration prompts. Metacognitive prompts include reflection cues.

Procedural prompts assist learners in the completion of specific tasks (Ge & Land, 2004). Examples include:

- "An example of this…"
- "Another reason that is good…"

Elaboration prompts help the learner to formalize thoughts and explanations (Ge & Land, 2004). Examples include:

- "What is a new example of…"
- "Why is it important?"

Procedural prompts may include activity prompts to ensure and assist in completion of specific aspects of the activity (Davis & Linn, 2000). Examples include:

- "The manual states you need to…"
- "The major points of the document included…"

Metacognitive or reflective prompts help learners think about the processes they are using, bringing them out into the open for scrutiny (Davis & Linn, 2000). Lin, Hmelo, Kinzer, & Secules, (1999) examine the type of metacognitive interventions or cues used in a technology-enhanced learning environment. The authors of this article draw upon their combined years of experience in this area, as well as a review of the literature, to present some observations and guidelines for designers that plan on incorporating metacognitive interventions in their designs for technology-supported learning environments.
Four types of metacognitive prompts are identified:

- **Process displays** - To show students what process they have gone through to accomplish a particular task.
- **Process prompts** - To call student's attention to their own processes while they are performing a particular task.
- **Process modeling** - To show students how an expert would think through or solve a similar problem.
- **Reflective social discourse** - To provide students with multiple perspectives on content or process through focused social discourse.

The placement of these structures is somewhat implied by their very nature. As the authors contend,

> The aim of teaching students to reflect on their thinking processes is to increase their awareness of their own learning and to enable them to use that awareness in other situations. The power of technology for learning can be greatly enhanced through support for reflection, which helps learners construct the new kinds of knowledge and skills they need in this age of information. (Lin, et al, 1999, p. 60).

Prompts assist students by enabling them to focus on procedures, features, and the nature of the context in which the problem is situated (Lin & Lehman, 1999). The exact optimal placement, sequencing, and mixing of different prompt types is uncertain, according to Davis and Linn (2000). It appears that the addition of prompts induces a positive element into a learning environment, but it is hard to quantify. For example, in a study comparing activity-only to activity plus self-monitoring prompts, differences between the groups was evidenced by the difference in inclusion of scientific explanations by the activity plus self-monitoring prompt group (Davis & Linn, 2000).
Related to the mixing of different prompt types is that activity prompts alone may encourage a step-by-step process through a learning environment, as opposed to a holistic understanding of the issues within the environment (Davis & Linn, 2000). The inclusion of metacognitive prompts, these authors contend, may alleviate this, leading to sophisticated knowledge integration.

Other variables that may affect how prompts assist learners are the types of learners, context, and environment in which they are used (Lin & Lehman, 1999). Prompts that work for college students in Chemistry may not be as effective (or perhaps more so) than those same prompts used for elementary students in biology, for example.

Question prompts are very important for those learners who tend to jump immediately into finding solutions for complex problems (Lin, Hmelo, Kinzer, & Secules, 1999). The learners may not pause to reflect on prior knowledge or consider a complete strategy.

**Empirical Studies on Scaffolding and Prompts**

To date, several researchers investigating metacognition and its relationship to problem-based learning have focused on the obvious link between metacognitive skills, problem solving, and transfer of learning to both near and far problem situations (Lin, 1993; Delclos & Harrington, 1991, King, 1991a, 1991b, 1992). The results of these studies indicate that the use of metacognitive interventions in a problem-solving environment are generally beneficial. However, none of these studies provide a great amount of detail on the precise location of the metacognitive interventions within the learning environment, or on the nature of the interventions themselves.
King (1991a) conducted a study to investigate the effectiveness of embedding cognitive and metacognitive strategies in a computer-assisted problem-solving situation. Peer guidance was used to facilitate this experiment. One experimental group used guided questioning to facilitate cognitive and metacognitive activity during the problem-solving situation. A second group simply asked and responded to partner's questions during problem solving. The third (control) group received no training or instruction in questioning. Guided questioners outperformed both other groups on a test of problem solving and a novel computer task. It is the author's contention that guiding questions prompt students to create their own higher-order questions, which in turn facilitate the use of metacognitive strategies.

The guided questions fell into three categories: Planning, monitoring, and evaluation. A planning question example is as follows: "What is the problem?" A monitoring example is "Do we need a different strategy?" An evaluation question example is "What worked?"

Fisher's protected least squares difference (LSD) procedure was used to examine planned multiple comparisons among the three group means. These comparisons indicated a significant difference ($p < .05$) between the guided group, and the unguided-questioning and control group.

While King's study yielded significant results, a great deal of information about the exact parameters of the study are unaccounted for. Where the guided questions were used, what types were used, their frequency, and the responses to them are unaccounted for. Without this information, it is difficult to determine the exact structure and activity of
the guided question groups. This in turn makes it difficult for researchers to carry this type of study forward.

Xiaodong Lin (1993) conducted a study to investigate, in part, the relationship between metacognition and problem solving. The study attempted to show that adding metacognitive interventions to a problem-solving situation in a hypermedia environment would result in superior learning, as measured by tests of near and far transfer. A pretest-posttest control group design with random assignment was used to gather quantitative data to support her hypotheses. Four treatment groups were used: cognitive cues, metacognitive cues, affective-awareness cues, and a control group (no cues). Results showed that the subjects in the metacognitive group performed significantly better on near transfer measures (p=.009) and far transfer measures (p=.014) than all other groups. An additional qualitative analysis performed by randomly choosing 12 subjects from each group for post-task interviews indicated that metacognitive questions made students focus on processing of information and enabled them to attend to the ways a problem was solved. This, in turn, improved far transfer of problem solving.

Some observations about treatments in Lin's study, a dissertation study, need to be clarified. Lin's study is quite detailed, but an exact description of where, when, and what type of metacognitive cues were used is lacking. Without this information, it would be difficult to replicate the study and/or derive valid new studies based on it. Also, she conducted a four week pre-training phase, during which subjects were trained on how to respond to different cues. If one interprets this phase as a treatment, then multiple-treatment interference must be considered as a threat to the external validity of this study. She later (X. Lin, personal communication, September 25, 2000) reported many subjects
scored extremely high when using some of her assessment instruments, indicating this observation cannot be entirely discounted.

These two studies are exemplars of one problem that occurs in investigations of metacognitive interventions in a problem-solving situation: Lack of detail on the type of and placement of the metacognitive intervention(s) within the learning environment. They are also exemplars of what these types of studies typically examine: cognitive higher-order things skills at the analysis level or above. To date, no studies have detailed the types and placements of the metacognitive intervention(s), nor have they examined the effectiveness of metacognitive interventions on acquisition of lower cognitive skills, such as knowledge and comprehension.

Other empirical studies support the use of scaffolding and prompts in an instructional environment. Osman and Hannafin (1994) conducted a study that showed a positive effect when questions were presented to the learner before actual "learning" began. In particular, this may enhance recall of the main points of a passage of text.

van Zee and Minstrell's (1997) qualitative case study describes "a reflective toss," consisting of a student statement, teacher question, and additional student statements. The teacher catches the student's meanings, then throws the responsibility for thinking about them back to the student. This study was conducted in a suburban high school in a physics classroom. Questions from the teacher began with "What do you...," "Do you...," and so on. The influence of the teacher's questions and comments on the student's reflective process was evident in the transcribed portions of the interactions, demonstrating how these prompts affect and guide learners.

Chi, Bassok, Lewis, Reimann, and Glaser (1989) conducted a study with 10 students on the application of Newton’s laws of motion and on how this initial learning relates to their subsequent problem solving. They found that question prompts that guided students to
self-generate explanations facilitated problem solving. They also concluded that poor students seldom detect comprehension failures, asking only vague questions. Good students, on the other hand, do detect comprehension failures and ask specific questions, actively engaging in self-explanation.

Saye and Brush (2002) created a multimedia learning environment named Decision Point! for teaching history. In their environment, they differentiate between hard and soft scaffolds. Hard scaffolds are those permanent "static" things built into the environment, such as the structure of a user-accessible database. Soft scaffolds are more just-in-time prompts, both dynamic and situational. A soft scaffold example is when a teacher asks a student to elaborate on an idea with a leading question. The authors of this qualitative study concluded that hard scaffolding is limited in achievable learning gains. It requires a master teacher (utilizing soft scaffolding techniques) to align all aspects of the learning environment for superior learning.

Davis and Linn (2000) used the Knowledge Integration Environment (KIE) (see Bell, Davis, and Linn, 1995) to investigate the use of prompts to increase reflection. They ran three studies. Study one compared the effects of self-monitoring prompts and activity prompts on project success. There were two groups in study one. The first group received only activity prompts. The second group received both activity and self-monitoring prompts. Study two was a replication and refinement of study one. Study three investigated the kinds of reflection self-monitoring prompts elicit as well as the relationships between reflection and success on the given project. They concluded that prompts can help students complete an activity, but may not elicit an integrated understanding of the general aspects of the activity; instead reinforcing a rote, one-path solution that is not generalizable. Reflection prompts can enable sophisticated knowledge integration, but a variety of these types of prompts are needed, as individuals respond to prompts differently.

Bell and Davis (2000) investigated the effectiveness of scaffolding in the form of
prompts and hints by using Mildred, a guidance-on-demand system within KIE. Mildred provides three types of hints – activities, evidence, and claims. Mildred includes four types of notes – activities, evidence, claims, and reflection. Bell and Davis found that directed (specific) prompts constrained individual's boundaries of thought. Students receiving generic prompts cited significantly more ideas, displayed a significant higher number of coherent thoughts, and reflected more on their processes. It is thus implied that there may be an optimal level of specificity in prompting.

Cho and Jonassen (2002) investigated the use of scaffolds to assist in the argumentation phase of solving ill-structured problems. They predicted that providing these scaffolds would increase problem-solving performance. The experiment was constructed with 20 three-person groups. Ten groups solved well-structured problems; ten groups solved ill-structured problems. Within each of these problem types, half (five groups) used a bulletin board system to assist in solving the problem. The other half used software named Belevedere, a constraint-based tool developed by the University of Pittsburgh to support students in the creation of socially constructed arguments. Their experiment produced significant results. Groups solving ill-structured problems produced more arguments in general, while the scaffolded group produced more claims and evidence than the non-scaffolded groups.

**Motivation**

Learner motivation is an important variable to consider when developing, monitoring, and assessing instructional effectiveness. Motivation is a hypothetical construct. It cannot be directly and scientifically measured. Psychologists concerned with learning and instruction use the term motivation to describe those processes that can
energize and give direction or purpose to behavior (Wlodkowski, 1989). It is highly unpredictable and changeable, subject to many influences beyond the control of teachers and designers (Keller, 1987). Heckhausen (1991) writes:

The term motivation in psychology is a global concept for a variety of processes and effects whose common core is the realization that an organism selects a particular behavior because of expected consequences, and then implements it with some measure of energy, along a particular path. (p. 9).

There are many, many definitions of motivation. Most of these definitions fall into two categories, physiological definitions and psychological definitions. Under each of these two categories are hundreds of definitions. Motivation is affected by many other cognitive factors and the individual's location in space and time. For example, cultural context can affect a person's achievement motivation (Travers, 1982). As Fukász (1985) states, motivation must always be studied in the context of historical traditions and the economic, social, and cultural conditions of the country in question. Motivation and culture are inseparable (Wlodkowski, 1999).

Definitions of Motivation

Physiological

Physiological definitions of motivation deal only with observable facts concerning measurable bodily functions. In general, the term “energized” is used to describe motivation. The animal must be active to be motivated. (Travers, 1982). Behavior is energized through a strong external stimulus, called a drive stimulus. (Hull,
Drive states have to do with basic bodily needs, such as thirst, hunger, and the need to reproduce. H. A. Murry called these viscerogenic needs, needs related to bodily needs. (Travers, 1962).

While some aspects of motivation can be explained in purely physiological terms, (such as heightened heart rate), there are many aspects of the origin of motivation that defy this objective scrutiny. Thus, many years ago scientists turned towards possible cognitive explanations of motivation.

**Psychological**

Scientists have long debated if humans are endowed with cognitive sources of motivation (Travers, 1982). Scientists cannot provide satisfactory empirical reasons for how motivation without external stimuli arise (Travers, 1982). It is possible that many aspects of motivation are learned. H. A. Murry called these psychogenic needs, needs that are learned (Travers, 1982).

**Importance of Motivation in Learning**

It is almost universally accepted that there is a positive correlation between motivation and learning. Dewey (1938) wrote that most important attitude that can be formed is a desire to learn. The more motivated a person is about a given subject, the more likely s/he will learn about that subject. Malone (1981) claims that intrinsically-motivated students may spend more time and effort learning, feel better about that
learning, and use that learning more in the future. Schank (1999), in defining the eight most important things one must consider when building the Virtual University, places motivation at the top of the list. An understanding of the particular conditions that energize human behavior is needed if we are to successfully control motivational constructs in instruction (Travers, 1982). Unfortunately, our understanding of motivation is a “weak link” as applied to learning and design processes (Duchastel, 1997).

**Relationship Of Learners To Motivation And Learning**

Learners have some unique needs and up-front desires when it comes to learning. Most are very goal oriented, and want instruction that they can immediately apply to their job or life (Knowles, 1980). Adults are highly pragmatic learners. They want instruction that gives them the ability to do something (Wlodkowski, 1989). Adults will actively seek out learning situations they consider optimal. They purposefully engage in learning situations to meet a goal, to achieve competence. Motivation is high and intrinsic in these individuals (Wlodkowski, 1989). Adults also have a need to take charge of their learning (Keller, 1987; Penland, 1979). While they may want and need guidance in choosing amongst alternatives, they want to make the final decision. When adults see they are responsible for their learning they are likely to be motivated (Wlodkowski, 1989). Finally, it is possible that adults are motivated to learn because of their need to grow, to become more than they are (Knowles, 1980).

The type of adult and his/her environment has impact on instruction delivery. It is typically written that adults in distance education courses tend to be highly mature,
capable of working and learning with relatively little guidance (Wlodkowski, 1989).

These people can be classified as motivated, for they seek out education. This is certainly true for some percentage of adults in distance education settings. However, there are other adults who lack these autonomous capabilities, have the education thrust upon them, and they bring little motivation to the learning environment. They may have a limited educational background, or one that is rife with failures and problems. These two groups obviously represent the extremes of what one may find in a given adult learner population, but they are both valid, significant groups.

In a motivational study of adult learners by Hancock (1994), he concluded that low conceptual learners (LCL) and high conceptual learners (HCL) will learn better and with higher motivation in situations that meet their learning needs. LCL people have relatively few cognitive structures and want to minimize ambiguity in their learning. They prefer structured, hand-fed instruction. HCL people are more complex cognitively and can deal with (and perhaps prefer) less structured learning environments. Hancock’s findings supported these statements, suggesting that this is at least one way instructional designers can classify adult learners and thus develop appropriate instructional strategies for both groups.

For HCL people, motivational constructs embedded within the overall delivery of instruction are minimally needed, at best. For LCL people, motivational constructs probably should be included at key points, as this group lacks these constructs themselves.

Related to Hancock's work is the concept of field dependency (Witkin, 1977). Field dependent learners are those that rely on external cues for learning. Field
independent learners, on the other hand, are intrinsically motivated and can rely on environmental cues to positively manipulate the learning environment.

Achievement goals are another area where learner differences come into play. According to Elliot and Harackiewicz (1994), there are two types of achievement goals that affect both motivation and performance - performance achievement oriented or mastery achievement oriented. Performance achievement oriented individuals are interested in developing competency in relation to others, doing what is asked of them, often only shallowly processing information. Mastery achievement oriented individuals are interested in mastering the task for their own sake, and are not as interested in reaching a comparative norm. Obviously educators would like to see all individuals approach a learning situation with a mastery achievement framework.

**Instructional Design Models/Frameworks That Have An Implied Motivational Component**

According to Reigeluth and Moore (1999), the field of instructional design is undergoing a paradigm shift. This shift is towards a more student-centered, customized, active learning approach, and some indirect consideration to motivation is now given in many current instructional design theories. In many theories, little is given beyond mention of motivation's importance to guide the instructional designer in incorporating motivational strategies within an instructional lesson, module, course, or system.

Some authors provide general guidelines. For example, Cropley (1985) lists five general areas one should consider when designing motivating instruction for adults:
1. Organization: Activities should take place in an environment that makes sense to the learners, where connections between the subject matter and their real lives is obvious.

2. Content: The content of a course must be closely linked with the real-life needs and interests on the learner.

3. Teaching and Learning Activities: Allow the learners to regulate their own learning, including self-pacing and self-evaluation.

4. Educational Technology: Use educational technology to provide concrete activities that are self-directed, self-paced, and can be used in various locations, such as the home.

5. Staff and Staff Training: Staff members must be aware of adult learning needs, know how to function as facilitators, and be able to guide learners in the self-evaluation and self-pacing process.

Some authors admit motivation is important and may even overtly list it as an instructional event. For example, Dick, Carey, and Carey (2005) state that motivating learners should be done throughout an instructional activity. Some theories have motivational constructs covertly assimilated into the theory. Topic relevance is discussed by Hannifin, Land, and Oliver (1999) in their discussion of Open Learning Environments, as well as Jonassen's (1999) Constructivist Learning Environments. The link between relevance and motivation is overt here. In addition, these theories discuss scaffolding, or matching the task to the student's abilities. In a properly scaffolded learning environment, expectancy for success must be high. Vroom's (1964) expectancy-value theory, that contends that two essential motivational elements are value of the task
and expectancy of success, provide theoretical support for such scaffolding. Bandura's (1977) description of self-efficacy - the belief that one can or cannot execute some action - also provides theoretical support for scaffolding.

**Instructional Design Models/Frameworks That Have An Overt Motivational Component**

The ARCS Model by Keller (1987), the Time Continuum Model of Motivation by Wlodkowski (1989), the Motivational Framework for Culturally Responsive Teaching, also by Wlodkowski (1999), and the Taxonomy of Intrinsic Motivations for Learning by Malone and Lepper (1988) all include components for developing and assisting learner motivation. Each is discussed below.

**The ARCS Model**

The ARCS model was developed by John Keller over a period of approximately 10 years. ARCS stands for:

- Attention
- Relevance
- Confidence
- Satisfaction

ARCS is based on Vroom's (1964) expectancy-value theory, in turn derived from the writings of E. C. Tolman and K. Lewin. Tolman believed that an expectancy was the
anticipation held by an organism that under a given set of circumstances, a particular behavior would lead to a particular outcome (Beck, 1983). Each component of the ARCS model is briefly described below.

Attention – Gaining attention is a learning prerequisite. Getting and sustaining it is critical. One must arouse a student’s knowledge-seeking curiosity without over-stimulating it. The goal is to find the proper location between boredom and hyperactivity. The Yerks-Dodson Law directly supports this notion. The Yerks-Dodson Law states that as tasks are increased in difficulty, the optimum level of motivation declines (Travers, 1982). Cognitive Load Theory (CLT) also supports this idea. Instruction should create an optimal balance between the intrinsic load of the task and the ineffective-effective load ration of the instruction (Paas, Tuovinen, van Merriënboer, & Darabi, 2005). One technique to gain and keep attention is through the use of novelty. Novel objects or situations make the individual attend to the object or situation in an attempt to discover the nature of the object or situation (Travers, 1982). The use of color, animation, and sound can also be used as external stimuli to motivate learners. It attracts and retains users (Ritchie & Hoffman, 1997).

There are three basic ways to gain attention:

1. Perceptual Arousal
   
   Gain and maintain student attention by the use of novel, surprising, incongruous, or uncertain events in instruction.

2. Inquiry Arousal
   
   Stimulate information-seeking behavior by posing, or having the learner generate, questions or a problem to solve.
3. Variability

Maintain student interest by varying the elements of instruction.

Relevance – How does the instruction seem to meet the present and anticipated needs of the learners? Perhaps the most interesting aspect of this part of the ARCS model is Keller’s claim that relevance can not only come from what is taught, but also from how it is taught. For example, people with a high need for affiliation will perceive relevance in group projects. Others support this claim. Curiosity, creativity, and higher-order thinking are stimulated by relevant, authentic tasks of optimal difficulty and novelty for each student, according to Wagner (1998).

There are three basic methods for providing relevance:

1. Familiarity

Adapt instruction, use concrete language, use examples and concepts that are related to the learner's experience and values to help them integrate new knowledge.

2. Goal Orientation

Provide statements or examples that present the objectives and utility of the instruction, and either present goals for accomplishment or have the learner define them.

3. Motive Matching

Adapt by using teaching strategies that match the motive profiles of the students.
Confidence – Expectancy for success. Locus of control plays an important part here. Does the learner believe s/he is responsible for learning success (internal locus), or is s/he a helpless pawn in the learning environment (external locus)? People with an internal locus of control tend to attribute success to effort. People with an external locus look to luck or the difficulty of the task for determination of success. In his discussion of fear of failure people, Travers (1982) provides further validation for Keller’s argument that confidence is a motivational factor in instruction. Fear of failure people will accept the risk if the odds of success are either very good or very poor. Very poor chance failures can be blamed on outside factors. Success-oriented people will accept middle-of-the-road risks and avoid the high and low-risk situations. Low risks offer too little challenge, whereas high risks are too chancy.

There are three ways of building confidence in the learner:

1. Expectancy for Success
   Make learners aware of performance requirements and evaluative criteria.

2. Challenge Setting
   Provide multiple achievement levels that allow learners to set personal goals or standards of accomplishment, and performance opportunities that allow them to experience success.

3. Attribution Molding
   Provide feedback that supports student ability and effort as the determinants of success.

Satisfaction – How good do people feel about their accomplishments? Keller (1987) claims this category involves the normal reinforcements for work well done, but also
contends with issues of learner control. If a student must accomplish a goal to get a teacher-derived reward as opposed to an already-existing intrinsically satisfying reward, control of the learning situation is lost to the student. In these cases, learning satisfaction actually decreases. Malone (1981) certainly concurs with this statement, as do other researchers (see Zimbardo, 1969, and Lepper & Greene, 1979).

There are three ways of enhancing satisfaction:

1. Natural Consequences
   Provide opportunities to use newly acquired knowledge or skill in a real or simulated setting.

2. Positive Consequences
   Provide feedback and reinforcements that will sustain the desired behavior.

3. Equity
   Maintain consistent standards and consequences for task accomplishment.

The Keller ARCS Model also includes a design process that concerns itself with analyzing audience motivation, preparing motivational objectives and instructional elements, and assessment of motivational outcomes.

How applicable is the ARCS model to online learning environments? Arnone and Small (1999), implicitly support the ARCS model in their description of motivational factors in educational web sites. Web sites must be:

1. Engaging and stimulating - captures and maintains interest
2. Useful and Credible - elements that add value and promote relevance
3. Organized and Easy to Use - navigation, user control, help mechanisms
4. Satisfying and Effective - opportunities for interaction, exploration, fun, and building competence

**Time Continuum Model of Motivation**

Raymond J. Wlodkowski has devoted a great deal of thought to motivation and the adult learner. In general, he believes one should look for four aspects in any instruction (Wlodkowski, 1989):

- **Value** – Is the learning important?
- **Appeal** – How stimulating is the learning?
- **Perseverance** – How well do students maintain their involvement? Are other environmental factors clamoring for attention? Perseverance is greater when these distractions can be blocked out (Heckhausen, 1991). Lewin’s Theory of Systems Under Tension (Wlodkowski, 1989) supports this idea, as do certain interpretations of the Yerks-Dodson law. Atkinson and Birch’s Dynamic Action Theory (1970) claims that in a given point in time, there are many incomplete actions the individual needs to complete. All are scrambling for priority. This can cause a breakdown in perseverance.
- **Continuing motivation** – Using what was learned outside the learning experience. This can be tied to enhancing retention and transfer – showing students how to do this, at least initially.

While motivation is one of these four aspects, it is not as clearly defined as it is in his Time Continuum Model of Motivation:
Time Continuum Model of Motivation (Wlodkowski, 1989)

- Before Instruction
  - Attitude
  - Need

- During Instruction
  - Stimulation
  - Affect

- After Instruction
  - Competence
  - Reinforcement

Positive attitudes are established by clearly stating the goals of the course, using clear examples, and stating the criteria for evaluation. Adult learner needs are addressed by reducing or removing environmental components that lead to failure. Chances are provided to practice using a newly acquired skill or piece of knowledge before it is assessed. Assistance should always be available.

Most adult learners at the beginning of a learning sequence will ask “Do I need it?” and “What do I think of it?” These internal needs and attitudes interact with the stimulation and affective processes that occur during instruction.

To maintain learner attention, provide a variety of activities and different presentation techniques that stimulate the learner. Make sure the learner is an active participant in the learning process. To maintain positive attitudes, utilize cooperative goal and learning structures to maximize cohesiveness in the learning group. By maintaining
learner attention and a positive attitude, the learner’s effort to continue learning is maintained.

Increase learner competence by making the learner aware of progress towards goals via positive feedback. Include the progress towards mastery and demonstrate how the learner is responsible for his/her own learning. This reinforcement provides a strong motivational influence for continued/future learning.

The Motivational Framework for Culturally Responsive Teaching

Wlodkowski (1999) has developed another framework for examining and fostering motivation (see Figure 2.1). The Motivational Framework for Culturally Responsive Teaching is the blending of his earlier work and his attempt to integrate cultural sensitivity into the teaching process.

![Figure 2.1 The Motivational Framework for Culturally Responsive Teaching](image)
This framework has four essential components:

1. Establish inclusion by creating a feeling of respect and connectivity between teachers and students.
2. Develop attitude by ensuring personal relevance and choice.
3. Enhance meaning by creating challenging experiences that include learner’s values and perspectives.
4. Engender competence by creating an understanding that learners will learn about something that they want to learn about.

Wlodkowski describes 60 motivational strategies under these four categories that one can use to ensure motivation in virtually any learning situation. Some of these strategies are referenced below, where models are compared and contrasted.

**Taxonomy of Intrinsic Motivations for Learning**

The Taxonomy of Intrinsic Motivations for Learning was developed by Thomas W. Malone and Mark R. Lepper (1988). It is based on theoretical discussions on motivation both authors previously developed. The taxonomy is divided into two sections.

I. Individual Motivations

A. Challenge
   A.1. Goals
   A.2. Uncertain Outcomes
   A.3. Performance Feedback
   A.4. Self-esteem

B. Curiosity
   B.1. Sensory Curiosity
   B.2. Cognitive Curiosity
C. Control
   C.1. Contingency
   C.2. Choice
   C.3. Power
D. Fantasy
   D.1. Emotional Aspects
   D.2. Cognitive Aspects
   D.3. Endogenity

II. Interpersonal Motivations
   A. Cooperation
   B. Competition
   C. Recognition

Malone and Lepper’s Taxonomy is loosely based on several cognitive theories of motivation. Each aspect of their taxonomy is described below.

**Challenge** – Activities that provide an optimal level of challenge – neither too difficult or too easy. This is supported by the Yerks-Dodson Law, Lewin’s Theory of Systems Under Tension (Wlodkowski, 1989), and Atkinson and Birch’s Dynamic Action Theory (1970). Vgotsky’s (1978) Zone of Proximal Development suggests that there is a learning threshold in any individual that cannot be passed without external intervention. It could be argued that the external intervention necessary to pass this threshold should be constructed to provide an optimal level of challenge to the learner. Reiber (1992) argues this approach for the design of educational microworlds, but the same should hold true for any learning environment.

Stating an explicit goal is important in a traditional environment. Ausubel’s (1968) theory of advanced organizers supports this concept. For environments that may not have explicit goals, such as open-ended learning environments or open-ended case studies, emergent goals can be generated by the learners themselves (Malone & Lepper, 1988). This may hold true in complex educational environments as well.
An uncertain outcome is desirable to make the learning environment challenging. Malone & Lepper (1988) suggest this can be accomplished by varying the difficulty levels of the instruction, establishing multiple levels of goals (i.e., varying time constraints), providing incomplete information and making the learner seek out the missing elements, and applying randomness where possible (i.e., varying the room size when calculating the amount of paint needed to paint the room).

Performance feedback that is frequent, clear, constructive, and encouraging (building self-esteem) is required to make instruction intrinsically motivating. Numerous studies on feedback support these assumptions. See Cameron and Pierce (1994) for a meta-analysis of studies that examine the relationship between reinforcement, reward, and intrinsic motivation.

Curiosity – Sensory curiosity occurs when changes in light, sound, smell, etc. occur and one attends to that change. Special effects, such as zooming in, etc. all fall under this category. One use of sensory curiosity is for gaining attention. Cognitive curiosity can be stimulated by an incompleteness in the learning environment, an inconsistency, or an unparsimonious event.

Control – Control plays an important part in motivation, according to Malone and Lepper (1988). Learners will seek control of their learning environment. Knowles (1980) concurs with this statement, explaining that as a person matures, s/he moves from dependency to increasing self-directedness. When a learner makes a choice or takes an action, the result must be contingent upon that choice or action. Also, the learner must be able to make a reasonable amount of choices and not be straitjacketed into one learning path. Finally, the learner must perceive that s/he has power over the learning
environment, which is demonstrated both through overt contingent responses to actions and the ability to make choices.

**Fantasy** – Fantasy is a category unique to the Malone and Lepper Taxonomy. In a fantasy environment, mental images of physical or social situations not actually present are evoked. A role-playing game might fall under the fantasy category, as might a case study. From an emotional standpoint, fantasies can help one to experience power, success, fame, and fortune. For a fantasy to fulfill an emotional need, the learner probably needs to identify with the character(s) in the fantasy. Thus, a case study that contains a person or persons similar to the learner will probably evoke a string emotional response and be more interesting (and motivating) to the learner.

Fantasies may also help a learner to relate new learning to past experience. For example, using a dartboard simulation (or fantasy), something the learner is familiar with, the rules of physics can be explored in a way that makes sense to the learner.

Finally, fantasies where the skills to be learned and the fantasy itself are tied together in an endogenous relationship are believed to be more motivational. Such fantasies may provide for a state of flow. Such a state of flow must qualify as an optimally motivating experience. Flow is discussed in more detail in the following section.

The second part of Malone and Lepper’s Taxonomy deals with interpersonal motivations. They believe that cooperation and competition are equally important and should be used appropriately. Also, a learner’s achievement should be made available to other people, so the need for recognition in the individual is satisfied.
Comparison of Motivational Models/Frameworks

To illustrate some broad generalizations one can make about integrating motivational constructs into the instructional design process, the four models/frameworks discussed previously will provide the foundation for comparison and contrast of different motivational aspects (see Table 2.1). Although there are many more motivational theories that could be considered here, only the four models/frameworks described above will be used, for they represent a serious attempt to bring theory into practice.
Table 2.1
Comparison of four models concerning motivation

<table>
<thead>
<tr>
<th>ARCS (Keller)</th>
<th>Time Continuum (Wlodkowski)</th>
<th>Culturally Responsive Teaching (Wlodkowski)</th>
<th>Taxonomy of Intrinsic Motivation (Malone &amp; Lepper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Attention – Obtaining and sustaining</td>
<td>• Appeal – How stimulating is the learning?</td>
<td>• Establish the relationship of instruction to learner’s lives.</td>
<td>• Provide optimally-challenging activities.</td>
</tr>
<tr>
<td></td>
<td>• Provide a variety of activities and different presentation techniques.</td>
<td>• State goals.</td>
<td>• Change sensory conditions to arouse curiosity.</td>
</tr>
<tr>
<td></td>
<td>• Relevance – Meet the needs of the learners.</td>
<td>• Value – Is the learning important?</td>
<td>• State goals or allow goals to emerge.</td>
</tr>
<tr>
<td></td>
<td>• State goals.</td>
<td>• State goals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Continuing motivation – Use what was learned outside the learning experience.</td>
<td>• Establish inclusion of learner with teachers and other students.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Confidence – Develop an expectancy for success.</td>
<td>• Use clear examples.</td>
<td>• Provide an optimal level of challenge.</td>
</tr>
<tr>
<td></td>
<td>• Use clear examples.</td>
<td>• State criteria for evaluation.</td>
<td>• Provide performance feedback.</td>
</tr>
<tr>
<td></td>
<td>• State criteria for evaluation.</td>
<td>• Provide performance feedback.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provide performance feedback.</td>
<td>• Reduce or remove failure-causing components.</td>
<td>• Clearly state the rules and procedures of the class/course.</td>
</tr>
<tr>
<td></td>
<td>• Confidence – Develop an expectancy for success.</td>
<td>• Establish inclusion of learner with teachers and other students.</td>
<td>• Provide performance feedback.</td>
</tr>
<tr>
<td></td>
<td>• Use clear examples.</td>
<td>• State criteria for evaluation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• State criteria for evaluation.</td>
<td>• Provide performance feedback.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provide performance feedback.</td>
<td>• Reduce or remove failure-causing components.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Satisfaction – How good do people feel about their accomplishments?</td>
<td>• Enhance meaning by creating challenging experiences that include learner’s values and perspectives.</td>
<td>• Provide control over the learning environment</td>
</tr>
<tr>
<td></td>
<td>• Give learners control over reaching goals that are intrinsically motivating.</td>
<td></td>
<td>• Use fantasy to help the student experience power, success, fame, and fortune. Also helps learners relate new learning to a past experience.</td>
</tr>
</tbody>
</table>
As presented in Table 2.1, the four models/frameworks have a great deal of overlap. While semantics may differ and the degree of detail change, all models concur that getting and sustaining attention, relevance, competence, and satisfaction are important motivational constructs (as per the ARCS model). This is not to say the other models/frameworks are not unique and should be discarded. Each model presents unique insights that may not be apparent in the brief overview provided. Malone and Lepper’s Taxonomy, for example, discusses fantasy in great detail. This is an unknown component in all other models.

The Importance of Flow

In addition to several strong models/taxonomies concerning motivation and learning, the concept of flow must be examined. Flow is a term coined by Csikszentmihalyi (1990). It is a merging of the learner's total attention with the task at hand such that all other sensory and cognitive distractions are invisible to the learner. In these cases, the learner’s attention is totally on the learning environment and it is very difficult to distract him/her. The learner is unaware of time passing, and may later remark on this. Flow may be described as an optimal motivating experience, where the learner is so immersed in his/her learning that everything except the learning environment conceptually disappears for a time.

Jones (1998) contends that it is possible to create flow in educational games. He outlines eight criteria a learner must experience to achieve flow (see Table 2.2). As these
criteria are broadly based, these are easily adopted to online distance learning environments:

Table 2.2
Elements of flow

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Task can be completed.</td>
<td>Scaffolded tasks that rest within the Zone of Proximal Development.</td>
</tr>
<tr>
<td>2. Learners can concentrate on task.</td>
<td>Reduce cognitive load on environmental operations and low-level cognitive tasks.</td>
</tr>
<tr>
<td>3. Task has clear goals.</td>
<td>Provide problems that are relevant to the learner and the content.</td>
</tr>
<tr>
<td>4. Task provides immediate feedback.</td>
<td>Environment is responsive to user interactions and reacts accordingly. Actions that are deemed positive by the designer are positively reinforced. Actions that are deemed negative by the designer are negatively reinforced.</td>
</tr>
<tr>
<td>5. Deep (losing awareness of real environment &amp; loss of real-world concerns) but effortless involvement in task.</td>
<td>Relevance of task, smooth integration of tools and manipulation mechanisms into the environment, perception of moving towards a desired goal state.</td>
</tr>
<tr>
<td>6. Learners exercise a sense of control over their actions.</td>
<td>Learner control of the environment. Ability to navigate to a desired location. Ability to change the environment and see the results.</td>
</tr>
<tr>
<td>7. Concern for self disappears during flow, but sense of self is stronger after flow activity.</td>
<td>Achievable goals. Tasks within the Zone of Proximal Development. Eliminate personal &quot;danger.&quot;</td>
</tr>
<tr>
<td>8. Sense of time is altered.</td>
<td>Tasks and information must flow smoothly from one to the other. There can be no disjointed experiences, such as stopping to figure out what a particular button does in the middle of a task.</td>
</tr>
</tbody>
</table>

Thus, several sound models/taxonomies and theories exist as frameworks for developing learning instruction that is inherently motivating.
Goal Orientation

According to Elliot and Harackiewicz (1994), there are two types of achievement goals that affect both motivation and performance - performance achievement oriented or mastery achievement oriented. Performance achievement oriented individuals are interested in developing competency in relation to others, doing what is asked of them, often only shallowly processing information. Mastery achievement oriented individuals are interested in mastering the task for their own sake, and are not as interested in reaching a comparative norm.

Pintrich and Shunk (2002) provide an comprehensive analysis of current goal orientation theory:

Normative Goal Theory

• Mastery Goals

Individual has a focus on learning and self-improvement.

• Performance Goals

Individual has a focus on demonstrating ability, trying to do better than other or not appear worse than others.

Multiple Goal Perspective

• Mastery Goals
  
  o Mastery-approach goal

  Individual defines competence in terms of self-improvement and self-set
standards. When engaged in achievement-directed behavior, they focus on learning, skill development, creativity, and understanding.

When students approach achievement tasks with a mastery orientation, they experience a variety of desirable outcomes: enhanced interest in learning, more positive attitudes toward learning, viewing of errors as informational, attribution of failure to lack of effort (rather than lack of ability), academic engagement and effort, perseverance in the face of challenges, more risk-taking, and asking for assistance when needed (Pintrich & Schunk, 2002).

- **Performance Goals**
  - Performance-approach goal
    Individual engages in achievement behaviors for the purpose of demonstrating their ability, besting others, and obtaining recognition (Pintrich & Schunk, 2002).
  - Performance-avoidance goal
    Individual engages in activities to avoid looking dumb, stupid, or less able than other students.

Patterns of Interaction in Multiple Goal Perspectives

- **Additive Goal Pattern**
  Mastery and performance-approach goals have independent, positive effects on a single educational outcome.
Positive performance goal effects do NOT depend on a high level of mastery goals.

- Interactive Goal Pattern
  Mastery and performance-approach goals interact to produce positive effects on a single educational outcome. (Mastery goal X Performance-approach goal)
  Positive performance goal effects DEPEND on a high level of mastery goals.
  No college studies to date support this.

- Specialized Goal Pattern
  Mastery and performance-approach affect different outcomes.
  Example: Mastery goal predicts interest, but performance-approach goal predicts grade.
  Individuals adopting this pattern are optimally motivated?

- Selective Goal Pattern
  Individual focuses on the achievement goal that is most relevant to a single point in time. Example: Individual pursues mastery goal when reading course content, but pursues performance-approach goal when readying for a test.
Chapter 3

RESEARCH METHOD

Participants

The research participants were undergraduate college students from two Information Sciences and Technology (IST) classes; IST 110 and IST 250. Both these courses were appropriate for the experiment as described below. Quality web design is an important consideration in both courses, and individuals taking these courses will be expected at some time (both in college and in their future careers) to design a web site. It was estimated that between 80-100 subjects would be recruited from a pool of 150.

The Context of the Study

IST 250 (New Media and the Web) is a course designed to teach basic web design concepts. The curriculum includes collaborative learning and problem-solving experiences. IST 250 is taught in both a traditional (face-to-face class) and online manner. The traditional version usually meets twice a week for 75-minute sessions. The online version is administered by Penn State's World Campus, and is asynchronous in nature.
The content of IST 250 includes:

- Internet Introduction
- The End User and Design
- Design Considerations
- Overview of HTML
- Layout, Forms, Scripts
- Graphics on the Web
- Site Management
- Dynamic Interactivity
- Security and E-Commerce
- Advanced Design
- Multimedia and the Web

IST 110 (Introduction to Information Science and Technology) is a course designed to introduce basic concepts in information sciences and technology. The curriculum includes collaborative learning and problem-solving experiences. IST 110 is taught in a traditional (face-to-face class) manner, usually meeting twice a week for 75-minute sessions.

The content of IST 110 includes:

- Information Society
- Information Processing
- The History of Computing
- Computer Hardware
- Networks and Security
• Database Fundamentals
• Human Factors and HCI
• The Internet and WWW
• Organizations and IT
• Designing and Developing IT
• Implementing and Managing IT
• Future Directions

Participants in both classes may have had some prior experience in solving problems, but were still considered novices in solving ill-structured problems. In this study the problem scenario, the content, the format, and the nature of the problem-solving task were different from participants' prior experiences.

**Research Design**

The research questions are stated in Table 3.1, including techniques, tasks, materials, instruments, and data sources. This study was a mixed study design, integrating quantitative with qualitative methods. The quantitative method empirically measured individual's problem-solving outcomes on an ill-structured task. The independent variable was the cognitive and metacognitive prompts used. The dependent variable was the problem-solving process, measured by a rubric that assesses the four ill-structured problem-solving processes: problem representation, developing solutions, making justifications, and monitoring and evaluation. The quantitative method utilized a posttest-only control group design.
The qualitative method investigated contextual information about the individual's problem-solving process, such as how it affected their motivation and problem representation, solution development, making justifications, and monitoring and evaluation of solutions. This was accomplished via observation (through videotaping), interviews, and think-aloud protocols. Through these protocols, the researcher examined individuals' thoughts, actions, and decision-making, as well as their motivational states during the problem-solving process. This enabled the researcher to acquire views of individuals' problem-solving processes and motivational structures on an ill-structured task, in conditions with or without the influence of cognitive and metacognitive prompts.

Within a treatment, subjects were given a web-design task containing an ill-structured task to complete. Subjects "discovered" the parameters of the web site while interacting with the treatment, and developed a storyboard of the web site upon completion of the online learning environment.
Table 3.1

Overall study questions, data collection techniques, instruments, and data sources

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Techniques</th>
<th>Data Sources//Instruments</th>
</tr>
</thead>
</table>
| 1. Does the use of cognitive and metacognitive prompts have an effect on an individual's problem-solving outcomes (problem representation, solution development, making justifications, and monitoring and evaluation of solutions) and motivation in an ill-structured task? | • Rubrics to assess problem solving reports and storyboard. | • Students’ problem-solving report and storyboard.  
• Self-report survey of the ill-structured problem-solving experience. |
| 2. How does the use of cognitive and metacognitive prompts influence an individual's problem-solving processes (problem representation, solution development, making justifications, and monitoring and evaluation of solutions) and motivation in an ill-structured task? | • Think-aloud protocols.  
• Video-taping.  
• Observation.  
• Interviews.  
• Survey instrument. | • Students’ problem-solving report and storyboard.  
• Transcripts of video of select students working on the ill-structured task.  
• Transcripts of audio/video of post-intervention interviews. |
The Experimental Study

The posttest only experimental study was designed to answer Question 1 (see Table 3.1) by investigating the relationship between question prompts and problem-solving. This study was a mixed study design, integrating quantitative with qualitative methods.

The quantitative method empirically measured each individual's problem-solving outcomes on an ill-structured task. The independent variable was the cognitive and metacognitive prompts used. The dependent variable was the problem-solving outcome, measured by (a) analysis of problem representation, (b) developing solutions, (c) making justifications, and (d) monitoring and evaluation. The outcomes were measured through a problem-solving report (consisting of notes written during the problem-solving process) and storyboard which were completed by all students at the end of the instruction.

- The study utilized a treatment and control group: Treatment 1 was the control group. It did not include any prompting intervention.
- Treatment 2 included both cognitive and metacognitive prompts designed to assist and guide the individual through the problem-solving process.

This is visually represented in Figure 3.1:
Cognitive and Metacognitive Prompts Used

<table>
<thead>
<tr>
<th>Treatment 1 - Control</th>
<th>Cognitive and Metacognitive Prompts Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 2 - Experimental</td>
<td>X</td>
</tr>
</tbody>
</table>

Figure 3.1 Treatments

Subjects were randomly assigned to one of these two groups.

Within a group, subjects were given a web-design task containing an ill-structured problem to complete (see Appendix B). Subjects "discovered" the parameters of the website while interacting with the instruction, and developed a storyboard of the website upon completion of the online learning environment.

The qualitative method was designed to answer Question 2 (see Table 3.1) by investigating the relationship between question prompts and problem-solving processes, such as how it affected their motivation and processes of problem representation, solution development, making justifications, and monitoring and evaluation of solutions. This was accomplished via observation, interviews, and think-aloud protocols. Through these protocols, the researcher examined individuals' thoughts, actions, and decision-making, as well as their motivational states during the problem-solving process. This enabled the researcher to gain insights into individuals' problem-solving processes and motivational structures on an ill-structured task, in conditions with or without cognitive and metacognitive prompts.
**Ill-structured Problem-solving Task**

The scenario named “Critical Theory” from IST 250 was used as the basis for the problem-solving task. In Critical Theory, students take on the role of one of several companies “hired” to propose a web site for an up-and-coming rock group. The rock group will hire the company with the best proposal. Students will work on the problem individually.

Critical Theory is a problem-based scenario that is traditionally presented in textual form. The original textual presentation of the Critical Theory scenario outlines information on the band, a conversation with the leader of the band, demographic information about record sales, and the band’s target audience. Students read the problem, are given directions on how to approach the problem, and are given access to learning resources. Students are asked to produce a report that includes the storyboard for the site, as well as a Memorandum of Understanding (MoU), the goal of the project, the scope of the project, associated costs and required resources, estimated timeline, and outstanding issues. This report and associated storyboard served as the instruments for assessing problem-solving outcomes.

In problem-solving scenarios, there is a problem space and a learning space (Reigluth & Moore, 1999). These two spaces are conceptually different. The problem space is where much of the "higher order" thinking takes place. Situations are analyzed and synthesized, and potential solutions are evaluated. The instructional space is where learners acquire the "lower-level" skills; the necessary facts and concepts, skills, and attitudes to perform successfully within the problem space. Thus, the learner is presented
with the problem in the problem space, and may have to interact with things in this space to identify the true nature of the problem, make decisions, and so on.

The online learning environment contained the original Critical Theory scenario content in the problem space. It was here that the cognitive and metacognitive prompts were inserted for the experimental group. In this online learning environment, the problem space information was presented in more of a discovery mode. Subjects discovered this information as they progressed through the site. The instructional space was available to learners when they realized they were missing information they needed to solve the problem. The instructional space was in the form of a traditional web site, containing pages of text, graphics, and animation.

The learning environment contained many aspects of a Goal-Based Scenario (GBS) (Schank, Fano, Bell, & Jona, 1993). Students received a mission or goal – create a web site for the band, and an accompanying cover story that provides a reason to pursue that goal. The mission structure was provided via the band member's information, the band's history, an interview with the band's leader, and miscellaneous data about the band. The mission focus was design-oriented. The learner developed a storyboard and rationale for the storyboard specifying how the web site should be developed.

Unlike a GBS, the scenario operations of exploration and discovery were limited in the learning environment to relevant content needed by the learner and optional web sites the learner could explore for creative ideas.

As the problem presented in the learning environment was ill defined, the structure of the environment and guidance included was not as straightforward as it might be in a GBS. Providing this implicit structure and guidance would have structured
the ill-structured nature of the task, invalidating the experiment. Instead, prompts were used (in the experimental group) to assist the learner in developing structure and guidance.

Some of the information given may not have been considered by an individual to be directly relevant to the problem. As in any problem, the learner must sort through all information to determine what is relevant and what is not. Including non-relevant information adds ecological validity to the environment.

The online learning environment resided in ANGEL, Penn State's Course Management System. Although the learning environment consisted only of HTML, CSS and JavaScript, and could exist outside of ANGEL, additional functions available only within ANGEL were used to provide some of the prompting mechanisms for the experimental group. These additional functions included the use of the "My Notes" tool for subjects to use when prompted to write things, and the Action Editor to keep "behind the scenes" tracking of subject's progression through the environment.

The students produced a document that contained the following elements:

**Style Guide and User Specifications**

- General look and feel of the site
- Technical Requirements for users of the site
- Font information
- Color information
- Navigation scheme
- Justification for use of these styles/requirements
Storyboard and Flowchart

- Storyboard that indicates the design of site pages
- Flowchart that details the relationship/links between the pages

Qualitative Data Collection and Analysis

For the qualitative data, several subjects were randomly selected from both the control and experimental groups. These same subjects were asked to participate in a structured interview. Key points from the video tape served as discussion points. Audio transcripts (Appendix F) of these interviews were analyzed to ascertain contextual information about the individual's problem-solving process, such as how it affected their motivation and thinking during the process.

Post-Experimental Data Collection and Analysis

For the quantitative method subjects created a storyboard of a web site. Information to include in the storyboard was presented within the instructional task. All storyboards were collected and analyzed according to a modified scoring rubric (Appendix D) developed by Ge (2001). Subjects were not aware of the rubric prior to completion of the online learning environment. Due to the possible subjective nature of rubrics (Moskal & Leydens, 2000), two individuals performed a rating of each storyboard using the provided rubric. Inter-rater reliability was determined to be .79.
In addition, a modified questionnaire developed by Ge (2001) to investigate problem solving was administered to all subjects. Included in this questionnaire were questions related to the motivational aspects of the various prompts contained within the online learning environment.

For the quantitative data, both parametric and non-parametric analysis of variance were conducted, with problem solving as the dependent measure, and cognitive and metacognitive prompts as the two levels of the independent variable. The questionnaire was analyzed using descriptive statistics and summary of open-ended responses.

Materials and Instruments

The materials and instruments used for the experimental study included the material for the ill-structured problem-solving task (Appendix B), the question prompts treatment material (Appendix C), the scoring rubric (Appendix D), the structured interview questions (Appendix E), and the self-report questionnaire (Appendix G).

The Ill-structured Problem-solving Task Material

The ill-structured problem-solving task material (Appendix B) was a real-life complex problem related to web design developed by IST 250 instructional designers and subject matter experts within the IST College. This scenario is titled "Critical Theory" and revolves around designing a web site for a rock band.
Treatment Material Question Prompts

The treatment material (Appendix C) for the problem-solving task was adapted, in part, from Ge (2001). It consisted of 10 questions generated by IST professors for a related study. The questions are categorized into four types:

1. Problem representation prompts
   i.e., "How do I define the problem?"

2. Solution Prompts
   i.e., "How do I generate the solution?"

3. Justification Prompts
   i.e., "What is my argument for this solution?"

4. Monitoring and Evaluation Prompts
   i.e., "Am I on the right track?"

These questions were included in the problem introduction.

In addition, cognitive and metacognitive prompts defined by Davis & Linn (2000), Ge & Land, (2004), and Lin, Hmelo, Kinzer, & Secules (1999) were incorporated into the treatment material. These prompts appeared in a pop-up window when the subject accessed particular pages in the online learning environment. The nature and placement of the prompts was determined by the researcher and was validated by another reviewer with expertise in design of technology-based learning environments. Dr. Susan Land, the researcher's thesis advisor who has extensive expertise in this area.
Cognitive Prompts

Activity Prompts (AP) – What to do next (Davis & Linn, 2000). This prompt was used to guide the learner to the very next step in a process, or to assist the learner in determining the next step in a process. It is a micro-level prompt.

- "The band leaders said you need to do…"
- "The color expert said you need to be sure…"
- "You should proceed through each section of the Problem Introduction before proceeding to the Problem Resources Section."
- "Your document should include the following…"

Procedural Prompts (PP) – How to globally proceed with the task (Ge & Land, 2004). This prompt was used to assist the learner in see the "big picture." It is a macro-level prompt.

- "An example of this…"
- "Another reason that is good…"
- "What information do I need to solve this problem?"
- "As you analyze the problem, what are it's parts?"

Elaboration Prompts (EP) – Exemplars related to the task (Ge & Land, 2004). This prompt was used to provide or relevant examples to the learner, or to elicit relevant examples from the learner.

- "What is a new example of…"
• "This is similar to…"
• "Examine this site for creative ideas you can use in your site design."

Metacognitive Prompts

Process Displays (MPD) - Show students what progress they have gone through to accomplish a particular task (Lin, Hmelo, Kinzer, & Secules, 1999). This type of prompt visually assisted the learner in reviewing and assessing his/her processes and tasks done so far.

• "Here is a diagram of the steps you took…” – (Show diagram).
• A checkmark placed beside each menu choice in a learning environment as the learner finishes that section.

Process Prompts (MPP) - To call student's attention to their own processes while they are performing a particular task (Lin, Hmelo, Kinzer, & Secules, 1999). This type of prompt textually assisted the learner in reviewing and assessing his/her processes and tasks done so far.

• "What relationships did you observe between…”
• "What happened when you did…”
• "How do you define the problem?"
• "How will you ensure that a stranger reading your document and storyboard would exactly create what you designed?"
Process Modeling (MPM) - To show students how an expert would think through or solve a similar problem (Lin, Hmelo, Kinzer, & Secules, 1999). This type of prompt modeled the ideal approach to a task for the learner.

- "Joe, an expert in this area, did the following…"
- "Here is an expert's procedure for the following task…"
- "These examples came from experts in web design. As you view the content, try to match them with your ideas for the site you are designing."

Reflective Social Discourse (MSD) - To provide students with multiple perspectives on content or process through focused social discourse (Lin, Hmelo, Kinzer, & Secules, 1999). This type of prompt pointed out to the learner different points of view about a given process or approach to a task.

- "What did other members of your group think about…"
- "What did your partner do differently here?"
- "What information given to you from the different band members can you use in your site design?"

Scoring Rubric

An analytical rubric (Appendix D) was adopted from a rubric used by Ge (2001) and was used to score the result of the web site design storyboard and problem-solution report. This rubric was divided into (a) Representing the Problem, (b) Developing Solution(s), (c) Making Justifications for the Proposed Solution(s), and (d) Monitoring and Evaluating the Problem Space and Solutions. Subjects were not aware of the rubric.
prior to completion of the online learning environment. Due to the possible subjective nature of rubrics (Moskal & Leydens, 2000), two individuals performed a rating of each storyboard using the provided rubric. Inter-rater reliability was determined to be .79. The researcher downloaded all data from the course management system used and placed it in folders labeled Sub1, Sub2, etc. It was evident to both the researcher and the other rater which data was from the control group and which was from the experimental group.

**Observation and Think-aloud Protocols**

For the qualitative part of the study, several observation and think-aloud protocol techniques were used. Subjects were observed as they use the online instruction. Observations provided information on how different subjects interacted with the treatments. A structured interview (Appendix E) was conducted after the web site design storyboard and problem-solution report were completed.

The structured interviews allowed the researcher to ascertain contextual information about the individual's problem-solving process, such as how it affected their motivation and thinking during the process. It also allowed the researcher to investigate the subject's perceptions of the treatment.

**Self-report Questionnaire**

A self-report questionnaire (Appendix G) was adopted from a questionnaire used by Ge (2001). This questionnaire allowed the researcher to test for equivalency among
participants. The questionnaire includes questions on the subject's background, their prior experience with problem-solving situations, and their prior experience with online learning environments.

As reported by Ge (2001) the self-report on problem solving section of the questionnaire was modeled on work by Schoenfeld (1985) and Hong (1998). This section included 20 likert-scale questions, divided into four parts:

1. Interpretation of problem representation
2. Developing solutions and monitoring solution process
3. Making justifications and evaluating the problem-solving process
4. Specific strategies used to solve a problem

Procedure

The study was conducted during the 2006 Fall and 2007 Spring semesters at the Pennsylvania State University. During the summer of 2006, the researcher contacted IST 250 and IST 110 professors and instructors, explained the purpose of the study, and requested participation. Subjects received extra credit in the class for participation in the study. The value of the extra credit was determined by individual instructors.

Forty subjects were recruited in the Fall of 2006, and 39 were recruited in the Spring of 2007. The fall participants received the treatment without presence of the researcher. Many of these participants either used a public computer lab or a personal computer. These participants either completed the treatment in one session or took multiple sessions to complete. Fifteen of these participants were IST 250 students; the
remaining 25 were IST 110 students. The 39 spring participants received the treatment in a computer lab where the researcher was present and completed the treatment in one session. All these students were IST 110 students.

Prior to the study, the researcher met with each class whose instructor had agreed to participate. Informed consent was obtained from all subjects who agree to participate.

All subjects were added into a group within ANGEL, Penn State's Course Management System. Copies of associated materials were available for all subjects within this group.

All subjects received the quantitative measures. Subjects were randomly divided into control and experimental groups. The online learning environment and associated materials were distributed to all subjects via ANGEL. All subjects individually used the online learning environment and associated materials to produce the storyboard and report. The storyboard and report were returned to the researcher via ANGEL.

Six subjects in the fall of 2006 were randomly chosen to participate in the qualitative part of the study immediately after all subjects were assigned to either the control or experimental group. Three subjects were chosen from each group. Arrangements were made with these subjects for face to face videotaping and interviews. Upon completion of the storyboard and report, all subjects completed the self-report questionnaire (Appendix G). This questionnaire was web-based and resided within ANGEL.
Chapter 4
RESULTS AND DISCUSSION

This chapter presents the results of the experimental study as well as the subject interviews. The results of the experimental study, in response to the two research questions (see Table 3.1), will be reported first. Second, the findings from observations and think-aloud sessions will be summarized and discussed. Third, the findings from the subject interviews will be summarized and discussed. The interviews served to provide insights into the findings of the experimental study. An overview of the six interviews will be presented, with specific focus on the four ill-structured problem-solving processes and on student motivation. Fourth, the results of the self-evaluation questionnaire will be reported to provide a general profile of the participants' background information and their prior experience and knowledge in problem solving.

The Experimental Study Results

The purpose of the experimental study was to investigate the effects of question prompts in an online learning environment on student's ill-structured problem-solving performance on the processes of problem representation, developing solutions, making justifications, and monitoring and evaluation. The statistical differences between the two groups (treatment and control) were analyzed according to each of the four problem-solving outcomes. The research hypothesis was tested using a univariate analysis of variance (ANOVA) per procedures described by Tabachnick and Fidell (2001) and Fraenkel and
Wallen (2003), and Mann-Whitney U tests as appropriate. In addition, correlations of the dependent variables were determined.

**Statistical Data Analysis**

The statistical data analysis was performed to investigate research question 1: Does the use of cognitive and metacognitive prompts have an effect on an individual's problem-solving outcomes (problem representation, solution development, making justifications, and monitoring and evaluation of solutions) on an ill-structured task? The subjects' performance on each problem-solving outcome was measured via a scoring rubric (see Appendix D). The statistical data analysis was performed to determine the effects on each dependent variable, as well as the overall effects of the use of cognitive and metacognitive prompts.

**Descriptive Statistics**

Table 4.1 illustrates the means, standard deviations, and effect size for all four dependent variables. This study included 40 control and 39 experimental subjects. For purposes of this analysis, Problem Representation is abbreviated as PR, Developing Solutions as DS, Making Justifications a MJ, and Monitoring and Evaluating Solutions as ME.
SPSS Version 15 for Windows was used to determine the descriptive statistics.

Table 4.1
Summary of descriptive statistics and effect sizes

<table>
<thead>
<tr>
<th>Treatment Group</th>
<th>Control (N=40)</th>
<th>Experimental (N=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Dependent Variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representing Problem (PR)</td>
<td>4.15</td>
<td>2.17</td>
</tr>
<tr>
<td>Developing Solutions (DS)</td>
<td>3.23</td>
<td>1.59</td>
</tr>
<tr>
<td>Making Justifications (MJ)</td>
<td>.93</td>
<td>1.31</td>
</tr>
<tr>
<td>Monitoring and Evaluation (ME)</td>
<td>.18</td>
<td>.55</td>
</tr>
</tbody>
</table>

Comparison of Treatment Effects for Each Dependent Variable

To determine the proper data analysis technique, the data was examined to ascertain normality. SPSS version 15 for Windows was used to create histograms of the four dependent variables. The histograms are displayed in Figure 4.1

Figure 4.1 Histograms of distribution of the four dependent variables
As dependent variables PR and DS are normally distributed, Analysis of Variance (ANOVA) tests were used to analyze the statistical differences between control and experimental groups for these two dependent variables. MJ and ME are not normally distributed. As both have a positive skew, non-parametric Mann-Whitney U tests were used to analyze the statistical differences between control and experimental groups for these two dependent variables.

**ANOVA Tests on Dependent Variables PR and DS**

The analysis of variance on the dependent variables PR and DS indicated there were significant statistical differences in both dependent variables, favoring the experimental treatment. The effect of PR was highly significant, F(1,78) = 44.94, p = .000. The effect size of PR was 1.49, suggesting a large difference (Hedges & Olkin. 1985). The effect of DS was highly significant, F(1,78) = 28.6, p = .000. The effect size for DS was 1.19, suggesting a large difference (Hedges & Olkin. 1985). Table 4.2 illustrates this.

**Table 4.2**  
ANOVA effect for dependent variables PR and DS

<table>
<thead>
<tr>
<th>ANOVA Effect and Dependent Variable</th>
<th>Mean</th>
<th>Univariate F</th>
<th>Significance</th>
<th>Effect Size (Bias corrected method)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Group Effect</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representing Problem (PR)</td>
<td>7.36</td>
<td>44.94</td>
<td>p = .000**</td>
<td>1.49</td>
</tr>
<tr>
<td>Developing Solution (DS)s</td>
<td>5.23</td>
<td>28.6</td>
<td>p = .000**</td>
<td>1.19</td>
</tr>
</tbody>
</table>

** p < .01
**Mann-Whitney U Tests on Dependent Variables MJ and ME**

The Mann-Whitney U tests on the dependent variables MJ and ME indicated there were significant statistical differences in both dependent variables. MJ had a mean rank of 51.96 and an absolute Z score of 4.71, \( p = .000 \). The effect size for MJ was 1.25, suggesting a large difference (Hedges & Olkin. 1985). ME had a mean rank of 48.04 and an absolute Z score of 3.78, \( p = .000 \). The effect size for ME was .91, suggesting a large difference (Hedges & Olkin. 1985). Table 4.3 illustrates this.

<table>
<thead>
<tr>
<th>Mann-Whitney U Effect and Dependent Variable</th>
<th>Mean Effect Making Justifications (MJ)</th>
<th>Mean Rank</th>
<th>Mean Effect Monitoring and Evaluation (ME)</th>
<th>Mean Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.51</td>
<td>51.96</td>
<td></td>
<td>1.59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.71</td>
<td></td>
<td>3.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( p = .000^{**} )</td>
<td></td>
<td>( p = .000^{**} )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.25</td>
<td></td>
<td>.91</td>
</tr>
</tbody>
</table>

** Correlation of Treatment Effects Among the Dependent Variables

The correlation of the dependent variables was conducted to determine relationships between them. Variables PR and DS are relatively normally distributed and MJ and ME are not normally distributed. Therefore, the Pearson correlation method was used to determine the correlation coefficient between PR and DS. As the other variables are not normally distributed, Spearman’s rank correlation was used for the correlations of
all the other pairs of variables (PR and MJ, PR and ME, DS and MJ, DS and ME, and MJ and ME), Spearman’s rank correlation was used. Table 4.4 illustrates the correlations.

Table 4.4  
Correlations between all dependent variables

<table>
<thead>
<tr>
<th></th>
<th>PR</th>
<th>DS</th>
<th>MJ</th>
<th>ME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Representation (PR)</td>
<td>1</td>
<td>.802</td>
<td>.757</td>
<td>.523</td>
</tr>
<tr>
<td>Developing Solutions (DS)</td>
<td>.802</td>
<td>1</td>
<td>.707</td>
<td>.509</td>
</tr>
<tr>
<td>Making Justifications (MJ)</td>
<td>.757</td>
<td>.707</td>
<td>1</td>
<td>.640</td>
</tr>
<tr>
<td>Monitoring and Evaluation of Solutions (ME)</td>
<td>.523</td>
<td>.509</td>
<td>.640</td>
<td>1</td>
</tr>
</tbody>
</table>

All dependent variables are significantly correlated with each other. PR and DS have the highest correlation coefficient of 0.802, and PR and ME have the lowest of 0.523. The correlations between DS and ME, and ME and MJ are also lower than the other pairs.

**Comparison of Treatment Effects Among the Dependent Variables**

A non-parametric Mann-Whitney U test was used to investigate all four dependent variables to rank the dependent variables in order of their effect. The Mann-Whitney U test was chosen because a single test is needed to examine all four dependent variables simultaneously, dependent variables MJ and ME have a positive skew, and the dependent variables all use different scales. PR is measured on an 11-point scale, DS on an eight-point scale, and MJ and ME on a seven-point scale. The Mann-Whitney U test more accurately analyzes data under these conditions than ANOVA. Both the mean rank and Z value from this test can be used to determine which dependent variable had the best effect.
Table 4.5 shows all the mean ranks for the control and experimental groups among the four variables. PR has the largest mean rank (54.19) for the experimental group. In addition, the absolute Z score for PR is 5.48 for the experimental group, which is also the highest Z score. Therefore, PR is most significantly affected by the prompts. Also, ME is least affected by the prompts.

Table 4.5
Comparison of treatment effects among all dependent variables

| Dependent Variable | Mean Rank for Control Group | Mean Rank for Experimental Group | |Z Value|
|--------------------|-----------------------------|----------------------------------|---------|
| PR                 | 26.16                       | 54.19                            | 5.48    |
| DS                 | 28.15                       | 52.15                            | 4.71    |
| MJ                 | 28.34                       | 51.96                            | 4.71    |
| ME                 | 32.16                       | 48.04                            | 3.78    |

Findings related to the effects of question prompts on ill-structured problem-solving outcomes

Predicted Effects: Individuals receiving question prompts will demonstrate better problem-solving outcomes on an ill-structured task than their counterparts who did not receive the question prompts on (a) problem representation, (b) solution development, (c) making justifications, and (d) monitoring and evaluation of solutions.

Significant results were found for all aspects of this hypothesis. The experimental group (Mean = 7.36, SD = 2.07) performed significantly better (p>.01) on problem representation than the control group (Mean = 4.15, SD = 2.17). Direct observation of the data via student notes/storyboards revealed that experimental subjects divided into three categories of use. The first category of learners used the provided prompts “as is”,...
copying and pasting them into their notes and storyboards, then they answered each prompt. The second category represented the majority of the learners; they used the prompts, but responded to them in their own unique way. The third category did not appear to use the prompts at all, nor did they represent the problem in their notes or storyboard. This same categorization scheme was observed for solution development, making justifications, and monitoring and evaluation of solutions.

The experimental group (Mean = 5.23, SD = 1.74) performed significantly better (p > .01) on solution development than the control group (Mean = 3.23, SD = 1.59). The explanations and details provided by the experimental group were richer than the control group. To illustrate this, an exemplary solution from an experimental group subject is presented, followed by an example from a control group subject:

**Experimental Subject Main Page Description**

**Background Color:** Black

**Banner:** Across the top of the page will be the band’s name and logo in big letters against the black background.

**Menu:** This will be underneath the banner. The menu will be horizontal and run across the length of the page and banner. It will be red with bold white letters and have the following menu links: Home, Band Information, Music, Appearances, Merchandise, Fan Club, and Message Board. The Home link will just reroute the user back to the main page.

**Main Body:** The main body will have the album art in the center, with the title of the album underneath it. The album and title will be an alternate link to the page the Music link on the menu leads to. To the right of the album cover image will be two vertical blocks. The top block will have the listing of the next appearance of the band (and clicking on the block will lead to the Appearances page). The second block will be of a piece of merchandise (which links to the Merchandise page). The borders
of the blocks will be red. To the left of the album image will be two more vertical blocks. The top block will advertise the message board, and link to it. The bottom block will be an advertisement for the group’s Fan Club (and will link to that page).

Control Subject Main Page Description

For the band critical theory, the page I have come up with is a sort of interactive picture. One of which fits on the whole screen no pain in the scrolling needed.

This picture is a picture of a sort of darker, city ally such as Madison Wi, where it has posters, flyers, graffiti and all this stuff posted on the walls. This picture will be interactive, I will get back to this later. At the top of the website would be small texted, small enough not to really be noticed by any websurfer or fan there for the band.

The experimental group (Mean = 3.51, SD = 2.59) performed significantly better (p>.01) on making justifications than the control group (Mean = 0.93, SD = 1.31). The following excerpts illustrate the differences in the quality of justifications for an experimental and control subject, respectively:

Experimental Subject Justification Statement

As I analyze the problem, the first part I realize that needs to be analyzed is the main goal of the website, and the message that it is trying to convey. It is this message that will guide the rest of the website and keep it focused. Next, I would have to gather detailed information about the band to display on the website, most importantly a biography page. Since the band has no record company yet, it will be a good idea to stream songs from their album for those music listeners who are skeptical about the band or unsure about their music. Next, I would need to analyze the demographics of the site visitors and music fans, in order to tailor the design of the site to better suit their needs. It would be necessary to make
the site visually interesting, yet easy to navigate. In the end, the overall three parts of this site would be the general statement (goal), the detailed information, and how to make the site visually appealing.

I have to pay attention to the limitations of the end users computer. One important thing to consider is their Internet connection speed. Users will slower Internet connection will have trouble downloading larger files, such as song samples. It is important then, to make sure there are files that are smaller and of various qualities and sizes for users to download. People with slower speeds will benefit from files that are shorter clips. These shorter clips can be of various qualities as well, for extreme cases. It is important, however, to make sure the enjoyment is not heavily based on downloading sample songs. There must be other attractions to the website. Not only that, but the site should not be too flashy, with Flash programs or other advanced coding, as that will slow down the loading of the site.

**Control Subject Justification Statement**

Navigation must be easy.

Connection of user- simplest.

Tree format to make design easy.

Justifications made by the experimental group were directly related to the information provided by and asked for by the prompts. The control group provided very few justifications for their designs.

The experimental group (Mean = 1.59, SD = 2.12) performed significantly better (p>.01) on monitoring and evaluation of solutions than the control group (Mean = .18, SD = .55). Both groups were examined to determine the quality of the evaluations of their solutions, and their examination of alternative solutions. While significant results were obtained, it must be noted that the experimental group appeared to divide into two
categories in this area. Over half (52%) provided no evaluation of their solutions at all. The other 48% provided excellent rationales of their proposed solutions, but of that 48%, only 8 (20% of the total 39 experimental subjects) also provided any alternative solutions. Significant differences were observed here because only five (12%) of control subjects provided any rationals at all.

**Summary of the Experimental Study Results**

The outcomes of the statistical analyses confirm hypothesis one, showing that subjects receiving question prompts in an online learning environment demonstrated higher problem-solving scores on an ill-structured task than the subjects who did not receive the question prompts in (a) problem representation, (c) making justifications, and (d) monitoring and evaluation of solutions.

However, the approach taken to problem representation by the experimental subjects varied widely. Although specific prompts were available for the experimental subjects to use as textual guides in this area, not all of the experimental subjects used them in the manner intended.

Monitoring and evaluation of solutions was also not uniform across the experimental subjects. Experimental subjects either provided good rationales for their solution or none at all. Few experimental subjects provided alternative solutions, although they were prompted to do so.
Though not statistically significant ($F(1,78) = 3.74, p = .057$), experimental subjects wrote an average of 20.4% more than control subjects. The mean word count for experimental subjects was 1093.26. The mean word count for control subjects was 871.08.

The Qualitative Study Results

The purpose of the qualitative design of this study was to address research question 2: How does the use of cognitive and metacognitive prompts influence students’ problem-solving processes (problem representation, solution development, making justifications, and monitoring and evaluation of solutions) and motivation in an ill-structured task? This question was investigated using observations, think-aloud protocols, and interviews.

Observations of subjects were conducted in three lab sessions where subjects were exposed to treatment. Both control and experimental subjects were present in all lab sessions. Verbal interactions between subjects during the experiment were minimal and not related to the treatment. During the lab sessions, subjects were randomly chosen for short think aloud sessions. These subjects were asked what they were thinking at that moment, how they were approaching the problem, and what their next steps would be. The observer took field notes during the lab sessions.

Following treatment, six subjects (three control and three experimental) were randomly chosen for a structured interview (see Appendix 5). These interviews were videotaped and then transcribed and summarized.
Findings from Observations and Think Alouds

Twenty-four subjects were observed as they worked through the treatment materials. A video camera was used to record overall individual activities. The researcher also chose individuals to discreetly observe. Several individuals were chosen for direct questioning as they worked through the problem. Subjects had little difficulty navigating the online learning environment as evidenced by lack of questions in this area during lab sessions. The single common technical issue encountered was popup blockers. As popup windows were integral to the study, this problem was anticipated by the researcher, and instructions were embedded into the online learning environment in the initial screens subjects encountered.

The majority of comments from subjects during the lab session observations and think alouds centered around organizing a plan to solve the problem, choosing the information in the site to which it was important to attend, how to structure the proposed web site, and how to textually describe the proposed band web site.

Problem-Representation Processes: Strategies for navigating the problem space. This is analogous to the problem representation part of the problem-solving process. Observed subjects all exhibited an initial loss of what to do. While they thought they knew the general aspects of the problem – the band needs a web site - they were unsure of how to break the problem down into manageable parts. All observed subjects then chose a navigational strategy to acquire enough information to do this from the online learning environment. Based on an analysis of observational data, it was observed that subjects fell into three categories: methodical, non-methodical, and mixed. The subjects
in the methodical category proceeded through the online learning environment step by step, visiting each link in order and taking notes. Subjects in this category when questioned during a think aloud session usually replied they were relying on the online learning environment to guide their navigation. The researcher did not see any obvious differences between the control and experimental groups in the number of subjects in any particular category. Both groups appeared to have a similar number of subjects per category. Thus, prompts did not seem to influence an individual's initial overall problem representation strategy, even though solution prompts were included in the problem introduction for the experimental group.

The subjects in the non-methodical category skipped around a great deal. While the online learning environment did constrain the subjects initially, once the introduction was read, the majority of the online learning environment was open to them. These subjects would visit a page, skip to another page, then back to the original page. When asked why they were doing this, the common responses were that they were trying to pull information together, or trying to remember something they just read. For the former reason, this may hold some ties to metacognitive aspects of looking back and reflecting.

The subjects in the mixed category usually started out in the online learning environment by being non-methodical, then gradually transforming into a more methodical model. Of interest here is the observation that usually these subjects took no notes initially, but as they adopted a more methodical model, they began to take notes. When questioned, the replies varied from "I just want to look around first," "I need to see how big this thing is," and "I want to make sure I don't miss anything important before I start."
Problem-Representation Processes: Choosing the information in the site to which to attend. Subjects often commented on their uncertainty about which informational areas in the online learning environment to examine in depth. This is analogous to the problem representation and solution development part of the problem-solving process. The online learning environment was fairly complex, consisting of several areas with in-depth information. Subjects needed to make decisions about what information was relevant, and what was not. Subjects in the experimental group seemed to have an easier time with this, as evidenced by observation of subjects in lab sessions. Control group subjects would often ask the researcher which information was important, what they should look at, etc. Experimental subjects did not exhibit this behavior. Given that the prompts guided them towards relevant information, this is not surprising.

In all observed cases, subjects eventually cited the interview with the band members as the crucial data needed to develop an adequate representation of the problem. Of secondary importance were the suggested "favorite" web sites of the band members. Finally, the provided statistical data on the band was used by some subjects to finalize their representation of the problem.

Solution Development: How to structure the proposed web site. This category represents where the majority of the thought process was evident in observations of subjects. This aspect is analogous to the initial solution development part of the problem-solving process. Several common questions and responses to think aloud protocols generated the following themes: What does the band want, what does the band need, what does the album cover mean (The album cover from the band's first album was included in the online learning environment.), how should I do (create) the navigation, and what
pages should I include in the site? It was at this point that many observed subjects would visit other (real) band sites and base their decisions on what the observed. All observed subjects followed this pattern. It is possible that the links to other bands provided in the online learning environment, coupled with the band interviews that contained specific references to preferred band web sites, structured the environment too well, impacting the problem-solving process in an unanticipated way. This is discussed in Chapter 5.

_Solution Development and Making Justifications: How to textually describe the proposed band web site._ All subjects were required to submit a two-page maximum textual description of the proposed web site. This was the last step in the problem-solving process. In addition to a problem solution, this is the point where solution justification and assessment of alternative solutions occurred. Subjects at this point felt they had solved the problem and merely needed to document their solution. However, many observed subjects had trouble organizing their thoughts. Several subjects used graphics packages to develop visual aids to accomplish this, although this was not required. Others who did not have experience with graphics packages struggled at this point, unsure of how to proceed. The normal response at this point was that they were just going to do their best.

Only five subjects observed one on one attempted to look at any relevant information on the internet that existed outside the online learning environment. When questioned, most subjects responded they thought all the relevant information was included in the online learning environment.

Also, very few subjects expressed the need at this point to evaluate their solutions. During the think-aloud sessions, when asked by the researcher about justifications, the
majority of the subjects simply had not thought to do that. This was expected by the control subjects, but not the experimental subjects, as they were prompted to do so.

Motivation support by increasing attention and confidence: In addition to the above observations, the researcher asked 10 observed subjects in the experimental group if they liked the prompts and if so, why. Although this question was asked towards the end of the treatment, it is possible it influenced their subsequent use of the prompts. Seven of the 10 subjects responded positively. They felt the prompts ensured they would not make any major mistakes. They felt the prompts helped show them what to do, and gave them confidence they were doing the right thing. The prompts directed their attention to important parts of the online learning environment and made them think about what they were doing. This is analogous to Keller's (1999) beliefs that learner support is important for motivating learners in instruction by reducing frustration, increasing self-efficacy, encouraging strategic behaviors, and providing a fail-safe learning environment.

Interviews

While all participating subjects were invited to be interviewed, only nine accepted the invitation. Six of these subjects (three subjects in the control group and three subjects in the experimental group) were chosen at random for a structured interview (see Appendix E). These interviews were between 20 – 35 minutes in length, and divided into three sections. The first section consisted of gathering some basic information such as major and class standing. The second section consisted of questions on how the subject
approached and solved the problem. The questions in the third section were on motivational aspects of the online learning environment. Finally, subjects in the experimental group were asked how the prompts affected them from a motivational standpoint. General observations on the subjects and the interviews are summarized below.

Subject 1. Subject 1 was a sophomore (with junior standing), male, accounting major in the control group. He took 25 credits in High School to jump-start his degree program. He reported that he had little experience in similar ill-structured problem activities, and that he believes in task completion, equating time on task with quality of achievements. He was able to complete the assignment by careful continuous reference back to the online learning environment. He spent three to four days with seven to eight entries into the environment to complete the assignment. Without specific guidance prompts, he made some design decisions that did not satisfy all the demands of the assessment rubric.

This subject solved the problem by gathering all the needed information while often referring back to the provided guidelines. This included visiting other band web sites provided in the online learning environment. He tried to visualize himself as a web designer, picking easy navigational choices and relying on past experiences with other software for interface ideas. Many ideas came from other web sites as well. He considered several different formats initially, then pieced these formats together for the final concept. He relied on input from fellow roommates for ideas and criticism.

This subject reported that he didn't know what to expect at first, but was confident he would succeed. He was overwhelmed at first, uncertain of the scope of
work. He had difficulty clearly defining the problem. But, after an initial exposure to the environment, he found the directions clear, and proceeded to gather information from the online learning environment.

In terms of assessing the quality of his own work, he said that he had the most difficulty describing how the links in the proposed web solution would operate. He believed more could be done in his design, but he did accomplish the goals described in the guidelines. He did not indicate he considered any alternative solutions, nor did he attempt to justify his solution. He believed he performed adequately in relation to other people.

Subject 2. Subject 2 was a female sophomore accounting major in the experimental group. She seemed to be someone who follows along with a given assignment without too much embellishment. She approached the problem by gathering the information she thought was needed, skipping around a bit at first to get the big picture. She tried to tie previous knowledge to this task, although she had never done this type of project before. She spent four days in the online learning environment over a two-week period.

To develop a solution, she took notes while exploring the online learning environment, skipping around, then she when back and investigated all parts of the online learning environment in detail and tied her initial notes into her plan. She found designing a web site a new experience, and asked herself what she had done like this before in an attempt to call upon prior knowledge in related areas to assist her in formulating the problem and her solution.
The subject relied heavily on the information and examples provided in the online learning environment to assist her in developing a solution. The prompts helped her to consider different alternatives and perspectives. Although she knew the band leader liked one particular site, she chose not to use it as a guideline because it was too "busy." When she first used the online learning environment she was overwhelmed, but the prompts quickly alleviated her concerns. They helped her to organize her thought and her notes, relieve frustration, and made her realize the problem-solving task was not going to be as difficult as she initially conceived it to be.

She reported that she used the online learning environment well. She copied and pasted the prompts into her notes. This confirmed to her that she wasn't skipping anything important. In terms of self-assessment, she felt she performed average in relation to others. She felt that some students probably had more creativity and experience in designing web sites, while others just did the task to complete it. She did not rely on others for comments or suggestions.

She reported that the prompts helped to give an idea of what was coming, what to expect and how to make the site. They helped her define the scope of the problem. The prompts helped her build notes and stay organized, serving as an evaluation mechanism. She did not mention considering alternatives to her solution.

However, she also indicated that she didn't understand all the prompts – the ones on color use are an example. She felt that some prompts asked for too many things at one time. She exhibited some selectivity in the prompts to which she attended. The prompts that she found helpful she would answer.
Subject 3. Subject 3 was a senior female Health and Policy Administration major with an IST minor in the experimental group. She never experienced an online learning environment like the one used in the study, but had experienced offline problem-solving situations in classes. She had some experience using Penn State's Course Management System, ANGEL, in courses she took. She did the treatment in one session, taking about two hours to complete the assignment. Initially, this subject didn't seem very engaged in the interview. It was difficult to obtain more than terse responses. She seemed to view the assignment as a simple, get-it-done exercise. Of note is one comment made about constraints. She felt she should follow the prompts verbatim, and didn't express any need to add her own ideas. In this case, it appears that prompts may have limited self direction. If prompts guide the individual towards a solution, there is little need to self-generate a unique solution.

The subject approached the problem by reading through all the sections linearly. She took notes on the bigger sections, and looked at all the prompts. She used all the prompts to take notes. Then she diagrammed the web site and wrote the paper. She reviewed some sections several times. The interview section was one of the sections reviewed often.

In order to approach the problem, she had to believe it was a real site. She thought about what web sites she knew of and how they worked. She looked at existing sites to see how information was presented in those sites. She wanted the site to be simple and direct, and tied all together. She considered several alternatives for the main design, referencing the provided album cover as a constraint she felt necessary to use as a
guideline. The provided demographics were another constraint she felt she had to work within.

The subject expressed positive feelings towards the online learning environment. She liked the self-pacing and the immediate availability of resources. She was uncertain at first about the scope of the work. She felt she performed adequately, but perhaps not as well as IST majors. However, comparison of her work to others was not important to her. The provided prompts guided her, providing information on what she did and didn't know. She tried to focus on what she didn't know, skimming instruction as needed. The prompts also served to quickly alleviate initial anxiety, giving her confidence the scope of the project was within her abilities to grasp. She liked the immediate appearance of prompts when entering a section of the online learning environment, and that you could call them up again as needed. She copied and pasted these prompts into a word processing document as starter points for notes she took and created. She did not become frustrated with over-prompting, or with the same prompt appearing more than once. As she stated: "Well, when you clicked on each section, and that other box came up, with all those questions? That really made me think of what's going to be on that section, what I needed to write about. I thought that really helped."

Subject 4. Subject 4 was in the experimental group. She was a female junior Marketing major, with a minor in Information Systems and Statistical Analysis. She was very energetic and engaged in the process. She reported that she enjoyed the assignment, but felt she didn't have any prior skills here.

This subject had never experienced an online learning environment that contained an ill structured problem, although she had experienced problem solving in class
situations before. She looked at the problem two to three times before actually starting work. It took her two sessions to complete. She spent about three hours total on the problem.

The subject approached the problem as a professional in marketing. She wanted to successfully market the band, and the proposed web site was a way of doing this. She felt that the band member interviews, the provided demographic data, and tour dates were all critical in defining the problem. She used this information in the problem solution, and justified her solution by indicating this data brought the band's personality into the site.

The subject also felt that some constraints existed that helped define her problem solution. The provided album cover was one example of this. She also expressed the need for a simple, clean site, with a consistent look for each page. Her justification for this was the many existing web sites that she found confusing to navigate. She also felt constrained by the medium used for providing the solution – text. She wished she could have used other media – graphics, animations, etc. in her solution, finding it impossible to express herself in a text-only report. Of note here is the hidden presence of monitoring and evaluation of solutions. It was not until the interviewer asked specific questions related to this area that the subject indicated she has monitored and evaluated her solutions.

The subject found the online learning environment challenging and liked the open-ended nature of the problem. She found the environment straight forward, and started by knowing her ultimate goal. Then she proceeded to figure out the steps to accomplish her goal. "Awesome!" was her last remark on the environment.
While initially concerned about the scope of the assignment, the prompts quickly alleviated this concern. Her main frustration was navigational in nature. The "next" button on some pages was not obvious. She initially missed some pages because of this and had to backtrack. Overall, she felt she used the environment well.

The subject used the prompts to guide her note-taking process. She felt she would not do well without them. She was not concerned with overprompting, and did review the prompts several times.

Subject 5. Subject 5 was in the control group. She was a sophomore female in Meteorology. She was somewhat quiet and reserved. It was difficult to draw information out of her. She did the treatment in one session, taking two to three hours to complete it. She reported that she had never done anything similar, with the exception of a video project from IST 110. She reported that was fairly open ended.

The subject approached the problem by taking notes as she read information. She wrote down the most important points from each section. Then she printed the notes to use as a reference when she developed the written description of the web site. She rearranged her notes as she did this.

The subject's main considerations for the site were the audience needs. She felt, based on provided band statistics, the site must be geared towards a younger crowd, and the information provided on the band was critical in her decisions. She also felt the site should be uncomplicated yet eye-catching, so one could not get lost. With the exception of not being sure about how much information to put on a page, she seemed confident in her abilities to design a good web site for the band after she had done so, but expressed
doubts when she first entered the environment. She referred to web sites she liked or didn't like as a guide as part of her decision process. She did not consider any justifications for her site design, although she did collaborate with her roommates about her solution. They reinforced her decisions.

She was very uncertain about her ability to perform adequately at first, saying "I'm not going to be able to do this. I've never had any experience with it." Once she was in the online learning environment for a period of time, she felt better. The subject expressed some frustrations using a word processor to write her report, and the time it took to take notes. It is of interest that this subject took notes, as she was in the control group and was not expressly prompted to do so.

The subject felt she did not perform well in relation to other people, but this was not a concern for her. As she had no prior experience, she did not feel much was at stake.

**Subject 6.** Subject 6 was a male sophomore Mechanical Engineering major in the control group. A musician, this subject has experience developing web sites and claims to have broad knowledge of self-taught web design skills. He did the assignment in one sitting, taking two and one half to three hours to complete it.

He reported that he read through the entire online learning environment, taking notes as he did so. He felt it was a straight-forward process, having visited a multitude of band websites before. However, he was unclear about what information was important to take notes on. This indicates he had prior knowledge to draw upon, but was uncertain how to apply that prior knowledge.

The subject took ideas from web sites he knew of, wanting a simple interface and pages that looked like the band sounds like. This was his main justification for his design.
He believed the online learning environment contained all the needed information for the content of the site.

He did consider some design alternatives, such as a Flash-based introduction. He decided against these alternatives due to technical reasons, fearing some users would not have the needed hardware and software to experience these alternatives. He also considered bandwidth issues and monitor size. He did not discuss these possible alternatives with anyone, nor did he discuss his final solution with anyone.

He expressed mixed feelings about working in an online learning environment. He expressed dissatisfaction with environments that work best when you have two monitors and you must switch your attention back and forth. He also expressed dissatisfaction with supplemental print-based instructions that do not match the online learning environment. He preferred an environment with clear directions.

The subject felt confident with his abilities to succeed at this task. He felt the online learning environment was straightforward. He did not like the slowness of lab computers, nor that they lacked the graphics software he wanted to use. He felt the instructional part of the online learning environment contained too many links. He also did not like how sections of the environment were locked until one performed some action. For example, the online survey would not open until one submitted the site design document.

In terms of self-assessment, he felt he performed above average, as he has designed web sites before. He didn't care how he performed in relation to other people, stating that you should always do your best.
Summary of Qualitative Findings

The following section presents a summary of some of the themes of the interviews and observations:

Reducing frustration and stress. The initial frustration and stress all subjects felt was primarily at the beginning of the use of the online learning environment. Question prompts may have helped the experimental subjects reduce this by reducing the time this stress was felt. The prompts also guided the experimental subjects to form an initial plan for solving the problem.

Increasing self-efficacy and encouraging metacognition. The use of question prompts seems to positively support self-efficacy and the use of metacognition. Subjects in the experimental group asked far fewer "Should I do…” and "Is this right?” questions in the think-aloud sessions than control group subjects.

Providing for a fail-safe environment for learning. The question prompts received by the experimental group did provide opportunities for a fail-safe environment for learning. The experimental subjects interviewed did not exhibit any anxiety over the danger of failing the problem-solving task. Most thought it was a straight-forward task, indicating the prompts helped to organize the ill-structured problem. The prompts helped to give an idea of what was coming, what to expect and how to make the site. They helped define the scope of the problem. The prompts helped them build notes and stay organized. They guided the subject towards the correct path.
Summary of Overall Study Findings

The use of question prompts in an online learning environment led to better problem-solving outcomes in the areas of (a) problem representation, (b) solution development, (c) making justifications, and (d) monitoring and evaluation of solutions. However, observations of how the question prompts were used indicated that problem representation and monitoring and evaluation of solutions is not consistent. A bi-modal model was evident for these two areas; either the experimental subjects produced little or no evidence in these areas, or they produced exemplary evidence. Apparently, the effects of using the prompts must be compelling, since despite the inconsistency of use across subjects in the treatment group, a significant difference nonetheless resulted.

The use of question prompts in an online learning environment also leads to increased motivation as evidenced by student reports of a reduction of frustration and stress, an increase of self-efficacy and use of metacognitive strategies, and by providing for a fail-safe environment for learning.

Subject Background and Profile Information

Please see Appendix G – Self-Report Questionnaire for the complete questionnaire. Forty-five questions were presented to all subjects. The questions were divided into four categories: (1) Background Information (questions 1-16), (2) Problem-solving Skill Information (questions 17-36), (3) Motivators Information (questions 37-42), and (4) Mental Effort Information (questions 43-45).
Table 4.6 details the results of post hoc tests, including means and standard deviation for selected questions. A one-way analysis of variance (ANOVA) was used for this analysis. The post hoc tests did not show any significant differences in question area means between the control and experimental groups in any of the question areas.

It is probable that the subject's self-rating of skills in all areas is subjective and higher than it actually is, as all subjects, regardless of treatment, rated themselves highly. This is inconsistent with the problem-solving outcomes indicated by the experimental study quantitative results. This data does provide evidence that the control and experimental groups were noticeably equal in their perceived problem-solving abilities.

Table 4.6
Selected question means, standard deviation, and F ratio

<table>
<thead>
<tr>
<th>Area by Treatment Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 2 - Problem-solving Skill Information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area 1 – Prob. Representation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>18.425</td>
<td>3.11</td>
<td>.67</td>
<td>p = 0.41</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>18.825</td>
<td>3.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area 2 - Problem Solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>17.82</td>
<td>2.47</td>
<td>.74</td>
<td>p = 0.39</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>17.3</td>
<td>2.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area 3 - Metacognitive Skills</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>17.45</td>
<td>3.20</td>
<td>.36</td>
<td>p = 0.55</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>17.05</td>
<td>2.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area 4 - General Problem-solving Strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>16.38</td>
<td>2.95</td>
<td>.069</td>
<td>p = 0.79</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>16.55</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 3 - Motivators Info.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>15.88</td>
<td>4.65</td>
<td>.0006</td>
<td>p = 0.98</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>15.85</td>
<td>4.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category 4 – Mental Effort</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>40</td>
<td>7.75</td>
<td>2.49</td>
<td>.021</td>
<td>p = 0.88</td>
</tr>
<tr>
<td>Experimental</td>
<td>40</td>
<td>7.83</td>
<td>2.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Background Information

The first part of the self-report questionnaire examined some basic information about the subjects.

Gender. Of a total of 79 participants, the majority (57, 73%) of the subjects were male. Twenty-two (27)% were female. In the control group there were 28 (70)% male and 12 (30)% female. In the experimental group there were 29 (73)% male and 11 (27)% female. The ratio of male to female between the two groups was similar. The distribution of gender across the groups appeared equivalent.

Major. The majority of subjects (64, 81%) were not in the IST major. Many were taking the IST 110 class as a requirement for their major, or were minoring in IST. The subjects taking the IST 250 class (14, 18%) were all IST majors and were taking IST 250 as a requirement for their major. In the control group there were 7 (9)% IST majors and 33 (42)% non-IST majors. In the experimental group there were 9 (10)% IST majors and 31 (39)% non-IST majors. The distribution of IST majors to non-IST majors across groups appears equivalent.

Class standing. Overall, 16 (20)% of subjects were freshman, 40 (50)% of subjects were sophomores, 17 (21)% of subjects were juniors, and 8 (9)% of subjects were seniors. In the control group there were 9 (22)% of freshman, 19 (48)% of sophomores, 11 (28)% of juniors, and 1 (2)% of seniors. In the experimental group there were 7 (17)% of freshman, 21 (51)% of sophomores, 6 (15)% of juniors, and 7 (17)% of seniors. The distribution of class standing across the groups appeared equivalent.
Reason for taking this class. Overall, 49 (57%) reported they took the class because it fits their schedule, 25 (29%) reported they took the class because someone recommended the professor to them, and 11 (14%) reported they took the class for no particular reason. In the control group 25 (62%) reported they took the class because it fits their schedule, 11 (27%) reported they took the class because someone recommended the professor to them, and 7 (11%) reported they took the class for no particular reason. In the experimental group, 24 (61%) reported they took the class because it fits their schedule, 14 (35%) reported they took the class because someone recommended the professor to them, and 4 (4%) reported they took the class for no particular reason. The main other reason for taking this course was to fulfill a requirement for a minor. The distribution of reasons across the groups appeared equivalent.

Experience with solving problems of this nature. Overall, the majority 53 (66%) indicated they had never solved a problem of this type before. In the control group, 0 (0%) indicated they did so often, 14 (35%) indicated they did so a few times, and 26 (65%) indicated they never had done so. In the experimental group, 2 (5%) indicated they did so often, 11 (27%) indicated they did so a few times, and 27 (68%) indicated they never had done so. The distribution of experience with solving problems of this nature across the groups appeared equivalent.

Self-rating of computer skills in an online learning environment. Overall, the majority (61%) indicated they were competent in their skills. Discussions with subjects supported this rating. In the control group, 4 (10%) indicated they were expert, 25 (62%) indicated they were competent, 8 (20%) indicated they were a novice, and 3 (8%) indicated they were clueless. In the experimental group, 3 (7%) indicated they were
expert, 24(60%) indicated they were competent, 11(27%) indicated they were a novice, and 2(6%) indicated they were clueless. The distribution of self-rating of computer skills in an online learning environment across the groups appeared equivalent.

**Self-rating of web creation and web software skills.** Overall, subjects self-rating was distributed equally here between competent, novice, and clueless. Only 5(6%) indicated they were an expert. In the control group, 3(8%) indicated they were expert, 8(21%) indicated they were competent, 14(37%) indicated they were a novice, and 13(34%) indicated they were clueless. In the experimental group, 2(5%) indicated they were expert, 7(17%) indicated they were competent, 23(58%) indicated they were a novice, and 8(20%) indicated they were clueless. The distribution of self-rating of web creation and web software skills across the groups appeared equivalent.

**Self-rating of enjoyment of using online learning environments.** A 1-5 point Likert scale was used here, with 5 indicating a high level of enjoyment, a 1 indicating a low level of enjoyment. Overall, the majority 58(73%) of subjects indicated a middle (3) to high (4) enjoyment. In the control group, 1(2%) indicated they highly (5) enjoyed it, 18(45%) indicated they enjoyed it (4), 15(38%) indicated they felt neutral (3), 6(15%) indicated they had a low level of enjoyment (2), and 0(0%) indicated they had the lowest level of enjoyment (1). In the experimental group, 3(8%) indicated they highly (5) enjoyed it, 5(12%) indicated they enjoyed (4) it, 21(52%) indicated they felt neutral (3), 8(20%) indicated they had a low level of enjoyment (2) and 3(8%) indicated they had the lowest level of enjoyment (1). The distribution of Self-rating of enjoyment of using online learning environments across the groups appeared equivalent.
Self-rating of enjoyment of using this particular online learning environment. A 1-5 point Likert scale was used here, with 5 indicating a high level of enjoyment, a 1 indicating a low level of enjoyment. Overall, the majority 61(76%) of subjects indicated a middle (3) to high (4) enjoyment. In the control group, 1(2%) indicated they highly (5) enjoyed it, 16(41%) indicated they enjoyed (4) it, 16(41%) indicated they felt neutral(3), 4(10%) indicated they had a low level of enjoyment (2) and 2(6%) indicated they had the lowest level of enjoyment (1). In the experimental group, 1(3%) indicated they highly (5) enjoyed it, 8(20%) indicated they enjoyed (4) it, 21(52%) indicated they felt neutral(3), 7(17%) indicated they had a low level of enjoyment (2) and 3(8%) indicated they had the lowest level of enjoyment (1). The distribution of Self-rating of enjoyment of using this particular online learning environment across the groups appeared equivalent.

Problem Solving Skill Information

The second part of the self-report questionnaire examined the students' perception and implementation of their problem-solving skills. There were 20 questions categorized into four areas. The first area (questions 17-21) examined problem representation and initial approach to a problem. The second area (questions 22-26) examined problem solutions and how one works through a problem. The third area (questions 27-31) examined metacognitive skills such as solution monitoring and evaluation. The fourth areas (questions 32-36) examined general problem-solving strategies. Every question was rated on a 1-5 Likert scale, with 1 being never and 5 always. The maximum score for each question area was 25 points while the minimum score was 5 points. Table 4.6 illustrates the
ANOVA results of post hoc tests, including means and standard deviations for each question area. No significant differences were found between the control and experimental groups. The effect of Category 2, Question Area 1 – Problem Representation was not significant, $F(1,79) = .69, p = .41$. The effect of Category 2, Question Area 2 – Problem Solution was not significant, $F(1,79) = .74, p = .39$. The effect of Category 2, Question Area 3 – Metacognitive Skills was not significant, $F(1,79) = .36, p = .55$. The effect of Category 2, Question Area 4 – General Problem-Solving Strategies was not significant, $F(1,79) = .069, p = .79$. These self-reported ratings are questionable, given the results of the subjects in the control group. Overall, the distribution of subjects across the control and experimental group were equivalent.

**Motivators Information**

The third part of the self-report questionnaire (questions 37-42) examined different possible reasons for why the online learning environment was or was not motivating. Although not statistically significant, the control group indicated slightly higher preferences for the way the text, graphics, and information were presented, and the way they could manipulate the environment. They also indicated higher enjoyment of visual progress clues in the environment. The effect of Category 3, Motivators Information was not significant, $F(1,79) = .0006, p = .98$. Given that the control group did not receive any scaffolding in the environment, this may be an indicator that these subjects were relying on these other factors to mentally structure the environment.
Mental Effort Information

The fourth part of the self-report questionnaire examined the mental effort put forth by the subjects. The effect of Category 4, Mental Effort was not significant, $F(1,79) = .021, p = .88$. Overall, the distribution of subjects across the control and experimental group were equivalent.
Chapter 5

GENERAL DISCUSSION

Overview of the Findings

The purpose of this study was to investigate the effects of scaffolding strategies on supporting problem-solving processes, motivation, and outcomes on an ill-structured task within an online learning environment. Problem solving processes and motivation were measured by think-aloud protocols, observation, and interviews. Problem solving performance was measured according to four processes: (a) problem representation, (b) developing solutions, (c) making justifications, and (d) monitoring and evaluation. The qualitative and quantitative findings related to the two research questions are summarized below. Implications for instructional design are then presented, followed by implications for future research.

1. *Question prompts had a significantly positive effect overall on subjects' problem-solving outcomes on an ill-structured task, specifically in (a) problem representation, (b) solution development, (c) making justifications and (d) monitoring and evaluating solutions.*

The results indicate that the experimental group (those receiving prompts) significantly outperformed the subjects in the control group (no prompts) on all four processes: (a) problem representation, (b) developing solutions, (c) making justifications, and (d) monitoring and evaluation. However, inspection of each student's data showed
that making justifications and monitoring and evaluation of solutions was not uniform across the experimental subjects. Experimental subjects either provided good rationales for their solution or none at all. Once interviewed, an experimental subject commented "There are obviously alternative solutions, but I am happy with mine." The prompts that directed experimental subjects to justify their solutions and mention alternatives were not uniformly effective.

Question prompts seemed to enhance subjects' cognitive process and understanding of domain knowledge, as evidenced by their solutions. This confirms Ge's (2001) findings. However, while prompts that directed subjects to lengthy sections of instruction within the online learning environment were initially attended to, subjects often would not spend more than a few minutes in these instructional areas. Think-alouds revealed that subjects felt there was too much information there, and more importantly, they were losing sight of the immediate task. This may be related to a loss of flow (Csikszentmihalyi, 1990) and is discussed later in this chapter.

Question prompts seemed to elicit more verbose responses. On average, experimental subjects wrote 20.4% more than control subjects. Bell and Davis (2000) noted a similar phenomena in their study.

*Question prompts appeared to influence students’ problem-solving processes and motivation on an ill-structured task.*

Observation and think-alouds appear to indicate that students in the experimental group became acclimated to the online learning environment faster than students in the control group. Students in the experimental group seemed able to make decisions about which available information was relevant to the task on their own. Interviews with
students in the experimental group indicated they were able to formulate the problem and develop a solution easier than students in the control group. Interviews with students in the experimental group suggest that prompts may influence the processes of making justifications and monitoring and evaluation of solutions. These findings generally support the hypothesis that question prompts not only support well-structured problem solving as reported by Schoenfeld (1985) and King (1991, 1992), but also support ill-structured problem solving as reported by Ge (2001). These findings also support King and Rosenshine's (1993) study that indicates that elaborated questions in a problem-solving environment mediate learning by facilitation explanations, comprehension, and knowledge mapping. Question prompts positively affected monitoring and evaluation of the problem space, confirming previous studies (Palincsar & Brown, 1984; 1987, King, 1991a; 1991b; Davis & Linn, 2000; Ge, 2001; Ge & Land, 2004) that structured guidance through questioning enhances metacognition.

While no subjects in the experimental group actually claimed to be more motivated by prompts, question prompts seemed to affect elements of subjects' motivation as evidenced by reported reduction of frustration and stress, an increase in self-efficacy, an increase in strategic behavior, and by providing a fail-safe environment for learning. For example, many control subjects reported that they were confused when first entering the online learning environment, and this confusion lasted longer than it did for experimental subjects. One control subject even wrote "I'M CONFUSED." in the notes the subject took. Control subjects seemed more nervous throughout the process, as evidenced by body language, questions asked, and start-stop typing techniques. Interviewed control subjects indicated a higher level of uncertainty and lack of
confidence in their ability to produce a good problem solution. Experimental subjects, on the other hand, felt the environment was comfortable and contained all the needed information for success.

**Implications for Instructional Design**

This study suggests a number of implications for instructional design when question prompts are used as a scaffolding support strategy. However, the prompts may have other effects that impact instructional design.

**Question Prompts as a Scaffolding Strategy**

Question prompts can serve as both cognitive and metacognitive scaffolding supports. However, monitoring and evaluation of solutions was not uniform across the experimental subjects. Experimental subjects either provided good rationales for their solution or none at all. Few experimental subjects provided alternative solutions, although they were prompted to do so. The need for argumentation with others to develop rationales may be needed for individuals with little ill-structured problem solving experience. Simply providing the opportunity for argumentation may not be sufficient, as evidenced by Ge (2001). Instead, argumentation itself may need to be scaffolded (Cho & Jonassen, 2002). They suggest that constraint-based argumentation scaffolds increase the generation of coherent arguments and problem solving activities during problem solving.
Other research supports this suggestion. de Jong and van Jooligan (1998), in a meta-analysis of problem solving research, report that many times subjects will choose a course of action and stick with it, not considering alternative solutions or even deviating from their chosen solution, no matter how strong the evidence that the chosen solution will be non-optimal. In this study, observations and interviews support this. Subjects either self-organized their processes (control group) or were assisted via prompts in their organization (experimental group), but regardless of group, did not deviate from a solution once a solution was chosen.

Thus, the need to integrate some type of social activity or consideration of alternative perspectives into instructional problem solving situations is indicated. It is unclear if this activity needs to be face to face, synchronous, or asynchronous, and is one area in which further research is needed.

Related to the need for better and/or different argumentation methods in an online problem-solving environment, prompting may constrain individuals from considering creative approaches and solutions. Observations and interviews indicated that experimental subjects were content to allow the prompts to guide them. While metacognitive prompts suggested they consider their own past experiences and the experiences of experts, they may have also constrained the creative process and inhibited self direction at times. Subjects in both the control and experimental groups asked if it was "OK" to leave the online learning environment and look at other web sites for ideas. In other words, all subjects believed that all the information needed was within the online learning environment itself, or was linked to the environment. Given the subjects lack of experience with ill structured problem solving, this is not surprising. For the most part,
subjects were used to well-structured problems where the problem space was clearly defined and resources to solve the problem were immediately available. Further research in how prompts may negatively constrain the creative, self-directed process in an ill structured problem solving experience is indicated.

The structure of the online learning environment may also affect the subject's belief that creativity and exploration outside the environment is necessary. All interviewed subjects indicated that the online learning environment was logically structured. The online learning environment was fairly complex, consisting of several areas with in-depth information. Subjects needed to make decisions about what information was relevant, and what was not. Subjects in the experimental group seemed to have an easier time with this. Given that the prompts guided them towards relevant information, this is not surprising. However, even control group subjects felt the online learning environment was robust. If the environment was less coherent and less "logical," how would this affect the subject's creativity and exploration of the problem? In other words, when using question prompts, should designers provide less structure in other aspects of online learning environments in an effort to find an optimal balance between designed support and forced subject creativity and exploration? How will the removal of some structure affect motivation? Can question prompts fill this motivational gap? Related to this is the possibility that in a well-constructed site from an instructional design perspective, students will believe they know what to do, while in fact they are not meeting the designed goals/intentions of the instructor.

Prompts may be at odds with the development and use of self-directed processes. As Land (2000) points out, complex learning environments require the learner to generate
questions and maneuver appropriately, yet novice learners lack the ability to do so. Prompts may assist the learner in this area, but finding the optimal balance between too much openness and over prescription is problematic.

If such a balance may be obtained, prompts may be the key mechanism for bridging the gap between directed and open-ended learning environments. Directed learning environments are traditional, bottom-up ones where learning is carefully designed and sequenced. Open-ended learning environments (OLEs), on the other hand, have flexible learning goals and/or the means to obtain them are flexible (Hannafin, Land, & Oliver, 1999). Scaffolding is an important instructional aid in these environments due to their open, unconstrained nature. In particular to this study, strategic scaffolding, scaffolding that emphasizes alternative approaches (Hannafin, Land, & Oliver, 1999), may have proven useful in the areas of monitoring and evaluation of solutions, and making justifications. Given the mixed findings in these two areas in this study, future research should consider the use of strategic scaffolding in conjunction with the argumentative scaffolds previously discussed.

**Question Prompts as a Motivational Strategy**

Keller (1999) posits that cognitive and metacognitive prompts may serve a motivational scaffolding role in online learning environments. They may serve to:

- reduce frustration and stress,
- increase self-efficacy and encourage metacognition,
• encourage strategic behavior that leads to increased motivation, and
• provide a fail-safe environment for learning.

All observed subjects experienced a period of initial frustration where they were uncertain on how to approach and solve the problem. That period of time for the subjects in the experimental group was shorter, as evidenced by observations, think alouds, and interviews. The Yerks-Dodson Law states that as tasks are increased in difficulty, the optimum level of motivation declines (Travers, 1982). If ill-structured problems are perceived of as extremely difficult, and prompts can reduce the amount of time this frustration occurs, then prompts may act as a catalyst for enabling motivation in an individual.

Perceived self-efficacy is defined as people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, 1994). According to Bandura, successes build a robust belief in one's personal efficacy. Subjects in the experimental group exhibited a higher degree of confidence than control group subjects in observations, think alouds, and interviews. In interviews of experimental subjects, they either directly or indirectly alluded to the role prompts played here. It appears in this study that prompts bolstered self-efficacy by enabling success, however, a longitudinal study investigating this possibility is needed to ascertain this possibility. Also, as Ge (2001) points out, high self-efficacy may influence student's self-regulation processes in an undesirable fashion. It may inhibit them seeking knowledge or strategies that improve their problem-solving skills. If so, this may be a reason for the mixed finding in making justifications and monitoring and evaluation of solutions.
Strategic behavior is not in and of itself motivating. People engage in strategic behavior every day without a motivational outcome. Prompts did encourage strategic behavior in this study, as evidenced by the experimental subject's notes and reports generated. Strategic behavior is tied to success, which in turn is tied to self efficacy. This may be the link between strategic behavior and motivation that Keller (1999) refers to.

Prompts can assist in providing a fail-safe environment for learning. The effectiveness of this depends on the exact nature of the prompts. It also depends on how well the individual attends to them. In this study, experimental subjects attended to prompts while representing the problem and developing a solution, but did not universally attend to prompts dealing with making justifications or monitoring and evaluating solutions. When attended to, prompts did alleviate concerns about doing things incorrectly, as evidenced by experimental subject interviews. Of interest is the observation that not only did many experimental subjects fail to attend to prompts dealing with making justifications or monitoring and evaluating solutions, they were unconcerned with and sometimes unaware of their failure in this area.

In this study, prompts did not seem to interrupt flow experience. Flow is a merging of the learner's total attention with the task at hand such that all other sensory and cognitive distractions are invisible to the learner (Csikszentmihalyi, 1990). Prompts by their nature are interruptive and distracting. No subjects in think alouds or interviews claimed that the prompts were distracting, nor did they believe that over-prompting was a problem. This may be a possible explanation for failure to attend prompts about making justifications and monitoring and evaluating solutions. If an individual proceeded linearly through the online learning environment, those prompts would have occurred towards the
middle to end of the process. If the individual was in a state of flow and the prompts became "invisible" to them, then they would have ignored them.

Flow state may also partially explain an individual's reluctance to examine the provided tutorial material in depth. Two traditional "page turner" instructional areas were included in the online environment. They provided some basic web page design instruction on the best use of color, fonts, etc. Most observed subjects did not spend more than a few minutes in these areas and thus could not have thoroughly examined the content. Think alouds revealed the subjects wanted to concentrate on the task at hand and saw this instruction as a distraction.

**Use of Online Learning Environments for Technological Scaffolding**

Ge (2001) indicated the need for this study; a study similar to hers but one where the scaffolding occurred at the individual level only. This study confirms the hypotheses about the effectiveness of question prompts in scaffolding students' ill-structured problem solving processes in an online learning environment. The effectiveness of this strategy in other learning environments, including traditional classroom instruction and blended learning situations is unclear and suggests possible areas for future research.

The results for monitoring and evaluating solutions in the ill-structured problem were uneven in this study. Past studies (see Ge, 2001) have experienced similar results. It may be that argumentation is a necessary component for this area (Cho & Jonassen, 2002). Critical argumentation itself may need to be scaffolded. The role of the online learning environment here is unknown. Should the environment itself include this
scaffolding, does the social nature of the argumentation require the presence of other "live" learners and experts, or is some sort of combination ideal?

The exact nature of the prompt, structure, and combinations needed here is unclear. Further research here is warranted to determine not only how to best use prompts during an augmentative process to capture alternative solutions and strengthen solution rationales, but to determine overall best uses of scaffolding in emerging complex online learning environments.

Some work is being conducted here. Tabak (2004) terms this sort of combination "synergy." Tabak posits that this is part of distributed scaffolding, an emerging design in rich learning environments that combines social and material supports. Each type of support has an optimal use. For example, software scaffolds may be best suited to step-by-step inquiry decisions, while teacher and peer support is best suited for immediate feedback and elaboration. The use of different scaffolds in tandem may lead to a synergistic learning effect.

Quintata, et al. (2004) in their scaffolding work to support science inquiry suggests one design framework. They suggest that this framework can serve to facilitate future research in this area. As with Tabak, they emphasize that multiple forms of scaffolding are critical for optimal learning to occur.

Prompts are technically easy to insert in any online learning environment that uses standard web pages for the delivery of content. In addition, other environments that can be used to investigate prompting have existed for some time. Computer-Supported Intentional Learning Environments (CSILE) (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989) allows students to build a collective knowledge base. The Knowledge
Integration Environment (KIE) provides reflective prompts as scaffolding (Davis & Linn, 2000). SpeakEasy (Hoadley & Lynn, 2000) in KIE provides for asynchronous discussions. In any case, research in this area should be enhanced by the simplicity of the technology needed to support it.

Implications for Future Research

Removing Scaffolding Over Time

The traditional view of scaffolding in learning is initial support that is gradually removed as the learner acquires the ability to perform without it. This view is being challenged (Puntambekar & Hübscher, 2005), in part due to the changes and limitations in online tools. In traditional scaffolding initial support is provided by an instructor or peers, is adapted to an individual's needs, and is eventually faded away. In a contemporary setting, blanket scaffolding (the same scaffolding provided for all) is provided with no customization for an individual, and in most cases, support is permanent and unchanging.

For traditional scaffolding, it is unknown how well prompts in a particular online learning environment using an ill-structured problem will assist or hinder an individual in similar or dissimilar problem-solving situations. In other words, do prompts in an online learning environment facilitate cognitive flexibility? Cognitive flexibility is defined as a nonlinear "criss-crossing" of mental landscapes in a context-free manner (Spiro, Feltovich, Jacobson, & Coulson, 1991). An ideal problem solver would exhibit cognitive
flexibility, being able to apply general strategies to a new problem while modifying older existing situational-specific strategies to match the needs of the new problem. The answer to this question is unknown, and is an area of possible research.

The notion that scaffolding may not ever be faded opens an area of research not previously considered. What differences in learners and instruction between traditional (faded) and contemporary (non-faded) exist? Is contemporary scaffolding effective? How will traditional and/or contemporary scaffolding affect transfer of knowledge from one problem-solving situation to another?

**Prompts, Creativity, and Task Complexity**

Observed and interviewed subjects in the experimental group indicated that the prompts in the online learning environment provided more than adequate structure for solving the problem. This is not unexpected; the prompts were designed to do that. However, the experimental subjects also exhibited a confirmatory attitude towards the problem-solving process and a lack of creativity in their approach to solutions. Creative thoughts were exhibited by observed control subjects. As indicated on the post-participation survey, in the absence of prompts, the control group relied on their manipulation of the environment and other visual progress clues to mentally structure the environment.

Do prompts sometimes limit individual creativity? In an ill-structured problem, many possible solutions exist (Jonassen, 1997). The problem solver should create possible solutions, then evaluate them to choose the best alternative. Yet prompts may
limit this creative process by alluding to one best path through the problem. However, this issue must also be balanced with consideration of the fact that prompts more closely align learners with assessment criteria, which ultimately leads to improved overall performance in the areas identified as important to the instructor.

In well-structured problems an ideal path may be desired, but perhaps less so in ill-structured problems. Ge (2001) points this out by illustrating the need for research between the nature and the complexity of the task and students' needs for additional and perhaps different types of scaffolding during problem solving, such as peer interactions and argumentative processes. This question remains unanswered.

**Limitations of the Study**

To achieve significant subject numbers for this study, both IST 110 and IST 250 students were recruited. While ideal for IST 250 students, the content of the online learning environment was less so for IST 110 students. Observations and think alouds revealed that some IST 110 students were motivated by the extra credit offered for participation, while others were sincerely interested in the task itself. How this affected overall intrinsic motivation of the IST 110 students is unclear. Future studies investigating motivational issues should consider the ecological validity of the subject matter when choosing subjects.

The researcher encountered difficulty in lab runs of the study. Logging subjects into the online learning environment and attending to technical questions by subjects while conducting observations and think alouds was not ideal. When running the study
with more than five subjects per run, the researcher should have several lab assistants
versed in the technical aspects of the online learning environment. The assistants can deal
with log on and technical issues, freeing the researcher to solely conduct observations and
think alouds.

The labs used for this study contained computers with subtle differences. For
example, some machines could easily connect to the lab printer while others could not.
Future studies of this nature should identify a controlled lab environment for the study
and all computers should be subject to tests relevant to the study to ensure equivalency.

Although the online learning environment presented an ill-structured problem, the
design of the environment may have structured the problem and thus reduced the
complexity of the task. Ge (2001) noted the same limitation in her study. Finding a
balance between structure (to confine the problem to realistic time constraints) and
openness (to provide ecological validity) will remain an issue with this type of study.

Recruitment of subjects was difficult for this study. From a pool of 280 potential
subjects, only 79 participated in and completed the study. Many potential subjects only
briefly looked at the online learning environment before deciding against participation.
There was no significant difference in attrition rates between control and experimental
subjects. As noted previously, most subjects felt overwhelmed at first by the complexity
of the problem. Future studies of this nature could clarify to potential subjects that this
feeling is normal and to be expected, but does fade after an initial acclimation period.

The quantitative part of this study was constructed so subjects would first take
notes as they investigated the online learning environment, then they would construct a
written report detailing their problem solution. While some subjects followed this model,
others combined the notes and report into one, making it difficult to separate processes from outcomes. Future studies of this type should include safeguards to ensure all subjects clearly understand the need to separate artifacts that capture process from artifacts that capture outcomes.

While all participating subjects were invited to be interviewed, only nine accepted the invitation. Six of these subjects were chosen at random to be interviewed. Due to the nature of the study, no interviewees could be forced to participate, thus indicating some level of self selection. This may have biased the interview pool. Future studies could be constructed so the interview is considered a "mandatory" part of the study if extra credit is to be received for participation.

Although data analysis was thus not as straight-forward as anticipated, inter-rater reliability was .79. Two qualified individuals separately rated all subjects using the rubric in Appendix D. Ideally, an additional rater would be preferred for studies of this type. This rating was not blind in the sense it was apparent which subjects were in the control group and which ones were in the experimental group. Ideally, future studies of this type should be constructed so blind ratings can occur.
Bibliography


Journal of Educational Psychology, 81(4), 620-627.


Appendix A

Informed Consent Form for Social Science Research

The Pennsylvania State University

Title of Project:

THE EFFECTS OF SCAFFOLDING STUDENT'S PROBLEM-SOLVING PROCESS VIA QUESTION PROMPTS ON PROBLEM SOLVING AND INTRINSIC MOTIVATION IN AN ONLINE LEARNING ENVIRONMENT

Principal Investigator: Brett Bixler
210 Rider Building II
227 West Beaver Avenue
University Park, PA 16801
814-863-7763; bxb11@psu.edu

Advisor: Dr. Susan Land
10D Keller Building
University Park, PA 16802
814-863-5990; sml11@psu.edu

1. Purpose of the Study: The purpose of this research is to determine if prompting in an online learning environment leads to better understanding and motivation.

2. Procedures to be followed: You will be asked to use online educational materials to research and design a web site for extra class credit. First, you will be given access to an online site that contains learning materials and a fictional scenario where you will work with a potential client to meet the client's web site needs. You may be asked to participate in a videotaped interview where you will be asked questions about motivation. This videotape is for research purposes only and will not be shared with anyone. Next, you will design the web site on paper – you will not actually create it. Finally, you will complete a questionnaire that contains questions about your previous experience in problem solving, computer skills, etc.

3. Discomforts and Risks: There are no risks in participating in this research beyond those experienced in everyday life. Some of the questions are personal and might cause discomfort.

4. Benefits: You might learn more about yourself by participating in this study. You might have a better understanding of how to approach a web design project.
This research might benefit society by providing a better understanding of how to build online learning environments to ensure optimal learning.

5. **Duration/Time:** A maximum of five hours of your time will be required to participate in this study. The average time will be three hours. Time will vary from individual to individual, depending on reading and typing speed.

6. **Statement of Confidentiality:** Your participation in this research is confidential. Only the person in charge, and his/her assistants, will know your identity. The data will be stored and secured within ANGEL, Penn State's Course Management System, in password-protected areas. Data will also be stored in the principle investigator's office at 227 W. Beaver Ave, 210G Rider II, Univ. Pk., PA 16801 in a locked file cabinet. All individuals participating in the study will receive a simple code used by the researcher to classify you in all research documents. Only the principle researcher will have access to gathered data at the conclusion of the study.

   The Office for Research Protections and the Social Science Institutional Review Board may review records related to this project. In the event of a publication or presentation resulting from the research, no personally identifiable information will be shared.

7. **Right to Ask Questions:** You can ask questions about this research. Please contact Brett Bixler at (814) 863-7763 (work), 814-383-2537 (home), or bxb11@psu.edu with questions or concerns about this study. You can also call this number if you have complaints or concerns about this research. If you have questions about your rights as a research participant, or you have concerns or general questions about the research, contact Penn State University’s Office for Research Protections at (814) 865-1775. You may also call this number if you cannot reach the research team or wish to talk to someone else.

8. **Payment for participation:** The site you design will then be graded and extra credit up to 3% of the total course grade will be given. Should you choose not to participate, you will be given the opportunity to earn the same amount of extra credit by completing a similar web design assignment.

9. **Voluntary Participation:** Your decision to be in this research is voluntary. You can stop at any time. You do not have to answer any questions you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would receive otherwise.

   You must be 18 years of age or older to consent to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

   You will be given a copy of this signed and dated consent form for your records.

   __________________________________________  __________________________________________
   Participant Signature                         Date

   __________________________________________  __________________________________________
   Person Obtaining Consent                    Date
Appendix B

PROBLEM-SOLVING TASK MATERIALS

Online Learning Environment

The online learning environment was developed using HTML and Javascript, and was included in groups (one for the control group, one for the experimental group) in Penn State's Course Management System, ANGEL.

Figure B.1 A typical online learning environment screen.
Original Critical Theory Problem Material

Following is the original, text-based materials for the problem. These were adapted (as appropriate) for use in the online learning environment.

Problem Instructions

As a team and using these case materials, course content (IST 250 Topics 1, 2, and 3), and quality external resources, you need to analyze, plan, and design the “Critical Theory” band website. Your consulting team will be required to present your final analysis and design document to the band members in person. Your consulting company needs the business, so make sure your document and presentation are top notch!

During this problem solving process, teams may meet in person or virtually in the appropriate Course Communication Space. Your instructor will give you details specific to your section or campus.

Problem Introduction

Your consulting company needs some business. While the website building business has been good in the last three years, set-up expenses for the company have been high and this year’s profits have not been great. The IRS is not going to look kindly on the fact that you are operating at a loss again this year. Everyone has seemed to run out of patience with these high tech companies losing money. You have just been presented with an opportunity that might change everything for your company though!

“Critical Theory” is a talented alternative rock band based out of Madison, Wisconsin. The group has had a lot of success in Wisconsin and Illinois and has just
recently released an album of original music. They have not signed a contract with a recording company, however. The band is trying to make a push to the national scene and has decided that the World Wide Web could be the publicity medium to take them there. In fact, they have deemed it almost imperative since they do not have a recording company behind them. Currently, they have no website.

Critical Theory has contacted only a select number of consulting companies to submit a design proposal for their site. They will choose the one company that they feel is most in line with their vision of the website and will contract with them for the full development of their site. Your company is one of the consulting companies asked to bid on the project and you really want to win this contract! Good Luck!

Problem Objectives

In a professional manner and utilizing course content, problem resources, and external research, your team should:

- Illustrate the importance of the analysis and planning stage for website development by creating a high quality, professional document and presentation that plans and designs the Critical Theory website (*You do not need to develop it).
- Conduct, based on included problem resources, and document an end user analysis for the Critical Theory website.
- Identify the major project management issues within a Memorandum of Understanding (MOU) in the Critical Theory website including: the goal of the project, the scope of the project, associated costs and resources required, estimated timeline, and outstanding issues.
• Construct a web style guide for the Critical Theory website that outlines all layout and style plans for the site.
• Create a storyboard for at least the index page of the site that illustrates all page components, navigation areas, layout plans, etc.
• Create a flowchart for the entire site illustrating all site pages and how they work together and navigate in the site hierarchy.
• Present your design solution to the “Band” and your instructor and convince them that you have the winning solution.

Problem Assignment

Your final document and presentation should be submitted to the Course Communication Space in the appropriate Drop Box.

Document and Presentation Requirements

1. Document

Your document should contain the sections listed below. It should be 11-13 pages, single-spaced, and should include figures where appropriate or indicated. You may include appendices or other relevant information where necessary. Page lengths are approximate. Information on how the document will be assessed is located in the Critical Theory Document Rubric. The document is worth 60 points. Make sure you consult your rubric before you turn your document in!

• Executive Summary (1 page)
• About “Your Consulting Company”
• End User Analysis (2 pages)
• User Profile
• Data Sources

• Further Data Collection Plans

• Memorandum of Understanding (3 pages)

• What is the goal of the project?

• Who is involved? What is each team member’s role?

• What is the scope of the project? What will it include?

• How much will it cost?

• What is the timeline? When will it be completed?

• What other issues are outstanding?

• III. Style Guide (2 pages) and User Specifications

• General Look and Feel

• Page Layout

• Target Technical Audience (i.e. type of computer, display, browser, plug ins, etc.)

• Font Information

• Color Information

• Guidelines

• Homepage Storyboard (1 page)

• Site Flowchart and Navigation Scheme (1-2 pages)

• Works Cited (1 page in APA or MLA format)
2. Presentation

Each team will present their design solution to the client, Critical Theory, as well as to their instructor and classmates, during a scheduled class period. Your instructor will provide details about the time, location, and order of presentations.

Presentations should last 15 minutes; however, your client or your instructor may pose additional questions. You should integrate at least one of the following multimedia components: PowerPoint slides, a website prototype, or other multimedia. When thinking about which multimedia components to choose for your presentation, remember who your audience will be!

Be sure you focus on selling your solution to the client. Not all sections of your document may be appropriate to present; focus on the parts that will grab your clients’ attention and make them want to hire you to build this website!

Information on how the presentation will be assessed is located in the Critical Theory Presentation Rubric. The presentation is worth 40 points. Make sure you consult your rubric before you do your presentation!

Outline of Associated Topics

The topics covered in the Problem are:

Topic 1: Internet Introduction

Topic 2: The End User and Design

Topic 3: Design Considerations

Your instructor will look closely at how you integrate these Topics in your Problem Solutions. Be sure to read them carefully; the success of your solution will depend on it.
Problem Resources

Band Members

Linden Wright, Lead Vocals and Rhythm Guitar

Raghav Bajaj, Vocals and Lead Guitar

Steve Presciutti, Bass Guitar

Dustin Niehenke, Drummer

Jason Lally, Keyboardist

Graphic of First Album Cover
First Album Information

Album Title: Research Institution

Songs:

Track 1: Academic Fluke
Track 2: Metal Thimble
Track 3: Confinement
Track 4: A Cup of Tokens
Track 5: Mexican Ashtray
Track 6: Cognitive Dissonance
Track 7: Curtis in Circles
Track 8: Styrofoam Tools
Track 9: Surge
Track 10: Crates of Moss
Track 11: Argumentation
Track 12: Research Institution

Interview:

Your Interview with Band Leader, Linden Wright, Regarding Website Project

You: Hi Linden. What’s new?

Linden: Not too much.

You: Obviously, the reason I wanted to meet with you is to get a sense of what you want from this website. It will really help me formulate my plan if I can see what your expectations are.
Linden: Sure, no problem.

You: First of all, what do you see as the goal of this site?

Linden: Well, I think that it has to be a centralized location for all that is Critical Theory. You know, our music, our tour dates, info about us, maybe even some day we can have merchandise! We do not have a recording company behind us, so we have to be really proactive and market our band.

You: Do you ever anticipate getting a recording contract?

Linden: A few years ago, we would have said it was necessary for our success. But anymore, I am not sure we even want one. If we stay independent, we can market and sell ourselves. It won’t be easy, but we could certainly distribute our music much more cheaply through the web. Both the group and our customers would win because we cut out the middle man. The hardest part will be to get our name and website out there—the main reason we are so serious about this site!

You: Do you anticipate having the consulting company you choose maintain the site, or just develop it?

Linden: I am sure that none of us could maintain it. So, I would guess you would have to continue to do that. Unless we got a lot of money to hire someone internally!

You: OK. So, if you were to characterize who listens to your music, how would you describe them?

Linden: First of all, we obviously cater to the college crowd, which is mostly kids, but a lot of area professionals too. You know, I should get you some of the marketing data our manager has pulled together. It might help you out.
You: Do you have any information about computer usage among your fans?

Linden: If my memory serves me correctly, I think they asked some questions about that on the survey. But, I don’t know how detailed the information is. You might have to do some follow up work.

You: That was my next question. Do you have access to any marketing lists that we could use to send surveys?

Linden: Well, the closest thing we have to that is our Fan Club information. That’s probably about 500 names and addresses.

You: It would be great if we could use those. Would you mind if we sent them anything?

Linden: Well, I guess not. Just don’t sell the information!

You: Do you have any websites that you really like? It might help me with the look and feel of your site.

Linden: Yeah, I really like the Third Eye Blind site. And Red Hot Chili Peppers is great too. And a site that I really like, that is not really music related is Balthaser.com. It is just really cool!

You: Great, I will take a look at those. If you could characterize what you want your site to look like, what would you say?

Linden: Well, I guess I want it to represent who we are. Sort of dark and edgy, but not too dark. I mean we play alternative rock, but we are all pretty normal people. College graduates gone sort of bad, I guess… You might want to take a look at our album cover to see how we portray ourselves for that medium.

You: What is the status on content creation?
Linden: What do you mean by that?

You: Well, all the content that you want on the website, where will that be coming from and when? You see, in our design proposal, we may want to create a mock up of some of the pages and having real content would really help. Plus we like to use real content on our storyboards.

Linden: Oh, OK. I get it. We have some of that kind of stuff written for flyers and album covers. Let me get you everything we have so far and then we can see where we are.

You: Great. Thanks so much for all of the information. I will be in touch.

Linden: Thank you. Take it easy.

Marketing Data for CD Customers and Concert Attendees

Since “Research Institution” hit the store shelves, purchasing trends and demographics were documented by two of the biggest record stores in Madison, WI as a favor to the band (through a survey distributed at the time of purchase). This data was based on 472 completed surveys. In addition, the band’s manager analyzed trends in ticket sales and door traffic at concerts over a one year period.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>64% are 17-22 years, 22% are 23-27, 10% are 28-32, 4% are 32+</td>
<td>Ticket Sales/Door Info (similar numbers confirmed through purchasing survey)</td>
</tr>
<tr>
<td>Sex</td>
<td>66% Male, 34% Female</td>
<td>Ticket Sales/Door Info (similar numbers confirmed through purchasing survey)</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Data</td>
<td>Source</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Occupation</td>
<td>72% Students, 9% Teachers/Professors, 13% Service/Hospitality, 5% IT Related</td>
<td>Purchasing Survey</td>
</tr>
<tr>
<td>What other bands do you like?</td>
<td>Third Eye Blind, Smashing Pumpkins, Pearl Jam, Blink 182, 311, 3 Doors Down, Silverchair, Kid Rock, Marilyn Manson, Red Hot Chili Peppers, Sublime, Limp Bizkit</td>
<td>Purchasing Survey</td>
</tr>
<tr>
<td>Do you have access to a computer?</td>
<td>89% Yes, 11% No</td>
<td>Purchasing Survey</td>
</tr>
</tbody>
</table>

**Research Suggestions**

Online IST 250 Course Content

Problem Resources

Yale Style Guide: http://www.webstyleguide.com/

IST Web Style Guide: http://ist.psu.edu/styleguide/

PSU Web Style Guide: http://www.psu.edu/ur/webstyleguide/

Builder.com, Solutions for Site Builders: http://www.builder.com/

**Eventual Website Content and Sections**

From your conversations with the band, these are the major sections and functions that they think need to be included. They have encouraged you to be creative, however.

1. **History of the Band**

   Critical Theory was officially born in 1996 at the University of Wisconsin. Linden Wright and Steve Presciutti had been playing small bars and coffee houses in
Madison for about 6 months when they decided to audition for a drummer. After a few unsuccessful auditions, Dustin Neihenke emerged and began playing with Linden and Steve almost daily. By mid 1996, the three were starting to get some regular gigs in the Madison area and needed a name to go by. After setting up a gig at Tim’s SunDog, the manager of the club asked Linden what the name of his band was so he had something to put on his promotional flyer for the month. Linden responded with ‘Critical Theory’, which came directly out of a psychology book he was reading at the time for class. The name has stuck ever since.

Jason Lally was added to the rotation in mid 1997, which really added a new element to Critical Theory. Then, in late 1997, Linden met Raghav Bajaj in a music class at the University of Wisconsin. After the two played together a few times, Linden brought Raghav to a Critical Theory rehearsal to jam with the band. After a few rehearsals the band unanimously decided to offer Raghav a spot in the rotation, which he gratefully accepted. The band has been playing clubs and bars mostly in the Midwest, and has recently started playing some shows in Pennsylvania and New York. Critical Theory is currently planning an extensive tour that will cover the entire Midwest and portions of the Northeast United States.

2. About the Members

Linden Wright, Lead Vocals and Rhythm Guitar

Linden is originally from upstate New York and moved to Wisconsin after high school. He is the only member of the band with a Master’s degree, which is in the field of psychology. Most of Critical Theory’s songs were written by Linden such as ‘Academic Fluke’, ‘Mexican Ashtray’ and ‘Roller Coaster Cab’. Along with Steve and
Dustin, Linden is a founding member of Critical Theory and continues to handle all of the band’s management duties such as booking, albums, etc.

**Raghav Bajaj, Vocals and Lead Guitar**

Raghav, the newest addition to Critical Theory, came to the United States in late 1994 to attend Carroll College in Wisconsin. Before coming to the States, Raghav played guitar with various local musicians from his native country, India. Raghav met Linden while taking an elective course in Contemporary Jazz at the University of Wisconsin in 1997. Raghav had seen Critical Theory at local clubs in the area, and recognized Linden as a member of the band. Raghav approached Linden one afternoon after class about getting together to play some music, and after a few jam sessions, Raghav was officially in the band.

**Steve Presciutti, Bass Guitar**

Steve, along with Linden and Dustin, is one of the founding members of Critical Theory. Steve met Linden at the Barrymore Theater in 1995 at a Red Hot Chili Peppers concert. Steve recollects, “That was one of my favorite shows of all time! The band didn’t stop playing until 3 in the morning, and by that time the only ones still dancing our hearts out were me and Linden!” Steve and Linden visited the Barrymore Theater often to see bands play, and by early 1996 talks had begun about forming their own band, Critical Theory.

**Dustin Niehenke, Drummer**

Dustin, a music major at the University of Wisconsin, was the last original member of Critical Theory. Linden and Steve had been playing local bars as a duo in early 1996, and realized they needed to strengthen their rhythm section if they were to get
any gigs at larger venues. The two put up flyers all over campus encouraging drummers to come down to Steve’s house and audition. “Dustin came down to my place” recalls Steve, “with the smallest drum kit I have ever seen! He started playing some old Pearl Jam tunes, and his drumming was just insane! I’ve never met anyone who can keep a solid rhythm at such a fast pace as Dustin can.” In the middle of Dustin’s audition, Steve strapped on his bass and begun thumping out some chords. Shortly after, Linden picked up his guitar, and the three have been creating music ever since.

**Jason Lally, Keyboardist**

Jason joined the band at about the same time as Raghav. Linden, Steve, and Justin were looking to separate themselves musically from some of the other bands around Wisconsin at the time, but couldn’t really figure out how. Linden and Steve were at a party at a fraternity in Madison one night when they heard some very fascinating music. The two eventually made their way to the basement of the frat house to find a DJ with turntables set up in one corner of the room spinning music, and Jason in the other corner of the room playing his keyboards and synthesizers right along with the DJ. The two, amazed with the performance, made it a point to meet Jason later that night. After chatting for an hour, Jason agreed to come set his equipment up at Steve’s house the next day and play for a while. The next day, Linden, Steve, Justin and Jason played for hours, mixing in some Critical Theory originals with Pearl Jam, Red Hot Chili Peppers, and Alice in Chains cover songs. What amazed the band most was that Jason didn’t know any of the music, he was just playing to the sound the other 3 were producing. Even today, on songs such as ‘Argumentation’, Jason admits he’s still not sure what the ‘correct’ notes are. “In a lot of the songs we play, I’m out there playing different notes
every night. One night I may try and give a song like ‘Argumentation’ a very bouncy feel by playing fast, high notes. Other nights I may try and give it a dark feel by playing slow, low notes through a section.”

3. Tour Dates and Locations

<table>
<thead>
<tr>
<th>Date</th>
<th>Venue</th>
<th>Location</th>
<th>Time</th>
<th>Ages</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wed</td>
<td>Club Laga</td>
<td>120 Forbes Ave.</td>
<td>Doors @ 9p.m.</td>
<td>18+</td>
<td>$10</td>
</tr>
<tr>
<td>Feb 14</td>
<td></td>
<td>Pittsburgh, PA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri</td>
<td>Bloomfield Bridge Tavern</td>
<td>336 Akin St.</td>
<td>Doors @ 8p.m.</td>
<td>21+</td>
<td>$10</td>
</tr>
<tr>
<td>Feb 16</td>
<td></td>
<td>Pittsburgh, PA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat</td>
<td>Pittsburgh Deli Co.</td>
<td>5 Popper St.</td>
<td>Doors @ 9p.m.</td>
<td>18+</td>
<td>$15</td>
</tr>
<tr>
<td>Feb 17</td>
<td></td>
<td>Pittsburgh, PA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tues</td>
<td>Northwestern University</td>
<td>Sigma Nu Fraternity</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$7</td>
</tr>
<tr>
<td>Feb 20</td>
<td></td>
<td>112 Apple Ave.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thu</td>
<td>Wild Goose Bar</td>
<td>4265 N. Lincoln Ave.</td>
<td>Doors @ 8p.m.</td>
<td>21+</td>
<td>$10</td>
</tr>
<tr>
<td>Feb 22</td>
<td></td>
<td>Chicago, IL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat</td>
<td>Modjeska Theater</td>
<td>1134 West Michell St</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$15</td>
</tr>
<tr>
<td>Feb 24</td>
<td></td>
<td>Milwaukee, WI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri</td>
<td>Barrymore Theater</td>
<td>1 Bedford Ave.</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$10</td>
</tr>
<tr>
<td>March 2</td>
<td></td>
<td>Madison, WI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat</td>
<td>Barrymore Theater</td>
<td>1 Bedford Ave.</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$10</td>
</tr>
<tr>
<td>March 3</td>
<td></td>
<td>Madison, WI</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. News

Critical Theory recently announced a mini-tour to support their new album “Research Institution.” The new album “Research Institution” is a collection of some of
the band’s old songs that Linden, Steve and Dustin used to play around the local coffee shops in Madison, with a few newer songs written by Linden that have yet to be released.

The tour begins at the newly remodeled Club Laga in Pittsburgh for the CD release party, then moves back towards Madison for the next 2 weeks, culminating with a 2-night stand at the Barrymore Theater in Madison, the home of the band. Expect to hear a lot of new music from Critical Theory in support of their new album, but the band also plans on playing some of the old favorites as well.

Expect to see some more dates announced soon in the Madison and Milwaukee areas…

5. About “Research Institution”

“Research Institution” is Critical Theory’s first studio album. This album contains a lot of the older songs written by Linden such as ‘Academic Fluke’, ‘Confinement’ and ‘Curtis in Circles’. Other old songs on the album, such as ‘Metal Thimble’ and ‘Cognitive Dissonance’ have been slightly rearranged by the band for the album to give the songs a new feel. “After getting in the studio and playing some of our older tunes, we decided that a few of them could use a little ‘refinement’”, recalls Linden. “‘Metal Thimble’ and ‘Cognitive Dissonance’ are two songs on the album that we reworked. I think our fans will really be surprised with the new versions of these songs.” Some of the newer Linden songs on the album like ‘Mexican Ashtray’ and ‘Styrofoam Tools’ slow things down a bit and add a nice variety to the album. Also, Jason Lally makes his debut appearance as a songwriter on this album with his contribution ‘Surge’. Listeners will really get a taste of something different from Critical Theory on this track, with Jason’s electronic riffs leading the way.
The release party for “Research Institution” is scheduled for Wednesday, February 14th at Club Laga in Pittsburgh. Please come out and support the band.

6. Web Links

http://www.jambands.com - Find new album releases as well as tour dates for bands across the country.

http://www.wjjo.com/wimusicnews.htm - A great place to find out about bands playing in local bars and clubs all over Wisconsin.

http://www.newrock.com/ - WLUM 102.1 radio station. A great station that has helped us spread our tunes for over a year now. Also, listen for free ticket giveaways to Critical Theory shows in the Madison area.

http://www.daveonbass.com - Our friend Dave the Bassist keeps an updated page of links to all things music related in Wisconsin. Go check out his site to find out about local Wisconsin bands.

http://www.redhotchilipeppers.com - What can we say? One of our favorite bands and a great site to boot!

http://www.3eb.com - Third Eye Blind Website

http://www.balthaser.com - Balthaser.Com Website
Appendix C

Treatment Material

Location of the Prompts in the Learning Environment

The learning environment is divided into three sections:

Problem Outline

- Problem Introduction
- Problem Goals and Objectives
- Document & Storyboard Requirements
- Associated Content
- Web Links

Problem Resources

- Band Members & History
- Interview
- Band Info.

Problem Solution (Only the Experimental Group sees this)

- Developing the Paper and Storyboard

The location of the various prompts is defined in the table below.
Table C.1

Location of Prompts Within the Learning Environment

<table>
<thead>
<tr>
<th>Location</th>
<th>Type of Prompt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction, page 1</td>
<td>AP  PP  EP  MPD  MPP  MPM  MSD</td>
</tr>
<tr>
<td>Problem Introduction, page 3</td>
<td>x    x    x</td>
</tr>
<tr>
<td>Problem Goals and Objectives</td>
<td>x    x</td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements</td>
<td>x    x</td>
</tr>
<tr>
<td>Associated Content</td>
<td>x    x</td>
</tr>
<tr>
<td>Web Links</td>
<td>x</td>
</tr>
<tr>
<td>Band Members &amp; History</td>
<td>x    x</td>
</tr>
<tr>
<td>Interview</td>
<td>x    x</td>
</tr>
<tr>
<td>Band Info.</td>
<td>x    x</td>
</tr>
<tr>
<td>Developing the Paper and Storyboard</td>
<td>x    x</td>
</tr>
<tr>
<td>Menu Choices</td>
<td>x</td>
</tr>
</tbody>
</table>

Cognitive Prompts

- AP - Activity Prompts
- PP - Procedural Prompts
- EP - Elaboration Prompts
Metacognitive Prompts

- MPD - Process Displays
- MPP - Process Prompts
- MPM - Process Modeling
- MSD - Reflective Social Discourse

Storyboard for the Learning Environment

Main Layout

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Information (and prompts for the experimental group) appears here.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td></td>
</tr>
<tr>
<td>Problem Goals</td>
<td></td>
</tr>
<tr>
<td>and Objectives</td>
<td></td>
</tr>
<tr>
<td>Document &amp; Storyboard</td>
<td></td>
</tr>
<tr>
<td>Requirements</td>
<td></td>
</tr>
<tr>
<td>Associated Content</td>
<td></td>
</tr>
<tr>
<td>Web Links</td>
<td></td>
</tr>
</tbody>
</table>
------------

<table>
<thead>
<tr>
<th>Problem Resources</th>
<th>Within section navigation buttons appear here.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band Members &amp; History</td>
<td></td>
</tr>
<tr>
<td>Interview</td>
<td></td>
</tr>
<tr>
<td>Band Info.</td>
<td></td>
</tr>
</tbody>
</table>
------------

<table>
<thead>
<tr>
<th>Problem Solution (Only exp. Group sees this)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing the Paper and Storyboard</td>
<td></td>
</tr>
</tbody>
</table>
Subjects entering the learning environment will first see the first screen of the Problem Introduction.

**Note:** The prompts are labeled for clarity of purpose; these labels will not actually appear in the learning environment itself.

**Problem Introduction (Experimental Group Only)**

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>As you work through this problem, please read and think about the following questions.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem Outline</strong></td>
<td>1. How do I define the problem? (MPP)</td>
</tr>
<tr>
<td><strong>Problem Introduction</strong></td>
<td>2. Am I on the right track? How do I know? (MPP)</td>
</tr>
<tr>
<td><strong>Problem Goals and Objectives</strong></td>
<td>3. What are the parts of the problem? (PP)</td>
</tr>
<tr>
<td><strong>Document &amp; Storyboard Requirements</strong></td>
<td>4. What information do you need to storyboard this web site? (PP)</td>
</tr>
<tr>
<td><strong>Associated Content</strong></td>
<td>• What information is already available?</td>
</tr>
<tr>
<td><strong>Web Links</strong></td>
<td>• What information do I need to generate?</td>
</tr>
<tr>
<td><strong>Problem Resources</strong></td>
<td>• What are the technical components?</td>
</tr>
<tr>
<td><strong>Band Members &amp; History Interview Band Info.</strong></td>
<td>o Where will I obtain the technical information I need?</td>
</tr>
<tr>
<td><strong>Problem Solution</strong></td>
<td>• What non-technical information do you need? Where will you obtain it?</td>
</tr>
<tr>
<td><strong>Developing the Paper and Storyboard</strong></td>
<td>o How will the site be used, by whom, and for what?</td>
</tr>
<tr>
<td></td>
<td>o Who would be the users?</td>
</tr>
<tr>
<td></td>
<td>o What information do you expect the users need?</td>
</tr>
<tr>
<td></td>
<td>o What level of prior knowledge do you expect the users to have?</td>
</tr>
<tr>
<td></td>
<td>o How would a user ideally interact with the proposed site?</td>
</tr>
<tr>
<td></td>
<td>5. What should the site do? What are its parts? (PP)</td>
</tr>
<tr>
<td></td>
<td>Use the &quot;My Notes&quot; Tool to write down your thoughts.</td>
</tr>
</tbody>
</table>
(Click on the "Next" button.)
Problem Introduction (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Problem Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td>Your consulting company needs some business. While the website building business has been good in the last three years, set-up expenses for the company have been high and this year’s profits have not been great. The IRS is not going to look kindly on the fact that you are operating at a loss again this year. Everyone has seemed to run out of patience with these high tech companies losing money. You have just been presented with an opportunity that might change everything for your company though!</td>
</tr>
<tr>
<td>Problem Goals</td>
<td>“Critical Theory” is a talented alternative rock band based out of Madison, Wisconsin. The group has had a lot of success in Wisconsin and Illinois and has just recently released an album of original music. They have not signed a contract with a recording company, however. The band is trying to make a push to the national scene and has decided that the World Wide Web could be the publicity medium to take them there. In fact, they have deemed it almost imperative since they do not have a recording company behind them. Currently, they have no website.</td>
</tr>
<tr>
<td>Associated Content</td>
<td>Critical Theory has contacted only a select number of consulting companies to submit a design proposal for their site. They will choose the one company that they feel is most in line with their vision of the website and will contract with them for the full development of their site. Your company is one of the consulting companies asked to bid on the project and you really want to win this contract! Good Luck!</td>
</tr>
<tr>
<td>Web Links</td>
<td>(Click on the &quot;Next&quot; button.)</td>
</tr>
<tr>
<td>Problem Solution</td>
<td>Developing the Paper and Storyboard</td>
</tr>
</tbody>
</table>

Experimental Group Only Prompts:

- How do I define the problem? (MPP)
- What information do I need to solve it? (PP)
- Where can I find this information? (PP)

Use the "My Notes" Tool to write down the answers to these questions.
Problem Introduction (Experimental Group only)

<table>
<thead>
<tr>
<th><strong>Problem Outline</strong></th>
<th>Problem Introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>You should proceed through each section of the Problem Introduction before proceeding to the Problem Resources Section. (AP)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Problem Introduction</strong></th>
<th>Problem Goals and Objectives</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Problem Resources</strong></th>
<th>Band Members &amp; History Interview Band Info.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Problem Solution</strong></th>
<th>Developing the Paper and Storyboard</th>
</tr>
</thead>
</table>

Experimental Group Only Prompts:

- How do I define the problem? (MPP)
- What information do I need to solve it? (PP)
- Where can I find this information? (PP)

Use the "My Notes" Tool to write down the answers to these questions.
### Problem Objectives (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Problem Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td>• Illustrate the importance of the analysis and planning stage for website development by creating a high quality, professional document and presentation that plans and designs the Critical Theory website. You do not need to develop/code it.</td>
</tr>
<tr>
<td>Problem Objectives</td>
<td>• Create a storyboard for the site that illustrates all page components, navigation areas, layout plans, etc.</td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements</td>
<td>• Create a flowchart for the entire site illustrating all site pages and how they work together and navigate in the site hierarchy.</td>
</tr>
<tr>
<td>Associated Content</td>
<td>• Submit your design solution to your instructor.</td>
</tr>
<tr>
<td>Web Links</td>
<td></td>
</tr>
<tr>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>Problem Resources</td>
<td></td>
</tr>
<tr>
<td>Band Members &amp; History Interview Band Info.</td>
<td>Experimental Group Only Prompts:</td>
</tr>
<tr>
<td>-----------</td>
<td>An expert web designer would ask, &quot;Is this similar to a problem I've dealt with before?&quot; If so, how did I handle it? (MPM)</td>
</tr>
<tr>
<td>Problem Solution</td>
<td>As you analyze the problem, what are it's parts? (PP)</td>
</tr>
<tr>
<td>Developing the Paper and Storyboard</td>
<td>What are the technical components? (PP)</td>
</tr>
<tr>
<td></td>
<td>What are the non-technical components? (PP)</td>
</tr>
<tr>
<td></td>
<td>Use the &quot;My Notes&quot; Tool to write down the answers to these questions.</td>
</tr>
</tbody>
</table>
Document & Storyboard Requirements (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Document &amp; Storyboard Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td>Your document should: (AP)</td>
</tr>
<tr>
<td>Problem Objectives</td>
<td>• explain the purpose of the site,</td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements</td>
<td>• describe how it would be built, and</td>
</tr>
<tr>
<td>Associated Content</td>
<td>• describe how it will look.</td>
</tr>
<tr>
<td>Web Links</td>
<td>Your storyboard should visually depict the site in such a way</td>
</tr>
<tr>
<td>Problem Resources</td>
<td>that it is easy to imagine how the real site would look and function.</td>
</tr>
<tr>
<td>Band Members &amp; History Interview Band Info.</td>
<td>ExperimentaL Group Only Prompts:</td>
</tr>
<tr>
<td>Problem Solution</td>
<td>What are items you should include in your storyboard? List</td>
</tr>
<tr>
<td>Developing the Paper and Storyboard</td>
<td>them now for inclusion in your document. (AP)</td>
</tr>
<tr>
<td></td>
<td>What issues surround the site design about which the band</td>
</tr>
<tr>
<td></td>
<td>needs to know? (PP)</td>
</tr>
<tr>
<td></td>
<td>How will you ensure that a stranger reading your document and</td>
</tr>
<tr>
<td></td>
<td>storyboard would exactly create what you designed? (MPP)</td>
</tr>
<tr>
<td></td>
<td>Use the &quot;My Notes&quot; Tool to write down the answers to these</td>
</tr>
</tbody>
</table>
|  | questions.
## Associated Content (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Associated Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td>Internet Introduction</td>
</tr>
<tr>
<td>Problem Objectives</td>
<td>The End User and Design</td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements</td>
<td>Design Considerations</td>
</tr>
<tr>
<td>Associated Content</td>
<td></td>
</tr>
<tr>
<td>Web Links</td>
<td>Experiment Group Only Prompts:</td>
</tr>
<tr>
<td>---------</td>
<td>You need to use this information to plan the technical aspects of the site. As you read this information, make a list of what you believe you'll use and the rationale for using them. (AP)</td>
</tr>
</tbody>
</table>

| Problem Resources | |
|-------------------| The information and examples in this content came from experts in web design. As you view the content, try to match them with your ideas for the site you are designing. (MPM). |
| Band Members & History Interview Band Info. | Use the "My Notes" Tool to write down the answers to these questions. |

| Problem Solution | |
|------------------| |
| Developing the Paper and Storyboard | |
Web Links (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Web Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Objectives</td>
<td>• IST Web Style Guide: <a href="http://ist.psu.edu/styleguide/">http://ist.psu.edu/styleguide/</a></td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements Associated Content</td>
<td>• IST 250 Additional Resources: <a href="http://www.personal.psu.edu/staff/b/x/bxb11/IST250/250links.html">http://www.personal.psu.edu/staff/b/x/bxb11/IST250/250links.html</a></td>
</tr>
<tr>
<td>Web Links</td>
<td>• PSU Web Style Guide: <a href="http://www.psu.edu/ur/webstyleguide/">http://www.psu.edu/ur/webstyleguide/</a></td>
</tr>
<tr>
<td>Band Members &amp; History Interview Band Info.</td>
<td>• JamBands - Find new album releases as well as tour dates for bands across the country: <a href="http://www.jambands.com">http://www.jambands.com</a></td>
</tr>
<tr>
<td>Problem Solution</td>
<td>• Dave on Bass - Our friend Dave the Bassist keeps an updated page of links to all things music related in Wisconsin. Go check out his site to find out about local Wisconsin bands: <a href="http://www.daveonbass.com">http://www.daveonbass.com</a></td>
</tr>
<tr>
<td>Developing the Paper and Storyboard</td>
<td>• Red Hot Chili Peppers - One of the band's favorite bands and a great site to boot: <a href="http://www.redhotchilipeppers.com">http://www.redhotchilipeppers.com</a></td>
</tr>
<tr>
<td></td>
<td>• Third Eye Blind Website - <a href="http://www.3eb.com">http://www.3eb.com</a></td>
</tr>
<tr>
<td></td>
<td>• Balthaser.Com Website Builder - <a href="http://www.balthaser.com">http://www.balthaser.com</a></td>
</tr>
</tbody>
</table>

Experimental Group Only Prompts:

The links to bands should serve as good examples of current rock band sites. Examine them for creative ideas you can use in your site design. (EP)

As you examine the band sites, ask yourself, "How did the developers of these sites make their design choices?" (MPM)

Use the "My Notes" Tool to write down the answers to these questions.
<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Band Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td><strong>Linden Wright, Lead Vocals and Rhythm Guitar</strong></td>
</tr>
<tr>
<td>Problem Objectives</td>
<td>Linden is originally from upstate New York and moved to Wisconsin after high school. He is the only member of the band with a Master’s degree, which is in the field of psychology. Most of Critical Theory’s songs were written by Linden such as ‘Academic Fluke’, ‘Mexican Ashtray’ and ‘Roller Coaster Cab’. Along with Steve and Dustin, Linden is a founding member of Critical Theory and continues to handle all of the band’s management duties such as booking, albums, etc.</td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements</td>
<td><strong>Raghav Bajaj, Vocals and Lead Guitar</strong></td>
</tr>
<tr>
<td>Associated Content</td>
<td>Raghav, the newest addition to Critical Theory, came to the United States in late 1994 to attend Carroll College in Wisconsin. Before coming to the States, Raghav played guitar with various local musicians from his native country, India. Raghav met Linden while taking an elective course in Contemporary Jazz at the University of Wisconsin in 1997. Raghav had seen Critical Theory at local clubs in the area, and recognized Linden as a member of the band. Raghav approached Linden one afternoon after class about getting together to play some music, and after a few jam sessions, Raghav was officially in the band.</td>
</tr>
<tr>
<td>Web Links</td>
<td><strong>Steve Presciutti, Bass Guitar</strong></td>
</tr>
<tr>
<td>Problem Resources</td>
<td>Steve, along with Linden and Dustin, is one of the founding members of Critical Theory. Steve met Linden at the Barrymore Theater in 1995 at a Red Hot Chili Peppers concert. Steve recollects, “That was one of my favorite shows of all time! The band didn’t stop playing until 3 in the morning, and by that time the only ones still dancing our hearts out were me and Linden!” Steve and Linden visited the Barrymore Theater often to see bands play, and by early 1996 talks had begun about forming their own band, Critical Theory.</td>
</tr>
<tr>
<td>Band Members &amp; History Interview Band Info.</td>
<td><strong>Dustin Niehenke, Drummer</strong></td>
</tr>
<tr>
<td>Developing the Paper and Storyboard</td>
<td>Dustin, a music major at the University of Wisconsin, was the last original member of Critical Theory. Linden and Steve had been playing local bars as a duo in early 1996, and realized they needed to strengthen their rhythm section if they were to get any gigs at larger venues. The two put up flyers all over campus encouraging drummers</td>
</tr>
</tbody>
</table>
to come down to Steve’s house and audition. “Dustin came down to my place” recalls Steve, “with the smallest drum kit I have ever seen! He started playing some old Pearl Jam tunes, and his drumming was just insane! I’ve never met anyone who can keep a solid rhythm at such a fast pace as Dustin can.” In the middle of Dustin’s audition, Steve strapped on his bass and begun thumping out some chords. Shortly after, Linden picked up his guitar, and the three have been creating music ever since.

Jason Lally, Keyboardist

Jason joined the band at about the same time as Raghav. Linden, Steve, and Justin were looking to separate themselves musically from some of the other bands around Wisconsin at the time, but couldn’t really figure out how. Linden and Steve were at a party at a fraternity in Madison one night when they heard some very fascinating music. The two eventually made their way to the basement of the frat house to find a DJ with turntables set up in one corner of the room spinning music, and Jason in the other corner of the room playing his keyboards and synthesizers right along with the DJ. The two, amazed with the performance, made it a point to meet Jason later that night. After chatting for an hour, Jason agreed to come set his equipment up at Steve’s house the next day and play for a while. The next day, Linden, Steve, Justin and Jason played for hours, mixing in some Critical Theory originals with Pearl Jam, Red Hot Chili Peppers, and Alice in Chains cover songs. What amazed the band most was that Jason didn’t know any of the music, he was just playing to the sound the other 3 were producing. Even today, on songs such as ‘Argumentation’, Jason admits he’s still not sure what the ‘correct’ notes are. “In a lot of the songs we play, I’m out there playing different notes every night. One night I may try and give a song like ‘Argumentation’ a very bouncy feel by playing fast, high notes. Other nights I may try and give it a dark feel by playing slow, low notes through a section.”

(Click on the "Next" button.)
Band History

Critical Theory was officially born in 1996 at the University of Wisconsin. Linden Wright and Steve Presciutti had been playing small bars and coffee houses in Madison for about 6 months when they decided to audition for a drummer. After a few unsuccessful auditions, Dustin Neihenke emerged and began playing with Linden and Steve almost daily. By mid 1996, the three were starting to get some regular gigs in the Madison area and needed a name to go by. After setting up a gig at Tim’s SunDog, the manager of the club asked Linden what the name of his band was so he had something to put on his promotional flyer for the month. Linden responded with ‘Critical Theory’, which came directly out of a psychology book he was reading at the time for class. The name has stuck ever since.

Jason Lally was added to the rotation in mid 1997, which really added a new element to Critical Theory. Then, in late 1997, Linden met Raghav Bajaj in a music class at the University of Wisconsin. After the two played together a few times, Linden brought Raghav to a Critical Theory rehearsal to jam with the band. After a few rehearsals the band unanimously decided to offer Raghav a spot in the rotation, which he gratefully accepted. The band has been playing clubs and bars mostly in the Midwest, and has recently started playing some shows in Pennsylvania and New York. Critical Theory is currently planning an extensive tour that will cover the entire Midwest and portions of the Northeast United States.

Experimental Group Only Prompts:

What information here is relevant to your site design? (PP)
What information on the band can you use in your site design?
List it now. (AP)

Use the "My Notes" Tool to write down the answers to these questions.
### Interview Outline

**Problem**

- Introduction
- Problem
- Objectives
- Document & Storyboard
- Requirements
- Associated Content
- Web Links

**Problem Resources**

- Band Members & History
- Interview Band Info.

**Problem Solution**

- Developing the Paper and Storyboard

---

### Interview

**Your Interview with Band Leader, Linden Wright, Regarding Website Project**

**You:** Hi Linden. What’s new?

**Linden:** Not too much.

**You:** Obviously, the reason I wanted to meet with you is to get a sense of what you want from this website. It will really help me formulate my plan if I can see what your expectations are.

**Linden:** Sure, no problem.

**You:** First of all, what do you see as the goal of this site?

**Linden:** Well, I think that it has to be a centralized location for all that is Critical Theory. You know, our music, our tour dates, info about us, maybe even some day we can have merchandise! We do not have a recording company behind us, so we have to be really proactive and market our band.

**You:** Do you ever anticipate getting a recording contract?

**Linden:** A few years ago, we would have said it was necessary for our success. But anymore, I am not sure we even want one. If we stay independent, we can market and sell ourselves. It won’t be easy, but we could certainly distribute our music much more cheaply through the web. Both the group and our customers would win because we cut out the middle man. The hardest part will be to get our name and website out there—the main reason we are so serious about this site!

**You:** Do you anticipate having the consulting company you choose maintain the site, or just develop it?

**Linden:** I am sure that none of us could maintain it. So, I would guess you would have to continue to do that. Unless we got a lot of money to hire someone internally!

**You:** OK. So, if you were to characterize who listens to your music, how would you describe them?

**Linden:** First of all, we obviously cater to the college crowd, which is mostly kids, but a lot of area professionals too. You know, I should get you some of the marketing data our manager has pulled together. It might help you out.

**You:** Do you have any information about computer usage among your fans?

**Linden:** If my memory serves me correctly, I think they asked some questions about that on the survey. But, I don’t know how detailed the information is. You might have to do some follow up work.

**You:** That was my next question. Do you have access to any
marketing lists that we could use to send surveys?

Linden: Well, the closest thing we have to that is our Fan Club information. That’s probably about 500 names and addresses.

You: It would be great if we could use those. Would you mind if we sent them anything?

Linden: Well, I guess not. Just don’t sell the information!

You: Do you have any websites that you really like? It might help me with the look and feel of your site.

Linden: Yeah, I really like the Third Eye Blind site. And Red Hot Chili Peppers is great too. And a site that I really like, that is not really music related is Balthaser.com. It is just really cool!

You: Great, I will take a look at those. If you could characterize what you want your site to look like, what would you say?

Linden: Well, I guess I want it to represent who we are. Sort of dark and edgy, but not too dark. I mean we play alternative rock, but we are all pretty normal people. College graduates gone sort of bad, I guess…

You might want to take a look at our album cover to see how we portray ourselves for that medium.

You: What is the status on content creation?

Linden: What do you mean by that?

You: Well, all the content that you want on the website, where will that be coming from and when? You see, in our design proposal, we may want to create a mock up of some of the pages and having real content would really help. Plus we like to use real content on our storyboards.

Linden: Oh, OK. I get it. We have some of that kind of stuff written for flyers and album covers. Let me get you everything we have so far and then we can see where we are.

You: Great. Thanks so much for all of the information. I will be in touch.

Linden: Thank you. Take it easy.

Experimental Group Only Prompts:

What information here is relevant to your site design? (PP)

What information on the album can you use in your site design? (AP)

What information from Linden can you use in your site design? (MSD)

Use the "My Notes" Tool to write down the answers to these questions.
Band Info. - 1st Album Information (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>1st Album Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Outline</td>
<td>Graphic of First Album Cover</td>
</tr>
<tr>
<td>Introduction</td>
<td>Album Title: Research Institution</td>
</tr>
<tr>
<td>Problem</td>
<td>Songs:</td>
</tr>
<tr>
<td>Objectives</td>
<td>• Track 1: Academic Fluke</td>
</tr>
<tr>
<td>Document &amp;</td>
<td>• Track 2: Metal Thimble</td>
</tr>
<tr>
<td>Storyboard</td>
<td>• Track 3: Confinement</td>
</tr>
<tr>
<td>Requirements</td>
<td>• Track 4: A Cup of Tokens</td>
</tr>
<tr>
<td>Associated</td>
<td>• Track 5: Mexican Ashtray</td>
</tr>
<tr>
<td>Content</td>
<td>• Track 6: Cognitive Dissonance</td>
</tr>
<tr>
<td>Web Links</td>
<td>• Track 7: Curtis in Circles</td>
</tr>
<tr>
<td>Resources</td>
<td>• Track 8: Styrofoam Tools</td>
</tr>
<tr>
<td>Band Members</td>
<td>• Track 9: Surge</td>
</tr>
<tr>
<td>&amp; History</td>
<td>• Track 10: Crates of Moss</td>
</tr>
<tr>
<td>Interview</td>
<td>• Track 11: Argumentation</td>
</tr>
<tr>
<td>Band Info.</td>
<td><strong>Track 12: Research Institution</strong></td>
</tr>
<tr>
<td>Resources</td>
<td>(Click on the &quot;Next&quot; button.)</td>
</tr>
</tbody>
</table>
Experimental Group Only Prompts:

What information here is relevant to your site design? (PP)
What information on the album can you use in your site design?
List it now. (AP)

Use the "My Notes" Tool to write down the answers to these questions.
Band Info - Sales Data (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>Sales Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td>Since “Research Institution” hit the store shelves, purchasing trends and demographics were documented by two of the biggest record stores in Madison, WI as a favor to the band (through a survey distributed at the time of purchase). This data was based on 472 completed surveys. In addition, the band’s manager analyzed trends in ticket sales and door traffic at concerts over a one-year period.</td>
</tr>
<tr>
<td>Problem Objectives</td>
<td></td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements</td>
<td></td>
</tr>
<tr>
<td>Associated Content</td>
<td></td>
</tr>
<tr>
<td>Web Links</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Resources</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Band Members &amp; History Interview</td>
<td></td>
</tr>
<tr>
<td>Band Info.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem Solution</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing the Paper and Storyboard</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>64% are 17-22 years, 22% are 23-27, 10% are 28-32, 4% are 32+</td>
<td>Ticket Sales/Door Info (similar numbers confirmed through purchasing survey)</td>
</tr>
<tr>
<td>Sex</td>
<td>66% Male, 34% Female</td>
<td>Ticket Sales/Door Info (similar numbers confirmed through purchasing survey)</td>
</tr>
<tr>
<td>Occupation</td>
<td>72% Students, 9% Teachers/Professors, 13% Service/Hospitality, 5% IT Related</td>
<td>Purchasing Survey</td>
</tr>
<tr>
<td>What other bands do you like?</td>
<td>Third Eye Blind, Smashing Pumpkins, Pearl Jam, Blink 182, 311, 3 Doors Down, Silverchair, Kid Rock, Marilyn Manson, Red Hot Chili Peppers, Sublime, Limp Bizkit</td>
<td>Purchasing Survey</td>
</tr>
<tr>
<td>Do you have access to a computer?</td>
<td>89% Yes, 11% No</td>
<td>Purchasing Survey</td>
</tr>
<tr>
<td>How many MP3 files do you download per week?</td>
<td>51% download 20 or more files, 21% download 10-20 files, 9% download 5-10 files, 12% download 1-5 files, 7% do not download MP3s</td>
<td>Purchasing Survey</td>
</tr>
</tbody>
</table>

(Click on the "Next" button.)

← Previous  Next →

Experimental Group Only Prompts:

What information here is relevant to your site design? (PP)
What information here can you use in your site design? List it now. (AP)

Use the "My Notes" Tool to write down the answers to these questions.
Band Info. - Tour Dates (Experimental and Control Group)

<table>
<thead>
<tr>
<th>Date</th>
<th>Venue</th>
<th>Location</th>
<th>Time</th>
<th>Ages</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wed Feb 14</td>
<td>Club Laga</td>
<td>120 Forbes Ave.</td>
<td>Doors @ 9p.m.</td>
<td>18+</td>
<td>$10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pittsburgh, PA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri Feb 16</td>
<td>Bloomfield Bridge Tavern</td>
<td>336 Akin St. Pittsburgh, PA</td>
<td>Doors @ 8p.m.</td>
<td>21+</td>
<td>$10</td>
</tr>
<tr>
<td>Sat Feb 17</td>
<td>Pittsburgh Deli Co.</td>
<td>5 Popper St. Pittsburgh, PA</td>
<td>Doors @ 9p.m.</td>
<td>18+</td>
<td>$15</td>
</tr>
<tr>
<td>Tues Feb 20</td>
<td>Northwestern University</td>
<td>Sigma Nu Fraternity 112 Apple Ave.</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$7</td>
</tr>
<tr>
<td>Thu Feb 22</td>
<td>Wild Goose Bar</td>
<td>4265 N. Lincoln Ave.</td>
<td>Doors @ 8p.m.</td>
<td>21+</td>
<td>$10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chicago, IL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat Feb 24</td>
<td>Modjeska Theater</td>
<td>1134 West Michell St</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Milwaukee, WI</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri March 2</td>
<td>Barrymore Theater</td>
<td>1 Bedford Ave. Madison, WI</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$10</td>
</tr>
<tr>
<td>Sat March 3</td>
<td>Barrymore Theater</td>
<td>1 Bedford Ave. Madison, WI</td>
<td>Doors @ 8p.m.</td>
<td>18+</td>
<td>$10</td>
</tr>
</tbody>
</table>

(Click on the "Next" button.)

Experimental Group Only Prompts:

What information here is relevant to your site design? (PP)

What information here can you use in your site design? List it now. (AP)

Use the "My Notes" Tool to write down the answers to these questions.
## Problem Outline

<table>
<thead>
<tr>
<th>Problem Overview</th>
<th>News</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Introduction</td>
<td>Critical Theory recently announced a mini-tour to support their new album “Research Institution.” The new album “Research Institution” is a collection of some of the band’s old songs that Linden, Steve and Dustin used to play around the local coffee shops in Madison, with a few newer songs written by Linden that have yet to be released. The tour begins at the newly remodeled Club Laga in Pittsburgh for the CD release party, then moves back towards Madison for the next 2 weeks, culminating with a 2-night stand at the Barrymore Theater in Madison, the home of the band. Expect to hear a lot of new music from Critical Theory in support of their new album, but the band also plans on playing some of the old favorites as well. Expect to see some more dates announced soon in the Madison and Milwaukee areas…</td>
</tr>
<tr>
<td>Problem Objectives</td>
<td></td>
</tr>
<tr>
<td>Document &amp; Storyboard Requirements</td>
<td></td>
</tr>
<tr>
<td>Associated Content</td>
<td></td>
</tr>
<tr>
<td>Web Links</td>
<td></td>
</tr>
</tbody>
</table>

## Problem Resources

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band Members &amp; History Interview</td>
<td></td>
</tr>
</tbody>
</table>

## Problem Solution

<table>
<thead>
<tr>
<th>Solution</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing the Paper and Storyboard</td>
<td></td>
</tr>
</tbody>
</table>

Experimental Group Only Prompts:

- What information here is relevant to your site design? (PP)
- What information here can you use in your site design? List it now. (AP)

Use the "My Notes" Tool to write down the answers to these questions.
Developing the Paper and Storyboard (Experimental Group Only)

<table>
<thead>
<tr>
<th>Problem Outline</th>
<th>As you &quot;solve&quot; this problem, please read and think about the following questions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Outline</td>
<td>• What are the risks and weaknesses with my solution? (MPP)</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>• What are my reasons/argument for my proposed solution? Can I explain why I took that approach? What is my chain of reasoning to support my solution?</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>• How would I justify this specific site design?</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>• What evidence do I have to support my solution (that is, the specific site design I developed)?</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>• Have I examined both the technical components and the issues with use, for example, usability and effectiveness?</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>• Are there alternative solutions?</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>o What are they?</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>o How are they compared with my proposed system?</td>
</tr>
<tr>
<td>Problem Outline</td>
<td>o What argument can I make or what evidence do I have to convince the band that my solution is the most viable?</td>
</tr>
</tbody>
</table>

Use the "My Notes" Tool to write down the answers to these questions.
Appendix D

Scoring Rubric

Scoring Rubric for Measuring Ill-structured Problem-solving Process

(adapted from Ge, 2001)

1. Representing the problem  (Subtotal Points: 11)

1.1. Define the problem

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Problem clearly and completely stated.</td>
<td>Critical Theory needs a web site that reflects the band’s personality,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>and enables them to reach out to their fans.</td>
</tr>
<tr>
<td>1</td>
<td>Problem vaguely or incompletely stated.</td>
<td>The rock band needs a web site.</td>
</tr>
<tr>
<td>0</td>
<td>Problem not stated.</td>
<td></td>
</tr>
</tbody>
</table>

1.2. Generate subgoals

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>At least one specific goal for problem solution is clearly stated.</td>
<td>“…to help the band increase it’s album sales.”</td>
</tr>
<tr>
<td>1</td>
<td>At least one goal for problem solution is clearly stated, but it is vague or general.</td>
<td>“…to help the band make more money.”</td>
</tr>
<tr>
<td>0</td>
<td>Subgoal(s) not stated.</td>
<td></td>
</tr>
</tbody>
</table>

1.3. Identify relevant information (known factors and constraints)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5-7 of the known factors and constraints (stated in the criteria) are identified.</td>
<td>Known factors and constraints: e.g.</td>
</tr>
<tr>
<td>2</td>
<td>3-4 of the known factors and constraints (stated in the criteria) are identified.</td>
<td>Band history.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Band information.</td>
</tr>
<tr>
<td>1</td>
<td>1-2 of the known factors and constraints (stated in the criteria) are identified.</td>
<td>Artistic desires of the band.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What the band wants on the site.</td>
</tr>
<tr>
<td>0</td>
<td>0 of the known factors and constraints (stated in the criteria) are identified.</td>
<td>Target audience demographics.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Target audience technical capabilities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Need to maintain the site.</td>
</tr>
</tbody>
</table>
1.4. Seek needed information

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>12-15 pieces of the needed information (stated in the criteria) discussed.</td>
<td>Needed information such as: Usability/ Accessibility/ Information User limitations and accessibility Usability Information Architecture Navigation &amp; Conceptual Design Types of Navigation Systems Design to Gain Attention Browser Considerations Browser differences Plug-Ins needed Helpers needed Displays Ideal monitor size and resolution Live Space accounted for Flexible and fixed web page designs Page size considerations Basic Text Issues Font size and style Font color Background vs. foreground color</td>
</tr>
<tr>
<td>3</td>
<td>8-11 pieces of the needed information (stated in the criteria) discussed.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4-7 pieces of the needed information (stated in the criteria) discussed.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1-3 pieces of the needed information (stated in the criteria) discussed.</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Needed information (stated in the criteria) is not discussed at all.</td>
<td></td>
</tr>
</tbody>
</table>

2. Developing solution(s) (Subtotal Points: 8)

2.1. Selecting or developing solutions, with explicit explanation.

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>A solution is selected or developed, with explicit explanation on how the solution works.</td>
<td>The explanation should include the interrelationship between different critical technical components and features, the needs of the users, and the needs of the band.</td>
</tr>
<tr>
<td>2</td>
<td>A solution is selected or developed, with minimal explanation on how the solution works.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>A solution is selected or developed, but without any explanation how it works.</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>No solution is selected or developed.</td>
<td></td>
</tr>
</tbody>
</table>
2.2. Quality of the solution(s) (Holistic Assessment)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Exceptional</td>
<td>The holistic assessment is based on the following:</td>
</tr>
<tr>
<td>4</td>
<td>Excellent</td>
<td>(a) Arriving at a solution required by the problem-solving task: Storyboard</td>
</tr>
<tr>
<td>3</td>
<td>Good</td>
<td>(b) The number of factors addressed, e.g., Usability/Accessibility/Information Navigation &amp; Conceptual Design Browser Considerations Displays Basic Text Issues</td>
</tr>
<tr>
<td>2</td>
<td>Weak</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Poor</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>No solution</td>
<td></td>
</tr>
</tbody>
</table>

3. Making justifications for the proposed solution(s) (Subtotal Points: 7)

3.1. Constructing argument

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Argument is well constructed.</td>
<td>Coherent and persuasive premises are provided to support the proposed solution, and factors or constraints are discussed.</td>
</tr>
<tr>
<td>2</td>
<td>At least one goal for problem solution is clearly stated, but it is vague or general.</td>
<td>Irrelevant or incoherent premises are provided to support the proposed solution, and factors or constraints are partially discussed.</td>
</tr>
<tr>
<td>0</td>
<td>Subgoal(s) not stated.</td>
<td>Premises are missing, and no factors or constraints are discussed.</td>
</tr>
</tbody>
</table>

3.2. Providing evidence

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Evidence to support the argument is strong and relevant.</td>
<td>The evidence has been tested, or based on previous experience or real examples.</td>
</tr>
<tr>
<td>2</td>
<td>Evidence to support the argument is relevant.</td>
<td>The evidence is plausible or based on imagery examples.</td>
</tr>
<tr>
<td>1</td>
<td>Evidence to support the argument is weak or irrelevant.</td>
<td>The evidence is not plausible or relevant at all.</td>
</tr>
<tr>
<td>0</td>
<td>No any evidence is provided.</td>
<td></td>
</tr>
</tbody>
</table>
### 4. Monitoring and evaluating problem space and solutions

(Subtotal Points: 7)

#### 4.1. Evaluating solution(s)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>The proposed solution is evaluated, and constraints are discussed, supported with reasoning.</td>
<td>A statement is made about the effectiveness or benefits of the solution. The pros and cons of the solution(s) (e.g. cost, risks, etc.) are discussed, supported with relevant evidence (e.g. from the past experience), as well as how the constraints can be overcome.</td>
</tr>
<tr>
<td>2</td>
<td>The proposed solution is evaluated, and constraints are mentioned, but no reasons are provided.</td>
<td>A statement is made about the effectiveness or benefits of the solution, and the constraints of the solution (e.g., risks, cost, etc.) are mentioned but not discussed in relation to pros and cons (e.g., cost, risks, etc.), nor supported with relevant evidence.</td>
</tr>
<tr>
<td>1</td>
<td>Evaluation of the solution is stated, but no reasoning is provided, and no constraints are mentioned.</td>
<td>A statement is made about the effectiveness or benefits of the solution, but the constraints of the solution (e.g., risks, cost, etc.) are not mentioned.</td>
</tr>
<tr>
<td>0</td>
<td>The solution is not evaluated.</td>
<td>No statement is made about the effectiveness or benefits of the solution.</td>
</tr>
</tbody>
</table>

#### 4.2. Assessing alternative solutions

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Alternative solution is stated, and the viability of the solution(s) is discussed.</td>
<td>At least one optional solution is discussed. Reasons are given on why an option is selected over the other(s), with constraints discussed.</td>
</tr>
<tr>
<td>2</td>
<td>Alternative solution is stated, but the viability of the solution is not discussed.</td>
<td>At least one optional solution is described, but no reasons are given on why it is selected.</td>
</tr>
<tr>
<td>0</td>
<td>Alternative solution is not mentioned at all.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix E

Structured Interview Questions

Background Information Questions

- Are you IST or other major?
- Are you freshmen, sophomore, junior or senior?
- Have you ever done a problem-solving task like this before? How often?

On Problem Solving

- Would you please tell me how you solved the problem in detail, for example, how you approached the problem at first, and how you came up with solutions?
- Did you consider various factors when you defined the problem? What were those factors that came to your mind?
- What were your reasons for selecting those solutions?
- Were you trying to compare different ideas and alternatives? What were those options?
- Did you think about different perspectives, alternatives, or constraints?
- Did you go back to your problem solution and test it? Could you give me an example?

On Motivation

- What type of web sites do you visit for fun?
- Describe an online learning environment you've experienced before.1
- Did you enjoy the challenge of the online learning environment? Please explain why. 1
- How confident were you that you would do well when you started using this online learning environment? 1
- Did you become frustrated at any point in the online learning environment? If so, where?
- Where in the online learning environment did you have to work hard to keep going? 1
- Do you think you used the online learning environment well or poorly? 1
- Did you use the online learning environment more than once? If so, why? 1
- How do you feel you performed in relation to other people? Does it matter to you? 1
- Describe any discussions about the online learning environment you had with other people.

On Question Prompts (for experimental group only)

- In what ways did you find the question prompts helpful in solving the problem. Can you give me some examples?

Appendix F

Interview Transcriptions

Subject 1 Transcript

I: Are you an IST major?

S: I'm an accounting major.

I: You're an accounting major? Great. Freshman, sophomore?

S: Sophomore, but I have a Junior standing.

I: Did you ever do a problem-solving task like this before?

S: Nothing this detailed and in-depth, but I've done similar things in my AP courses in high school and last year in my other course.

I: When you took a look at the problem, how did you approach it? How did you come up with your solutions?

S: First step was to gather all the information and everything you were looking for – what was required then. After that I want and gathered what I wanted to use. I found examples of good – the ones you recommended, and then some that I've always liked, a few of my bands that I liked, so I kinda took examples from them, gathered all their ideas, kinda compiled my web site based on probably eight other web sites. I took the coolest features from each and put it all together. At each step I made sure that I was following along with the guidelines that you had laid out. At the end I just went back and made sure I completed things.
I: What were some of the things you thought about as you were defining the problem? How did you go about doing that?

S: Well, I kinda just put myself in the shoes of someone who would really have to design a web site. Um, actually found it very interesting, something I kinda always liked designing things – how I want them to be, and so I looked at it as almost a kind of job, and I almost handled it like I was doing it for real. That's probably why it's almost four pages, three pages long. So I just handled it like I was really doing it.

I: Things that you chose, parts of the solution. What made you choose them over something else?

S: They are just the layout that I've always wanted web sites to be, because I find that the way I laid it out is the way that I'm most capable of navigating through. I thought what I picked was relatively easy. One of the unique things I chose was the freeze pane idea – I took that from Excel. This summer I did a lot of work for a company and I made some different Excel worksheets, and one of the things my boss told me helps out a lot is when he can scroll down but still have the header information come down with you. And I've thought about that on web sites. I mean, why not have the main bar come down with you the whole way? So I guess that's an example of something I tried that was new. So basically, that's what I felt was easiest to navigate.

I: Did you come up with a couple different ideas and try to compare and contrast them – what were some of those options you came up with? You mentioned the one you finally came up with, but what were some of the other things along the way?

S: Actually I did come up with a few other ideas. I kind of in the beginning laid out a couple different formats, and from there I basically took bits and pieces from each, and
that's what you will see in my final paper. The other ones just didn't flow quite as good. I had one main idea that I went with, but I took just a few things from each of my other ideas. The other ideas just didn't flow as well as I thought this one did. I actually had my roommates look at it – see what they thought, what they thought would be the best, and they gave me some constructive criticisms, to say the least. It was the one that just flowed the most, and it looked the most professional as well. Kind of what you see that's already out there, with a few adjustments.

I: OK, so some of the other ones you looked at didn't quite have the flow, didn't quite have that professionalism?

S: (Nods yes.)

I: Kind of along the same thing, did you think about different perspectives that people might be looking at, that sort of thing?

S: Well, I looked at, I thought about how different people might approach the web site. A true fan – so I came up with the idea of the groupies thing – where the true fan would just go there and they'd have their own place to go in, then the people that were kind of searching and didn't really know about them. So I took into account both perspectives and I tried to make the web site cater to both. Also, just what the band would want. If I was a band member, what information would I want to be putting out there for my fans.

I: You kind of mentioned this – you got some feedback from your roommates. So, did you go back – they kind of tested it for you is what you're saying – they kind of tested and went through it. What were some of the things they said about your earlier prototypes?
S: Well, actually, my one roommate is an IST major, and he has designed web sites for a company in my town and a police department in my town, so he had a lot to say, actually it was basically just him that helped me. He gave me a lot of ideas. He told me what not to miss – the key components to a web site, and I kind of used that and went from there. And he gave me a few other creative ideas, things that he thought were fun, like how many times people have visited the web site – shows up. He said, cause he also has a band, he said he likes to see how many people are visiting the web site.

I: Always useful. Ok, we're switching gears here a little bit. Talk a little bit about you and some motivational aspects. What kind of web sites do you visit for fun?

S: A lot of sports ones, actually. A lot of – Penn State sports page, ESPN. A lot of – Money websites, CNN Money is probably the one I do most. MySchwab account, stuff like that. So I took a little bit from there – no too much, because I was trying just to use other band ideas, but that's probably the web sites I visit the most.

I: Tell me about any kind of online learning environment you've been in before here at Penn State.

S: I'm taking Spanish classes. It used to be a three time a week class, but they cut it down to two times a week, but you make up for that third class by doing a large amount of stuff online. Every week we have assignments due online where they have all these different questions, you have to answer them, takes you almost three hours to do a week. So that's a good experience I've had. My accounting class I'm taking right now. Accounting 211 – they do a lot online. All the quizzes are online. We have to do a case study where we keep the books for a month then we do the closing. So actually I've been pretty active with online learning.
I: What do you think about the challenges, and do you like those kind of environments?

S: The only thing I don't like is they have to be extremely picky. And you might have the right answer, but you might not know how to enter it correctly into the answer space. I've actually run into that a few times in Spanish – not so much in Accounting – but mostly in Spanish, the ones that are fill in the blank? If you don't put it in exactly right, then it's wrong.

I: Sure.

S: But if it's something you'd hand into a teacher, they could look at it and be, "Oh, ok." That's what it is – the computer can't think, whereas a person can use their judgment.

I: Yeah, they have some programs out there that try to do that…

S: Yeah.

I: It's still just not any good. What else about – you say you do this in Spanish about three hours a week. Do you enjoy it?

S: Actually yeah. I kinda like getting out of the classroom, do it from wherever I want. I can go to the HUB and sit down there and do homework. I can do it in my room, which is where I usually do it. It's also, I can work on it with friends. Sometimes, especially in Spanish, I think it can teach me a little bit more than the teacher, because my teacher is always talking in Spanish and I have no clue what she's saying most of the time. So, unless we do something at my pace a little bit more, which is nice.

I: Ok.

S: And I've always been someone who likes to do things on my own.

I: When you started this, how confident were you that you would do well?
S: I actually didn't have any clue what to expect. I was actually nervous that we would be putting together an entire web site. But I wasn't too nervous that I wouldn't be able to do it, because if I ever set my mind to something I always get it done. Sometimes it takes longer than others.

I: That's always true. Did you become frustrated at any point?

S: No, not really. Everything was laid out extremely well. Directions were clear and precise what you wanted, and I never really ran into any roadblocks. Things just kept flowing, and luckily I had help from my roommate. No, I was never frustrated at all.

I: Were the instructions too much at any time?

S: At the beginning there was a lot to take in. I was kind of overwhelmed at first, but then when I got to the one part that told me what I had to do, I was like, "Oh, ok, I can do this." Because I though I had to take all that stuff and make it into a web site. But once I got to the point where it says just do a page layout, just word for word, I was like, "Ok, this isn't bad." So at first I was a little overwhelmed, but it didn't take very long to get out of that.

I: Is there any place in the online environment you had to work hard to keep going? Any place you got stuck?

S: Making sure that when I describe each one of the links that I describe it in enough detail that you would understand what I was trying to get at. Also, making sure that I did everything I wanted to. I went back a few times and noticed things that I missed. So I still don't know. There's probably stuff that I would come up with. Just trying to make sure that I did everything that I wanted to.

I: Do you think you used the environment well or poorly?
S: I think I used it pretty well. I think I definitely accomplished what I wanted to, and I think I completed all the guidelines of the things that you had set out for us. So I think that I did pretty well. Maybe not a hundred but…

I: Did you sit down and do it all in one setting?

S: No, not even close to it. Probably 5-7 different times. That's how I usually do stuff. I won't sit down for hours and do something, I'll do it in chunks, because I find it's better if I go, take a break, come back, and I have more of a fresh mind, number one. Number tow, I might notice errors that I made before. So I always like to do things in bits and pieces. Probably spanned over 3-4 days.

I: How do you feel you performed in relation to other people?

S: Probably definitely not the best. I probably spent just as much time, if not more, than other people, but I'm sure there's some great IST computer majors in the class that have probably seen a lot more of it, took a lot of classes in high school that dealt with this. So they probably have more stuff. I think I did pretty competitively.

I: Do you think the environment helped you in any way?

S: Yeah, definitely. I like that type of environment. I think it catered to my strengths.

I: We already talked about this You did talk to your roommates about this. Did you talk to anyone else?

S: No, they were all pretty cool about helping me.

I: You said one of them had some web design experience. How about your other ones?

S: No. Just the one. The other two just gave me ideas on what they liked.
Subject 2 Transcript

I: Are you IST or another major?

S: I'm an accounting major.

I: You're an accounting major? That's interesting, because I met with someone yesterday who was also an accounting major. IST and accounting – there must be something there.

S: Well, you have to take either IST or MIS for business majors, so…

I: OK, so that seems to be the course that people take. Are you freshman, sophomore…?

S: Sophomore.

I: Have you ever done a problem-solving task like this before?

S: I'm sure I have. I can't think of a specific one. But, I've had a lot of classes where I'm sure they've given us problem-solving tasks before but I feel like it was a long time ago. It was more like in my middle school stages.

I: So nothing recently, no courses. It wouldn't necessarily have to be online. It could be offline, but something similar in nature.

S: Well, I feel like most, a lot of the projects you are given are problem solving, but most of the projects I've been given recently have been research based. Like for classes lately they've all been research based.

I: Ok, fair enough. Tell me a little bit about how you solved the problem in detail. How you approached it, how you came up with solutions, that sort of thing.

S: Well, I went through the steps that were given, and took the notes on the My Notes. I basically just followed the instructions and went from there. I kind of read ahead a little bit, tried to see what else I was getting into next. Where I tried to answer the questions.
I: You said you read ahead a little bit. Did you skip around?

S: Yeah. And then I would like, I had to keep going back to things to, so I could incorporate things that I read before. As I went on, relevant stuff, things before too. Like as I was going I'd remember something that I heard before that might help me answer that question then.

I: What were some of the factors you considered when you were defining the problem for yourself?

S: I had to consider what, like what I has done that was like this before, and what was going on.

I: Ok. When you say what was going on…

S: Like, how to deal with making a web site. I'd never done anything like that before, so, I had factor in that this was something totally new to me.

I: Great. So that was one of the things that came into your mind. "I've never done a web site before – how do I do it?" How did the site help or hinder you in that?

S: Well the fact that for each one, it gave me questions to consider. That helped. It kind of gave me an idea of what was coming, like, how that would help me overall make the site. And I guess like throughout the thing, seeing examples of other web sites that they were looking for, and like, the different components that I thought should go into the web site. Like interviews and stuff like that helped.

I: Did you read any of the instruction that was in there?

S: Yeah.

I: You did. Ok. I was just curious on that.

I: The solutions that you chose. What were your reasons for choosing them?
S: Based on what I had heard, what I had seen in previous slides throughout the project. Mainly my main decisions came from the interview and, like of the band, and the band information itself. So that I thought the web site should be personal based, like so that they would approve of it.

I: Ok. You mentioned going and looking at other web sites.

S: Yeah.

I: Did that affect…

S: Yeah, that helped a little too. I focused on some web sites more than others. Like the other band web sites, mainly.

I: Ok.

S: And that helped give me an idea of what they were looking for, and what kind of ideas I could steal from those web sites.

I: Ok. When you were looking at all those things and you were thinking about it, were you trying to compare different ideas and alternatives from those sites, or from your own thoughts, or…

S: Yeah, I was mainly just like looking and seeing what captured my attention the most, and like, if it was too busy, if it was exciting, or… so I compared the different web sites and like, came up with my own ideas in my head, I guess.

I: And you said you were looking for stuff that wasn't too busy?

S: Yeah, well, I wanted it to be exciting, and like, in your face and capture your attention, but I felt like some of the web sites had so much going on all over the place it was kind of hard to keep track of things.
I: Ok, that's interesting. Now, just as a personal aside, in general, are you seeing web sites like that, not just for this assignment, but just in general, are you seeing stuff like, just too much?

S: Yeah, sometimes there's just like, when you have to go to a web site, and really like, search around for the link that you want, I feel that it should be more open and easy, user friendly. Cause some web sites just try to put so much on their opening page that you can see, like, they're a big company, they have a lot going on, but it sometimes just makes it more confusing and overwhelming.

I: Ok. So, some of the options you were looking for – you wanted it to be not too busy but exciting, you wanted it to be open and easy to use. Anything else you were thinking of as you were going through this?

S: I wanted to make sure there were pictures, stuff so that you weren't just looking at fonts, and I wanted there to be color and stuff. I guess it all goes with grabbing the attention.

I: Sure. Is there anything in the site that leaned you towards options or opinions of things that you should do.

S: In the site that helped us make the project?

I: Yeah.

S: Well, there was that one page that talked about how there's different color options and stuff like that. Some of the parts I didn't really understand all that well, so I guess mainly, I still went back to examples of other web sites, interviews and stuff. That helped.
I: Did you think about different perspectives, alternatives, or constraints? You talked about you wanted to make sure the band got what they wanted. Now were there any different perspectives you looked at in terms of, who might be viewing the sites?

S: Yeah, well I looked at a thing where it said that who the target audience was, and I tried to incorporate that a little bit. And the manager said what his favorite sites were, so I tried to figure that he would probably want his web site based around that too.

I: How about some of the alternatives that you looked at that you chose not to do? Or some thoughts you may have had.

S: The one web site that I looked up that I liked the best was I think Third Eye Blind, but I think Red Hot Chile Peppers was one of those sites where there was a lot going on. It wasn't that difficult to use, it was just – I don't know, I didn't really like it for some reason, but the guy did, so, I didn't know if I should use it even though I didn't like it, or try to use it because he did.

I: So you were weighing those two options. Which way did you go?

S: I chose to go more with what I liked, because I thought it would be easier to design, based on my own personal opinions. And I knew that he still liked the other site that I liked, too. So, I just focused more on that one.

I: So you came up with your solution. Did you go back, did you test it, did anyone look at it with you?

S: No, I just did it on my own.

I: What web sites do you visit for fun?

S: I don't really go to web sites for fun. The one that I go to most is Facebook, like everyone else here. But other than that I not really a… I used to use the internet mainly
for mainly research and email, like trying to find stuff, like if I need to shop, but I don't usually go to web sites just for like...

I: It's not fun…

S: Yeah.

I: Have you ever experienced any other kind of online learning environments? What online learning environments have you experienced before?

S: ANGEL, I've used ANGEL for a lot of things, quizzes, getting study notes. The most recent online thing I did was, my accounting professor put his lecture online. So you downloaded it and looked at his slides while you listened to his whole lecture. But other than that in like simple quizzes and stuff in ANGEL, there's been a lot of stuff you have online before, but most of my stuff has been based in the classroom. I never focused a project off online like that before.

I: So you haven't had a class here at Penn State that has a project that was online? There might have been component of it that you downloaded and looked at?

S; Yeah.

I: Do you enjoy the challenge of an online learning environment?

S: Yeah, sometimes it's frustrating. If things aren't up a lot of times, when ANGEL slows down it's frustrating because you can't do your assignments. I think that it's moving in the right direction.

I: How confident were you that you'd do well when you started using this particular problem?

S: Not very confident. I guess when I started reading it I was like, "Wow, I've never made a web site before – it's going to be a lot harder than I thought it was going to be, I
don't know how to do this." I don't know, like, how to incorporate all these different things into it. So I didn't think I was going to be successful at all.

I: Where did finally start feeling, "Hey, I can do this."

13:41

S: Well, when I realized I had to do a storyboard, and a lot of the stuff was laid out for me, so, there was no really right or wrong way to do it. Once I started getting more ideas together, putting more notes down based on questions and stuff I realized that maybe it wouldn't be as hard as I thought it would be.

I: Great. Did you become frustrated at any point?

S: Yeah. Mainly at the beginning, and I guess little parts throughout, I don't know.

I: Can you give me an example?

S: I guess like further in, like maybe if I opened a page and saw that this one had X, Y, and Z to do, and I'd get frustrated because… I don't know. Frustrated guess like in time, or something. I don't know.

I: What was it that frustrated you?

S: I guess my main frustration was going into it not having ever done a web site before. I think that my main frustration was that I didn't… I guess I was mainly frustrated in myself that I never, that I didn't know how to do this and I was afraid that I was doing it wrong. And so, I mean I guess, yeah, frustration, but I wasn't overall frustrated.

I: Was there anything in the environment that helped you overcome that frustration?

S: What? Like in the environment that was up there? Just like as the problem before – that it was all written there, that it was telling me what to do.

I: Do you think you used the environment well or poorly?
S: I think I used it pretty well. There were some things that I probably could have read more, or that I just sort of skimmed over, but I think all in all I took, as far as notes went I made sure I read the thing and took notes as much as I could, and like, helped me make the site. I'm sure I didn't use it to it's fullest advantage.

I: When you took notes, did you use the prompts that would appear and use them as the basis to start.

S: Yeah, I copied and pasted them onto the thing, and them answered the questions underneath it.

I: And you found that beneficial?

S: Uh-huh. To make sure that I wasn't skipping over anything.

I: Tell me about the time you spent. Did you do it all in one shot? Did you do over a period of a couple days?

S: I did it over a period of, I would say probably over a period of four days or so within two weeks. It was like when I had time to go to the computer lab and sit down for an hour or so.

I: Ok. So you did the work in a computer lab, you didn't do it in a dorm room?

S: Yeah.

I: How much time do you think you spent in a session?

S: Each time, I probably spent like, an hour on it. Forty-five minutes to an hour.

I: How do you think you performed in relation to other people?

S: Probably like average. I'm sure there were a lot of people out there that did a better job than me. They had experience before, or were just like more creative or something, but
I'm sure that there were people that just kind of went through it and tried to get the stuff done as quick as they could and didn't really put much effort into it.

I: Does it matter to you? Did it matter that you performed average, above average?

S: Yeah. I know that I wasn't getting a grade on it, but I'm also the type of person that doesn't want to do something really poorly. I mean, it did matter. I knew that I wanted to get it done and do a decent job on it.

I: Did you talk to anyone?

S: No. I did it all on my own.

I: In what ways did you find the question prompts on the screen that you copied and pasted useful?

S: I found them useful because it gave me an idea of what to expect, like what I was going into as far as that part of the project. It also help me that I had read it and then took notes on it. It helped me keep track of what I read before, because I went back to the notes when making the site and went back when I reached something where I knew I had seen something before on it. So it just helped me all the way through stay organized and track what was going on.

I: Was there any place where you thought, "Gee, I don't want to see these prompts anymore?"

S: Yeah. I mean, there were some times I was like, "Oh. I don't want to answer all these questions again, so like, some of them I just wouldn't answer as thoroughly as others, but the ones I found more helpful I would answer. If I knew at the end it would ultimately go more into the web site. Those were more of the ones I focused on more.
I: So you could tell that some of them looked like, this is just general, I should be thinking this way, and other ones were more specific?

S: There would be some questions like, after you read the interview, what information do you get from the interview that will help you make the web site, so for that one I would go to the interview and take out chunks of the interview that I know I wanted to see in the web site. Then there were other questions, like the one that I didn't understand much about, like the different color settings and font settings and stuff like that, that I tried to understand, that I took out.

Subject 3 Transcript

I: Are you an IST major?

S: I am an HPA major, with an IST minor.

I: What's your class standing?

S: Senior.

I: Have you ever done a problem solving task like this one before?

S: I think I have. It's never been this extensive, but, yes.

I: Can you give me an example?

S: Well, we were always given problems in classes and stuff. I really can't give an example. Especially not on the computer.

I: Ok. Not on the computer.

S: Yeah.

I: So this is the first time you've seen that kind of problem on the computer?
S: (Nods head yes.)

I: Let's talk about the problem itself. Tell me about how you solved the problem. How you approached it, that sort of thing.

S: Well, the first thing I did was I read through all the different sections on the computer, that had the intro, all the information. I just went down the list, read everything. And then I went back, and you know how in each section there were questions that were given? Like, what you should be looking for? Then I went through all of those, took notes. I just continued from there. And then I sort of diagrammed what I thought the web site would look like from the information given. And then I just wrote the paper.

I: So you approached it, it sounds like it was pretty methodical. You did everything step by step.

S: Yeah.

I: Ok. Did you go through things more than once?

S: Some of them, yeah. The section about the band members, and I think it was the intro, I think I went back to it a couple times. Or I just took notes on the bigger sections and looked at that.

I: What were some of the things you thought about as you were defining the problem, you were going through and trying to figure what it all was? What are some of the things that came into your head?

S: Well, when I first read it, I basically had to think that it was real, I was doing this. I first thought about the web sites that I've been to already, what I liked in a web site, what they usually have, how they go from one page to another. And then, just from the
information given about the band, how it was formed, I just kind of took it from there, incorporated it.

I: Ok. So the solution you come up with, what were some of the reasons for the solution you finally came up with?

S: My solution for the web site, it was pretty simple. I like that sort of style better. Other than that, it was more, I just put everything together and made it work.

I: Ok. When you were going through it, you were thinking of different ideas, alternatives, that sort of thing. What were some of the alternatives you came up with that you used or didn't use.

S: The one thing that I thought of doing from the image provided, the album cover? It was kind of dark and like, all over the place. It had a lot of surface matter. I thought of doing something like that for the main web page. Really dark, but not – I don't know how to explain it. Just having things everywhere on it. Just like artwork and stuff in the background. Just kind of go along with the album cover? But I didn't really like that, so I didn't do it.

I: How come you didn't like it?

S: I just don't like that type of web site. I like it more simple. I still made it relate to them, to what I thought they were, but I just kind of made it simpler.

I: Was there anything in the site that helped guide you towards solutions or away from them?

S: I think the band information? How it described how they formed, and who did what. I think that helped in designing their web site, their web page part. Like the band members web page. I think I put in different things that covered that.
I: How about some constraints or things that you might have thought but said, "I can't do that because of this, or – was there anything that you thought of, or was there anything in the site that guided you?

S: That put a constraint on me?

I: Yes. It might have put you in one direction versus the other.

S: Well, the information about who – the demographics page? That really set the direction for it. It was all younger people. Other than that, I don't really know.

I: Ok. So when you say the information that was provided there helped?

S: yeah. A little bit. Some more than others, but it all helped.

I: Did you go outside the site at all, when you were looking at things?

S: I don't think so. I might have looked at other web sites, other band members web sites, but I don't think so.

I: You don't recall looking at any?

S: I don't remember.

I: Ok. How about the instruction that was provided there? There were a couple links.

S: Oh yeah! I did go to those. There was a lot to them. I skimmed them, basically. I forgot about those. I just went to the ones that would help me, write the paper better, and design the site better. Stuff that I wouldn't know.

I: Do you have any web design experience?

S: I designed a web page, but it was just basically a computer science 101 – really simple.

I: Ok. When you were finished, did you go back and test your solution?

S: No.
I: Ok. What kind of web sites do you visit for fun?

S: I go on FaceBook a lot. I use Google all the time. Searching for stuff. I look for stores, buy stuff online.

I: Is this the first online learning environment you've ever been in?

S: Yes.

I: Ok, how about ANGEL, or anything else like that?

S: Yes. I just meant the first problem-solving thing.

I: Right. Anything else you've used for instructional purposes online?

S: I use Google to find things like that. Wikipedia.

I: Anything else?

S: I can't think of anything.

I: Have any of your courses here, have they done anything – it may not be online, on the web, but still might be computer based.

S: I took three classes online this past summer, but they were all on ANGEL. And I'm taking an online course now, Art 10, and they have their own specific web site, which I guess would be, a learning thing?

I: Sure.

S: They have their chapters and stuff online.

I: It’s not in ANGEL?

S: Right. It's connected to ANGEL, but it's not the same thing.

I: Is that through the world campus?

S: I think so. Actually, I don't know. It's just Art 10, and it's all online.

I: Do you enjoy the challenge of an online learning environment?
S: Yes. I really like it. It has a lot of benefits. I don't have to go to class. I can work on it when I want.

I: Anything else? No class, self paced…

S: I really like how it was online – I like computers, so it just works for me. And you just have all these resources right there, so if you don't understand something, you just look it up.

I: How confident were you that you'd do well, or not confident when you started this problem?

S: When I first started it I was a little worried, because I really didn't know how it was going to turn out. I really didn't know specifically what we had to do. But then as I went through it, I kinda got the hang of it, knew what I had to do. SO, it wasn't that bad.

I: What helped you get over that?

S: When I read all those different sections, that really helped. Because I just knew what I had to do.

I: Did you become frustrated at any point as you were going through the environment?

S: When I first went into that outside thing, where we had to read all those, I forget what it was (referring to instructional modules) – it was like instructions on how to help me? When I first realized how much there was, that was kind of frustrating. I really didn't want to read all that. Other than that, not really. Everything else was straight-forward and easy.

I: Where in the online learning environment did you have to work hard to keep going?

You mentioned the instructional section. Were there other sections? Places you got stuck, that you had difficulty with.
S: No, not really. At some point when I was trying to figure out all the different sites that the home page was going to be connected to, that was kind of hard. Trying to come up with new ones that a lot of other web pages don't have, that was kind of hard.

14:45

I: Do you think you were able to use the online environment well, poorly – how did it work for you?

S: I thought it went really well.

I: Was there anything that sticks out in your head that helped you with it?

S: When you clicked on each section and that other box came up with all those questions, that really made me think of what's going to be on that site and what I need to write about. I thought that really helped.

I: Tell me about the time you spent. Did you do it all at once, was it over a period of time?

S: I did it all at once. It took me I would say about an hour and a half, two hours. But granted I didn't read all that instruction.

I: Did you do it in a computer lab?

S: At my house.

I: How do you think you performed in relationship to other people?

S: I don't think I would have performed as well as other people, because I know a lot of people in that class are IST majors. They have a lot more education on site building, things like that, so, I think I got the basics.

I: Do you think the site helped you do those basics?

S: Yes. It covered all the basics.
I: Most of the IST majors in this class are in their first semester. Does that factor in?

S: I don't know. I'm not real literate on... but I guess it's a 110. I don't know.

I: Does it matter to you, how you did in relation to others?

S: No, not really. I mean, I hope I did well.

I: You say you didn't have discussions with other people?

S: I know other people in the class asked me if I did it, but that's basically all they asked. How long it took, what basically I had to do, but I didn't give them any specifics.

I: You mentioned about the prompts that would appear on the screen, and you said they were helpful. Can you give me some examples of how they were helpful?

S: Well, I think they popped up right away when you clicked on a section? And then you can close them out. Then after you read that section, you can actually click them on again, and that was really helpful. Because then you can go back and say, like "Oh, yeah, that's right. We read that." I thought that was really neat, how you could go back to it. And the fact that they were really helpful as well.

I: When you used those, did you use them to take your notes? Did you copy and paste them?

S: Uh-huh.

I: Did you have any problems doing that?

S: (Nods head no.)

I: Did you do that all in ANGEL, or did you copy them into Word?

S: I copied them into Word, and them I copied them in.

I: As you were building this list of questions and stuff, did that help you define, the further you went on, did things become clearer to you then?
S: Yeah, it did. In some ways it really helped, because then I could look at it all at once. See the problems. Yeah, it really helped.

I: Did you ever get frustrated with it?

S: No, not really. Because I basically had the questions and then I wrote the answers right underneath them, so, it was all in line.

I: Well, I know for some people, because it would always pop up, like if you left a section and came back to it a second time they'd pop up again. Was that a concern?

S: It was really no big deal.

Subject 4 Transcript

I: Are you an IST major?

S: Marketing, with a minor in information systems and statistical analysis. It's fun. I really like it. Which is basically like communication over technology. It's a lot of computer-based classes, a lot of internet. It was an alternative to IST, because I wanted to stay with computers, know more about them, but I was scared to go into the IST college, because I don't think I was that good at technology. It was sort of an alternative that my advisor pointed me toward.

I: What's your grade standing?

S: I'm a junior.

I: Have you ever done any problem assignment like this before?

S: Having to develop a web site? Or the process?

I: The process.
S: I think I've been in instances similar to that. Definitely.

I: Can you give me some examples?

S: Several of my classes I've had to develop web pages. A lot of them are open-ended. I had to figure out exactly what I wanted my final to be, and lead up to the steps, how to get myself to that final phase. Of course I asked myself several questions. Additionally, I took a lot of web-based classes. So I've had to go through ANGEL and things like that. So go through lessons, go through various steps. For the most part I answer questions that are already set up within that lesson or whatever. So there are questions I really ask myself, I just sort of figure out the answer. But I think a lot of steps are pretty similar to the Critical Theory problem that you have.

I: How about offline? Have you ever done any types of situations where you were doing it individually or in a team, but it wasn't on the computer?

S: I can't think of anything specifically. But a lot of group work, definitely. Especially for a bunch of classes for Group Speech. You're in a group, you have to have a final presentation, and you have to ask yourself, "What task can I run complete?" "Who can complete them the best?" Put everything, sketch it out, and then figure out what’s best and put it towards the final project. And of course there's always improvement as well. There was improvement with this project. Of course, you put down all the things that you need. If you don't like the way one page looks and whatnot, you know, just throw it out and start from scratch, or improve upon it as well.

I: Ok. I think we'll talk about that a little later, alternatives. That's good to know.

I: Tell me how you approached the problem. In general, what were your thoughts, process, that sort of thing?
S: I'm a marketing major, so I definitely tried to take it from a stance of, be professional. Trying to market span through the web site. Not only include their interest and what they want, but also do whatever I can to have them sign that contract with me, to have me run their web site. Because obviously, that was my main goal, trying to work towards achieving that, their business. So I took it through the steps, took it from a very professional marketing/advertising standpoint. It was hard for me to do it. If you wanted to, someone could take this project and really create a huge site on Front Page or Dreamweaver. Of course, it would take time, but I mean, like, I think it would be very different, taken like a film major's standpoint? From the marketing standpoint. Of course I think like a marketer or advertiser. Another student would probably put more towards, customer oriented, visually, sort of audience website, as opposed to a film major who would probably be more creative with what the artist wanted, the artist insight. I took it from my major sort of perspective.

I: That's a great observation. It's probably true, too. I think most people would approach it like that. We go from what we know…

S: Definitely!

I: Tell me about some of the factors you considered when you were looking at this. Not what we were just talking about, trying to market, but what were some of the things you saw in there, what were some of the things that, when you were going through, you thought, "This is important. I've got to consider this as I do it."

S: Definitely the biggest thing was the interview with one of the band members. Trying to get their perspective, and sort of their insight, with development. After all, it is their site. So that really was a major theme as I worked towards all the pages and parts of the
site they needed to include. That was probably one of the major things. I can't remember them all right now. Definitely the songs and everything. The obvious things that a band site would need to include, definitely the minimal things, minimal meaning the songs, the albums, stuff like that. Tour dates. Everything that a normal band would encompass. But definitely try to bring across their personality into the site.

I: Tell me about the solution that you did choose, and what led you up to some of the choices that you made for your final product.

S: Like some details about it, you mean?

I: Yes.

S: I believe that I used that album cover as the background. Sort of layered that a bunch of times. Sort of made it a solid background. I had a frame within the main page, and sort of as you clicked on the different tabs the background wouldn't move. I'm not sure exactly what that's technically called because I'm not an IST major…

I: It could have been a frame.

S: A frame, yeah, a frame and everything changed within it. So I definitely wanted to have a consistent, I really pulled together a similar feel for every page. That's why I sort of kept a template in the back. Basically I wanted to keep it pretty simple, but have the opportunity for the band to add stuff within their site. Sort of add their own personality. So give a rough sketch of what it could be, but they could add upon it.

I: So you're looking for some consistency and you kind of wanted the band's personality to come through?

S: Yeah, yeah, yeah.
S: Obviously if they chose their album cover it's something they all like. I definitely put that in there as one of the major, as the color scheme.

I: Was there anything in the ANGEL course as you went through it that helped you didn't help you make those decisions? Is there anything that happened?

S: A major thing – It all helped me, all of that was information that ultimately led me to the best site that I could produce, that I could make from a designer's standpoint. There were some – I think everything on the site was set up very well. I really liked how the checkmarks were there after I had clicked on the things. It showed that I had completed those and that I had seen them, and I know it's there. But I did have to go back because I did forget to press "Next" within the page, you know? But otherwise, all the points, all the information that was given really helped completely. Helped me figure out the design that I wanted, and figured out the best way to market this band to the audience.

I: Did you come with any alternatives that you didn't use, and if you did, why didn't you choose them?

S: I can't think of any right now. As I was doing it, of course I wanted to be more elaborate, and do everything I can to make like a really cool site. Be creative. But of course my talents aren't that good with web design. Also it was just a rough sketch in a Word document, so, but I can't think of anything now. I definitely had some cool ideas, but trying to construct them on a page didn't turn out.

I: Can you just think of one of those?

S: Something that I couldn't do on the web?

I: Or that you thought just wouldn't work, because it would be too difficult.
S: Playing music would be really nice to, open up the home page. Also having Flash and whatnot. Even clicking on the different icons and rolling over them, I mean there's really technical, like Flash and Java stuff that would be really cool on a music site. Obviously I couldn't display that on a Word document. Even if I could have pictures of the band, music videos, stuff like that. Adding more color and things into it, that would be awesome too. But of course I didn't. But yeah, being creative. I would put more content in it if I had more time, more visual aids to work with. Because in the Critical Theory there was a lot of words, a lot of content about them, but there wasn't much – I had no idea what the band members looked like. Which wasn't bad – that's fine. A lot of band's don't have any of their pictures, more artistic. Personally, as a girl, I've love to see what the band members look like. (Laughs)

I: I think you talked about some of the constraints you felt you were under. Anything else you want to mention – things that would steer you in direction or another.

S: I don't know. What do you mean by that?

I: Well, let's say you were thinking about adding a certain page to the site, based on the information you had. What you felt was appropriate, that sort of thing. Things that would limit you, or make you not choose an option. Constraints.

S: I think a big constraint, not a big constraint, but I do remember that the band was big in like, Wisconsin, or like some rural states. So I think there would be some audience restraints. Like current followers. Trying to display the band as they know them. I don't know the exact number of followers, but trying to please that audience. You can't market it to New York, LA, or some big audience. If the current audience isn't pleased, you can't try and make the band bigger than it is. That was just a minor detail I guess, but it had a
big effect on trying to keep it simple. Just because I thought, small, rural, audience, it’s probably a simple, not too complicated frilly band. That was one aspect why I thought I should keep it simple.

I: Did you do any testing of the site once you designed it? And testing can be from showing it to someone else to see what they thought, to whatever.

S: I totally, I was like, "Roommates, here. What do you think?" And they're like, "Yeah, cool." They weren't really paying attention. But I definitely spell checked and went over it, and asked myself, "Is this the best I can really do?" I approved of it myself.

I: Tell me about what web sites you look at for fun?

S: Facebook. I know it's terrible, but definitely Facebook.

I: Everyone looks at Facebook. It's interesting.

S: I like to look at sports websites. I love football and basketball. I really don't know stats or anything, I kind of feel cool looking at them, all the pictures and everything. A lot of Penn State web sites, for information.

I: Is that for fun?

S: Yeah, it definitely is. GoPSU Sports.

I: What kind of online learning environments have you experienced?

S: I've done computer classes – Web based training. I've done that a while ago, actually. I've done Microsoft Office a lot, and looked at help, gone through a lot of help steps. Microsoft Outlook, stuff like that. Adobe. All like, the programs I've done for web design, I've looked at help, tried to have them help me. That's pretty much it. ANGEL's definitely the biggest.

I: Can you think of one class you took in ANGEL that really sticks out in your mind.
S: Right now it's definitely EGEE. I'm taking that one the web, and everything's on the web, the lessons, and you hear the professor talking, as you go through lessons. It's EGEE 102. It's Environmental Protection and Energy Conservation. It's just set up really well. It's set up way different that any other ANGEL class. It just has so many lessons, and preview quizzes, and things like that. I think the lessons really stand out. Having the professor talk and do the calculations, all sort of in front of you with a little red cursor. It's done really well. I've done really well in that class. It's because I can pick up the computer and do whatever I want. I love going to classes, sometimes, when the weather is terrible like this, it's hard.

I: Tell me about the challenge of doing this. Did you like it?

S: I liked it a lot. I think it was really challenging. Especially because it was so open ended, you can be so creative. I honestly wish I could have elaborated on it more. I feel like, looking back, I could have spent more time on it. I would have loved to go on FrontPage and created a site. Even though I'm not that great in FrontPage, Dreamweaver, whatnot, I really love playing with it and learning things. Being in the computer lab and asking the person next to me, "Do you know how to do this?" And them giving me different insights, different hints on what to do. It was a great challenge, it was awesome that it was so open ended, that it allowed me to be so creative, but I feel like I could have been more creative. But it was fun, I liked it.

I: Good. I'm glad you found it challenging. How about any frustrations?

S: I don't think I really had that many frustrations. Going back and forgetting to click on some of the little arrows, that was kind of frustrating. I had to reread it and make sure I got all the information. But otherwise, using the notes, basically, I didn't write many of
my own notes, but I copied and pasted the things that I thought were the most important, that I really need to remember to include myself and whatnot. Also that was really helpful because I hadn't used notes previously.

I: When you say you copied and pasted stuff did you copy them right off the web page itself, or did you see a dialog box that would come up and say "Here are some things you should think about." Did you see that?

S: I don't remember. Other than the work through the problem questions,…

I: I'll explain why I asked that in a second. Is there any place you feel you got bogged down, or was really hard, or difficult to work at? Any place you felt overwhelmed, or "Gee, what the heck am I doing?"

S: No, I don't think so. It was really straight forward. I didn’t have a problem knowing what my ultimate goal was, and figuring out myself the steps I needed to do to get there.

I: Tell me about how you figured out the steps to get there. When did that happen?

S: Initially, knowing you were to create a web site, mentally, I definitely thought to myself, "Ok, there are steps I need to do. I need content, to have visual appeal, colors that work. I need to make it look professional. Basically all the aspects I know about, how to build that end web site. Basically taking those steps and as I'm reading, trying to figure out how to match the content to color, visual appeal, what makes sense, things like that. It was a process of reading, figuring out tat those are the steps that I knew. Sort of the line, new concepts (points to left) and steps that I knew (points to right).

I: How well do you feel you used the environment?

S: I think I used it really well. There's times I could of added more content from the site, like my personal site, going back and reviewing, going over and over again what's the
most important, what needs to be added, what would a viewer want to see. But otherwise, I think I used the content really well. You know, achieved my objective, trying to market it to an audience.

I: Tell me about the time you spent in it. Did you do it all at once? Did you do it over a period of a couple of days?

S: I looked at it a couple of times before I actually started it, so I always had in the back of my head what I needed to do. I probably took two sittings to actually complete the document, a pretty long period of time.

I: Did you spend two hours, four hours.

S: Probably like two and a half to three hours on it. On a laptop too. I'm slower on a laptop than I am on a regular computer.

I: Did you do it at your apartment?

S: Yes.

I: How would you rate your performance to other people?

S: From a scale 1-5? I think a 4. I'm pretty confident of my work. Like I said, I'm not professional, I'm not amazing at web design. If I had more background I think I could have been more creative, with the things I can do. I did a four, a solid four.

I: Does it matter to you, how you did in relationship to others?

S: Not really. Just because it's my creativity, it was pretty open ended. I put what I thought is logical and makes sense. Obviously went towards my objective.

I: Did you have any discussions with anyone?

S: I did it on my own, but I did ask members of my group in my IST class if they had done it, and what they thought about it. I talked to one person in particular. He was like,
"Yeah, I did it. It was fun." So after talking to him, this was the time I had glanced at it but hadn't done it yet. So, he was like, "Yeah, it's good." He's the type of person that likes bands and things like that. It sort of prompted me, "Ok, be creative." I mean, I was always going to do it; he sort of pushed me. Since I did it, you do it too.

Subject 5 Transcript

I: Are you an IST major?
S: Marketing, with a minor in information systems and statistical analysis. It's fun. I really like it. Which is basically like communication over technology. It's a lot of computer-based classes, a lot of internet. It was an alternative to IST, because I wanted to stay with computers, know more about them, but I was scared to go into the IST college, because I don't think I was that good at technology. It was sort of an alternative that my advisor pointed me toward.

I: What's your grade standing?
S: I'm a junior.

I: Have you ever done any problem assignment like this before?

S: Having to develop a web site? Or the process?

I: The process.

S: I think I've been in instances similar to that. Definitely.

I: Can you give me some examples?

S: Several of my classes I've had to develop web pages. A lot of them are open-ended. I had to figure out exactly what I wanted my final to be, and lead up to the steps, how to
get myself to that final phase. Of course I asked myself several questions. Additionally, I took a lot of web-based classes. So I've had to go through ANGEL and things like that. So go through lessons, go through various steps. For the most part I answer questions that are already set up within that lesson or whatever. So there are questions I really ask myself, I just sort of figure out the answer. But I think a lot of steps are pretty similar to the Critical Theory problem that you have.

I: How about offline? Have you ever done any types of situations where you were doing it individually or in a team, but it wasn't on the computer?

S: I can't think of anything specifically. But a lot of group work, definitely. Especially for a bunch of classes for Group Speech. You're in a group, you have to have a final presentation, and you have to ask yourself, "What task can I run complete?" "Who can complete them the best?" Put everything, sketch it out, and then figure out what’s best and put it towards the final project. And of course there's always improvement as well. There was improvement with this project. Of course, you put down all the things that you need. If you don't like the way one page looks and whatnot, you know, just throw it out and start from scratch, or improve upon it as well.

I: Ok. I think we'll talk about that a little later, alternatives. That's good to know.

I: Tell me how you approached the problem. In general, what were your thoughts, process, that sort of thing?

S: I'm a marketing major, so I definitely tried to take it from a stance of, be professional. Trying to market span through the web site. Not only include their interest and what they want, but also do whatever I can to have them sign that contract with me, to have me run their web site. Because obviously, that was my main goal, trying to work towards
achieving that, their business. So I took it through the steps, took it from a very professional marketing/advertising standpoint. It was hard for me to do it. If you wanted to, someone could take this project and really create a huge site on Front Page or Dreamweaver. Of course, it would take time, but I mean, like, I think it would be very different, taken like a film major's standpoint? From the marketing standpoint. Of course I think like a marketer or advertiser. Another student would probably put more towards, customer oriented, visually, sort of audience website, as opposed to a film major who would probably be more creative with what the artist wanted, the artist insight. I took it from my major sort of perspective.

I: That's a great observation. It's probably true, too. I think most people would approach it like that. We go from what we know…

S: Definitely!

I: Tell me about some of the factors you considered when you were looking at this. Not what we were just talking about, trying to market, but what were some of the things you saw in there, what were some of the things that, when you were going through, you thought, "This is important. I've got to consider this as I do it."

S: Definitely the biggest thing was the interview with one of the band members. Trying to get their perspective, and sort of their insight, with development. After all, it is their site. So that really was a major theme as I worked towards all the pages and parts of the site they needed to include. That was probably one of the major things. I can't remember them all right now. Definitely the songs and everything. The obvious things that a band site would need to include, definitely the minimal things, minimal meaning the songs, the
albums, stuff like that. Tour dates. Everything that a normal band would encompass. But definitely try to bring across their personality into the site.

I: Tell me about the solution that you did choose, and what led you up to some of the choices that you made for your final product.

S: Like some details about it, you mean?

I: Yes.

S: I believe that I used that album cover as the background. Sort of layered that a bunch of times. Sort of made it a solid background. I had a frame within the main page, and sort of as you clicked on the different tabs the background wouldn't move. I'm not sure exactly what that's technically called because I'm not an IST major…

I: It could have been a frame.

S: A frame, yeah, a frame and everything changed within it. So I definitely wanted to have a consistent, I really pulled together a similar feel for every page. That's why I sort of kept a template in the back. Basically I wanted to keep it pretty simple, but have the opportunity for the band to add stuff within their site. Sort of add their own personality. So give a rough sketch of what it could be, but they could add upon it.

I: So you're looking for some consistency and you kind of wanted the band's personality to come through?

S: Yeah, yeah, yeah.

S: Obviously if they chose their album cover it's something they all like. I definitely put that in there as one of the major, as the color scheme.

I: Was there anything in the ANGEL course as you went through it that helped you didn't help you make those decisions? Is there anything that happened?
S: A major thing – It all helped me, all of that was information that ultimately led me to the best site that I could produce, that I could make from a designer's standpoint. There were some – I think everything on the site was set up very well. I really liked how the checkmarks were there after I had clicked on the things. It showed that I had completed those and that I had seen them, and I know it's there. But I did have to go back because I did forget to press "Next" within the page, you know? But otherwise, all the points, all the information that was given really helped completely. Helped me figure out the design that I wanted, and figured out the best way to market this band to the audience.

I: Did you come with any alternatives that you didn't use, and if you did, why didn't you choose them?

S: I can't think of any right now. As I was doing it, of course I wanted to be more elaborate, and do everything I can to make like a really cool site. Be creative. But of course my talents aren't that good with web design. Also it was just a rough sketch in a Word document, so, but I can't think of anything now. I definitely had some cool ideas, but trying to construct them on a page didn't turn out.

I: Can you just think of one of those?

S: Something that I couldn't do on the web?

I: Or that you thought just wouldn't work, because it would be too difficult.

S: Playing music would be really nice to, open up the home page. Also having Flash and whatnot. Even clicking on the different icons and rolling over them, I mean there's really technical, like Flash and Java stuff that would be really cool on a music site. Obviously I couldn't display that on a Word document. Even if I could have pictures of the band, music videos, stuff like that. Adding more color and things into it, that would be
awesome too. But of course I didn't. But yeah, being creative. I would put more content in it if I had more time, more visual aids to work with. Because in the Critical Theory there was a lot of words, a lot of content about them, but there wasn't much – I had no idea what the band members looked like. Which wasn't bad – that's fine. A lot of band's don't have any of their pictures, more artistic. Personally, as a girl, I've love to see what the band members look like. (laughs)

I: I think you talked about some of the constraints you felt you were under. Anything else you want to mention – things that would steer you in direction or another.

S: I don't know. What do you mean by that?

I: Well, let's say you were thinking about adding a certain page to the site, based on the information you had. What you felt was appropriate, that sort of thing. Things that would limit you, or make you not choose an option. Constraints.

S: I think a big constraint, not a big constraint, but I do remember that the band was big in like, Wisconsin, or like some rural states. So I think there would be some audience restraints. Like current followers. Trying to display the band as they know them. I don't know the exact number of followers, but trying to please that audience. You can't market it to New York, LA, or some big audience. If the current audience isn't pleased, you can't try and make the band bigger than it is. That was just a minor detail I guess, but it had a big effect on trying to keep it simple. Just because I thought, small, rural, audience, it’s probably a simple, not too complicated frilly band. That was one aspect why I thought I should keep it simple.

I: Did you do any testing of the site once you designed it? And testing can be from showing it to someone else to see what they thought, to whatever.
S: I totally, I was like, "Roommates, here. What do you think?" And they're like, "Yeah, cool." They weren't really paying attention. But I definitely spell checked and went over it, and asked myself, "Is this the best I can really do?" I approved of it myself.

I: Tell me about what web sites you look at for fun?

S: Facebook. I know it's terrible, but definitely Facebook.

I: Everyone looks at Facebook. It's interesting.

S: I like to look at sports websites. I love football and basketball. I really don't know stats or anything, I kind of feel cool looking at them, all the pictures and everything. A lot of Penn State web sites, for information.

I: Is that for fun?

S: Yeah, it definitely is. GoPSU Sports.

I: What kind of online learning environments have you experienced?

S: I've done computer classes – Web based training. I've done that a while ago, actually. I've done Microsoft Office a lot, and looked at help, gone through a lot of help steps. Microsoft Outlook, stuff like that. Adobe. All like, the programs I've done for web design, I've looked at help, tried to have them help me. That's pretty much it. ANGEL's definitely the biggest.

I: Can you think of one class you took in ANGEL that really sticks out in your mind.

S: Right now it's definitely EGEE. I'm taking that one the web, and everything's on the web, the lessons, and you hear the professor talking, as you go through lessons. It's EGEE 102. It's Environmental Protection and Energy Conservation. It's just set up really well. It's set up way different that any other ANGEL class. It just has so many lessons, and preview quizzes, and things like that. I think the lessons really stand out. Having the
professor talk and do the calculations, all sort of in front of you with a little red cursor.

It's done really well. I've done really well in that class. It's because I can pick up the computer and do whatever I want. I love going to classes, sometimes, when the weather is terrible like this, it's hard.

I: Tell me about the challenge of doing this. Did you like it?

S: I liked it a lot. I think it was really challenging. Especially because it was so open ended, you can be so creative. I honestly wish I could have elaborated on it more. I feel like, looking back, I could have spent more time on it. I would have loved to go on FrontPage and created a site. Even though I'm not that great in FrontPage, Dreamweaver, whatnot, I really love playing with it and learning things. Being in the computer lab and asking the person next to me, "Do you know how to do this?" And them giving me different insights, different hints on what to do. It was a great challenge, it was awesome that it was so open ended, that it allowed me to be so creative, but I feel like I could have been more creative. But it was fun, I liked it.

I: Good. I'm glad you found it challenging. How about any frustrations?

S: I don't think I really had that many frustrations. Going back and forgetting to click on some of the little arrows, that was kind of frustrating. I had to reread it and make sure I got all the information. But otherwise, using the notes, basically, I didn't write many of my own notes, but I copied and pasted the things that I thought were the most important, that I really need to remember to include myself and whatnot. Also that was really helpful because I hadn't used notes previously.
I: When you say you copied and pasted stuff did you copy them right off the web page itself, or did you see a dialog box that would come up and say "Here are some things you should think about." Did you see that?

S: I don't remember. Other than the work through the problem questions,…

I: I'll explain why I asked that in a second. Is there any place you feel you got bogged down, or was really hard, or difficult to work at? Any place you felt overwhelmed, or "Gee, what the heck am I doing?"

S: No, I don't think so. It was really straight forward. I didn’t have a problem knowing what my ultimate goal was, and figuring out myself the steps I needed to do to get there.

I: Tell me about how you figured out the steps to get there. When did that happen?

S: Initially, knowing you were to create a web site, mentally, I definitely thought to myself, "Ok, there are steps I need to do. I need content, to have visual appeal, colors that work. I need to make it look professional. Basically all the aspects I know about, how to build that end web site. Basically taking those steps and as I'm reading, trying to figure out how to match the content to color, visual appeal, what makes sense, things like that. It was a process of reading, figuring out that those are the steps that I knew. Sort of the line, new concepts (points to left) and steps that I knew (points to right).

I: How well do you feel you used the environment?

S: I think I used it really well. There's times I could of added more content from the site, like my personal site, going back and reviewing, going over and over again what's the most important, what needs to be added, what would a viewer want to see. But otherwise, I think I used the content really well. You know, achieved my objective, trying to market it to an audience.
I: Tell me about the time you spent in it. Did you do it all at once? Did you do it over a period of a couple of days?

S: I looked at it a couple of times before I actually started it, so I always had in the back of my head what I needed to do. I probably took two sittings to actually complete the document, a pretty long period of time.

I: Did you spend two hours, four hours.

S: Probably like two and a half to three hours on it. On a laptop too. I'm slower on a laptop than I am on a regular computer.

I: Did you do it at your apartment?

S: Yes.

I: How would you rate your performance to other people?

S: From a scale 1-5? I think a 4. I'm pretty confident of my work. Like I said, I'm not professional, I'm not amazing at web design. If I had more background I think I could have been more creative, with the things I can do. I did a four, a solid four.

I: Does it matter to you, how you did in relationship to others?

S: Not really. Just because it's my creativity, it was pretty open ended. I put what I thought is logical and makes sense. Obviously went towards my objective.

I: Did you have any discussions with anyone?

S: I did it on my own, but I did ask members of my group in my IST class if they had done it, and what they thought about it. I talked to one person in particular. He was like, "Yeah, I did it. It was fun." So after talking to him, this was the time I had glanced at it but hadn't done it yet. So, he was like, "Yeah, it's good." He's the type of person that likes
bands and things like that. It sort of prompted me, "Ok, be creative." I mean, I was 
always going to do it; he sort of pushed me. Since I did it, you do it too.

Subject 6 Transcript

I: Are you in IST or some other major?

S: I'm in mechanical engineering.

I: What's you standing? Are you a freshman, junior…?

S: It's kind of confusing. I'm almost 4\textsuperscript{th} semester. I guess sophomore.

I: Because you changed majors?

S: No, because I took a whole bunch of classes over the summer, and like AP credits and 
stuff.

I: Ok, so you probably do have sophomore standing. Have you ever done a task like this
before? A problem-solving task.

S: A problem-solving task? Yeah, I guess so.

I: Can you give me some examples?

S: Just anything problem solving?

I: On the computer, that's great, off the computer, it doesn't matter.

S: On the computer? Well kind of along the lines of making web pages. I've made web 
pages before, and I've also made a couple DVDs for a couple Penn State bands. That's
kind of the same kind of thing. What they wanted, then kind of designing something
around that.
I: That's great! I never would have guessed that anyone in this class had ever done that. You said for bands? What kind of bands were they?

S: It's a band called Cloverleaf. It's a piano rock group. It's actually being released this winter. Not out yet.

I: So I think it's safe to assume that you have some experience making web sites and you've had some experience working with bands.

S: I do other tech stuff too.

I: How about offline? What kind of problem-solving stuff?

S: Offline?

I: If you've done a ton…

S: I'm an engineer, so it's kind of, it's what you do. Given a problem and find an answer. I've designed a grandfather clock before, like from a swinging pendulum and designing my own gears and everything.

I: I've always wanted one of those – a real old antique one. I think they're cool. The mechanisms are fascinating.

Let's talk a little more about the problem-solving process. Tell me a little bit about how you solved the problem in detail. Give me some details about how you went in, what you did.

S: I just read through all the stuff. Took notes on what they wanted. I thought it was really pretty straight forward. Just a band web site, I've been to a million of those. So it's just taking what I've seen before and just catering to what this particular group wanted.

I: Tell me a little about your solutions. How did you come up with your solutions? You said you've been to a lot of sites before, and you kind of took some of that.
S: Yeah, I took what I liked from other sites. I like the simple, some sites are real simple to view, and there's not words everywhere and it's hard to find stuff. I remember what I did – there were six little tabs along the left-hand side, and you just click on one tab and it took you to the topic you were looking for. So it's real simple.

I: What were some of the various factors that you thought about as you were going through the problem? You said you've been to a lot of sites, and you looked, and you thought about some of that stuff, and you talked about the interface, you wanted to keep it simple. What were some of the other things you were thinking about as you were going through this?

S: Making the page, it's kind of weird, but making the page look link what the band sounds like.

I: What led you to decide that's one of the things you thought you should focus on?

S: You can't have a metal group with a pink background. It's got to fit your audience. If two things have to match, someone's not going to want listen to you if they see your web site first.

I: Was there anything in the site itself that helped lead you to that decision? Or is that something you came up with based on prior experience?

S: It was based on prior experience. All the stuff I read, all the information there, I read the stuff for two hours and tried to figure out what I was supposed to take notes on, and all of it seemed to be common sense. Make the contrast of the text easy to read, keep it simple, cater to your audience, pictures are good.

I: What are some of the reasons that you chose what you did? We kind of covered that pretty much. Anything else that comes to mind?
S: (No response.)

I: When you were going through this and thinking of these factors, things you wanted to include in it, were there any options that you came up with that you thought, "No, that's no going to work. This is cool, but I can't do it because..." Are there things like that happened? What were some of the alternatives that you just didn't go with?

S: First I though of doing a Flash intro, and I kind of decided against that because every Flash page I've ever been to, it won't load depending on which computer you're on, or it takes 30 seconds. It sounds pretty quick, but it's slow for a page to load. And people my age, they see something that takes 30 seconds to load, and they automatically leave, because they don't want to wait.

I: It used to be thirty seconds for a page to load was acceptable, now it's down to eight.

S: I won't even wait eight seconds.

I: You won't even wait eight seconds, so it's got to be (snaps fingers) there.

S: Yeah. (Laughs.) What I was thinking of doing was loading the Flash thing up, and then have the links based off the Flash. I've seen a lot of sites that do that. So you would have to let the Flash load.

I: So you chose to not go with that because of the load issues?

S: Or what if people don't have Flash. You have to install it as a plugin for Firefox, I think, don't you?

I: Usually when you download Firefox it comes with Flash plugin, but there are times when it's updated or something, and you go to a site and it says you need the latest version Flash. Like you're saying, anything that gets in the way, you've lost your audience. Any other things you thought of besides Flash?
S: Not really, no.

I: So when you were thinking about building this site, did you think of any different perspectives that might guide the design of the site. Perspectives can be different perspectives you have, or audience perspectives, or whatever. It's a pretty broad word.

S: No, I don't think so. I kind of just come up with a thing, and was like, I'm gonna go with, after reading all the stuff.

I: How about any other kind of constraints? You mentioned Flash, but the constraint there was time, and maybe they don't have the plugin. Are there any other kind of constraints you thought about as you were building the site?

S: Bandwidth issues. A lot of sites, like after four days you have too much stuff on there. I realize that not every one has a huge monitor, you have to fit into a 17 inch monitor. I realize not everyone has a high speed internet connection, and there are some people that do, so like the videos that I put on there – I said there going to be some high bandwidth videos, you can watch in reasonably good quality, and then there's some tiny little videos that you can watch in lower quality that will load faster.

I: Now those constraints, was there anything in the site that led you to think about them, or did you just come up with them on your own?

S: You mean from what I read?

I: Yeah, from what you read on the site.

S: Well, the stuff I read in those web sites, it was all stuff I knew, or what all common sense. I didn't read too much of the HTML coding. I thought that was a little too in depth for the project. But like how to design the site? Probably just because I've designed web sites before and I kind of do all that stuff.
I: Did you go back to the problem solution after you came up with it; did you test it in any way? Did you show it to anyone? Did you get any feedback?

S: No.

I: What web sites do you visit for fun?

S: I look on eBay a lot. Musician's Friend. And a lot of guitar tab sites. And MySpace and Facebook.

I: Tell me about any online learning environment you've been in before.

S: Like ANGEL?

I: ANGEL's one.

S: When I took a class at a community college, last summer, we had this thing called Blackboard, and it was awful. It just didn't work.

I: Anything else? Any kind of tutorials, any thing like that?

S: I've done a lot of Premiere Pro tutorials. AutoCAD tutorials. And SolidWork tutorials.

I: Do you or do you not enjoy the challenge of working in an online learning environment?

S: I think it depends. If you can do it well, and make it so you don't have to keep flicking between windows, then it's good. If you don't have two computers, sometimes it's kind of hard. Like with AutoCAD tutorials, when your flipping back and forth, trying to read how to do something and do something at the same time, it's kind of annoying. It makes you just want to buy the book, rather than just do it online for free.

I: Ok, that's a physical constraint. How about the environments themselves? How they're structured, how they're sequenced.
S: Tell me if this counts as an online learning environment. In physics labs we have everything written down in a lab book, but you also write the lab in the computer, and your using a computer program to do the lab in?
I: That's absolutely an online learning environment.
S: Well, something that really bothers me about that is in the lab books, the directions do not correspond to the version of the software we're using. It makes it impossible to do the lab.
I: So inconsistent or incorrect directions…
S: Yeah, when they updated the software, they didn't update their lab manuals. To save money.
I: Anything else? Are there times you feel overwhelmed, or this is easy, I like how it flows, or not?
S: There's an online class I took this summer, and it was really hard to tell what was to be due when. The professor just kind of threw – it was the Blackboard thing, and the professor just threw everything onto Blackboard, and said, "Here's all the information." Didn't really say what to read, to look at or anything, or when anything was due, it was just kind of thrown at you. You basically had to decide for yourself what you were supposed to do with the whole class.
I: So having that direction on what to do – not having that, more frustration.
S: Yeah, that's basically – even without an online class, just a regular class, especially at Penn State, I really think going to class is just basically to be told what you are supposed to study for the test. I mean, I don't really learn that much in any class.
I: How confident were you you'd do well when you started using this problem?
S: I felt pretty good. The only overwhelmment, I guess, if that's a word, that I ran into, was when I clicked on the read all this kind of stuff. There were 12? Sites, but in half of those sites there were half a million other sites. So there was a lot to read, and a lot of the information overlapped.

I: So are these the band sites that you went to?

S: It was all the, how to design the web page.

I: The instructional part?

S: Yes. I thought the band part was straight forward.

I: Did you become frustrated at any point?

S: It wasn't frustration. I quit reading after a while. It started to get repetitious.

I: Ok. Any other thoughts? Navigation, any kind of information that was presented. Anything like that? Anything that bothered you in some way.

S: No, not really. You had to click on a page before you could move to the next one, move to the next topic? I didn't really like that, because I really wanted to see my end goal that I was working towards.

I: So you couldn't see the survey at the end until you did the site and submitted it, that sort of thing.

S: Not really the survey. Any of the information. I don't really remember how it was set up. I just remember it not letting you go to the next step, to see what was there.

I: Where did you have to work hard to keep going? Was there any other part of the site that dragged you down?

S: No, not really. The only thing that was dragging me down was, I tried to use the computers in that lab right there (points to an IST computer lab). They weren't very good.
They didn't have any software on them that I wanted to use. I made the pictures, Jpegs, rather than writing out text, just because I thought it was a lot easier to do that, but they didn't have Photoshop or any other program like that. They had this – I don't know what it was – a knockoff of Photoshop, but it was awful.

I: I wonder if it was a public lab, or an IST lab?

S: It was an IST lab.

I: Ok, so that had to do with the physical environment, but how about the learning environment itself? Inside that web site that was talking about the band and showing the different interviews, that kind of stuff. Anything there that bogged you down?

S: Something that would have been nicer is instead of having links that open new pages, it would have been nice if everything was contained in one web site. I realize that wouldn't really work for this, because you are linking to someone else's information, so you can't just copy it. But I think in doing that you could eliminate a lot of the repetition between the different sites. I guess it's like taking the easy way out.

I: Do you think you used the learning environment well or poorly?

S: I think I did alright. I definitely liked it more than having to buy a book.

I: What is it about a book you don't like?

(A short, off-topic discussion on book prices occurred at this point. It is not transcribed here as it has no relevance to the study.)

I: Tell me about the time you spent in the environment. Did you do it all at once? Did you do it over a period of time?

S: I did it all at once.

I: Do you know how much approximate time you spent?
S: Two and one-half to three.

I: How do you feel you performed in relation to other people?

S: I don't know what anyone else did, but a little bit above average. Just because I've done web sites before and stuff. And I knew what a band website was supposed to look like.

I: Would you attribute your performance above average to any effort you put into it, or your knowledge?

S: Both.

I: Does it matter how you did in relation to other people? Do you care?

S: I'd say, yeah, I care. I wouldn't want garbage. It's your study that you're doing, and if I was going to put that much time into it anyway, I might as well make it as good as I can.

I: Did you talk about this with anyone else?

S: The only thing I talked to with anyone else was, "Hey, did you do that assignment yet?"

I: Ok, you didn't sit down and say, "Here's what I did, what did you do?"

S: No, not really.
Appendix G

Self-report Questionnaire

1. Date: ______
2. Course and Section #: ______
3. Gender: Male __  Female __
4. I am in the IST major: Yes __ No __
5. I am in another major (specify): ____________________________
6. I am a:
   Freshman __  Sophomore __  Junior __  Senior __  Graduate Student __
7. Why do you take this class?
   It's required for my major. __  I am interested in it. __  I am thinking of making IST my major. __  Other (Please specify in the next question.)
8. Other reason for taking this course: ____________________________
9. Why are you enrolled in this class section?
   Because it fits my schedule. __  Because someone recommended this professor to me. __  No particular reason. __  Other (Please specify in the next question.)
10. Other reason for enrolling in this class section: ____________________________
11. How often have you solved a problem like the case study you have completed for this study?
    Often. __  A few times. __  Never. __
12. Please rate your computer skills in using online learning environments:
    Expert. __  Competent. __  Novice. __  Clueless. __
13. Please rate your computer skills in using Frontpage, Dreamweaver, or other web page creation applications:
    Expert. __  Competent. __  Novice. __  Clueless. __
14. Please rate your web page development skills:
    Expert. __  Competent. __  Novice. __  Clueless. __
15. How much do you like to use online learning environments? Please rate yourself on a 1-5 scale, with 5 being the highest and 1 the lowest:
    5  4  3  2  1
16. How much did you like this particular online learning environment? Please rate yourself on a 1-5 scale, with 5 being the highest and 1 the lowest:
    5  4  3  2  1

Directions: The following questions inquire how you solve a problem. Please read the following statements and circle the answer that best describes the way you are when you are trying to solve a problem. Think about a problem that you might see in a math or science class. There are no right answers. Please describe yourself as you are, not how you want to be or think what you ought to be:
<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Seldom/Rarely</th>
<th>Sometimes</th>
<th>Often/Frequently</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>17. Before you begin to solve a hard problem, what do you do?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think to myself, do I understand what the problem is asking me?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. I try to remember if I have worked a problem like this before.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. I think about what information I need to solve this problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. I ask myself, is there information in this problem that I don't need?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. I try to think about the constraints of the problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. I list all the information available and the constraints.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. I try to identify the critical relationships from the information given.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. I create a picture in my head or on a piece of paper to help me understand the problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. I plan all the steps as I work on the problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. I keep looking back at the problem after I do a step.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. I look back at my problem-solving process to see if it makes sense.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. I try to find evidence to justify and support my solutions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. I think about the solutions and see if there are alternatives.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. I try to look at the problem solutions from different perspectives.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. I test my solution or hypothesis by asking myself &quot;if…what…&quot;.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. I draw a picture to help me understand the problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. I develop a hypothesis first and then test it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. I pick out the steps I need to do for this problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. I prioritize the problems or goals and focus on the most critical one.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. I follow a problem-solving model.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Directions: The following questions inquire about the online learning environment you experienced. Please read the following statements rate yourself on a 1-5 scale, with 5 being the highest and 1 the lowest. There are no right answers.

37. I enjoyed the way text information was presented in the online learning environment. 5 4 3 2 1

38. I enjoyed the way graphics were presented in the online learning environment. 5 4 3 2 1

39. I enjoyed the way animations were presented in the online learning environment. 5 4 3 2 1

40. I enjoyed the optional information in the online learning environment. 5 4 3 2 1

41. I enjoyed how I could manipulate events in the online learning environment. 5 4 3 2 1

42. I enjoyed seeing my progress (menu checkmarks) in the online learning environment. 5 4 3 2 1

Directions: The following questions inquire about the mental effort you used in the online learning environment you experienced. For example, tying your shoes probably requires very little mental effort, but a complex math problem requires high mental effort. Please read the following statements rate yourself on a 1-5 scale, with 5 being the highest and 1 the lowest. There are no right answers.

43. How much mental effort did you expend as you used the online learning environment? 5 4 3 2 1

44. How much did you think about the way you tried to gather information as you used the online learning environment? 5 4 3 2 1

45. How well did you concentrate as you used the online learning environment? 5 4 3 2 1

1 Questions 17-36 are adapted from

2 Questions 37-42 are derived from Gee, J. P. (2003). What video games have to teach us about learning and literacy (1 ed.): Plagrave MacMillan, 175 Fifth Avenue, New York, N. Y. 10010.

VITA

Brett Alan Bixler

2814 Zion Rd. • Bellefonte, PA 16823
814-383-2537
E-mail: bxb11@psu.edu
Web: http://www.personal.psu.edu/bxb11/

Objective

To contribute strong leadership and e-Learning design skills to your organization.

Professional Profile

■ Strong leader seasoned in the use of quality interpersonal skills for managing and leading diverse teams.
■ Goal-oriented instructional design professional with significant and progressive curriculum development experience interacting with people and teams in instructional settings and beyond.
■ Excellent communicator with attentive listening and effective speaking skills.
■ Productive, punctual worker with solid time-management skills.
■ Exceptional troubleshooter and problem solver with solid detail orientation and organizational skills.

Employment History

Lead Instructional Designer, Educational Technology Services, Penn State University. Responsibilities include project and staff management, program outreach, university committee work, design and development of educational multimedia, in-service training and assistance; curriculum development; data analysis.

Senior Instructional Designer, Center for Learning and Academic Technologies, Penn State University. Responsibilities included project and staff management, program outreach, university committee work, design and development of educational multimedia, staff development, training, in-service training and assistance; curriculum development; data analysis; software programming; formative and summative evaluation of projects.

Senior Instructional Designer, Institute for the Study of Adult Literacy, Penn State University. Responsibilities included grant writing, project management, program outreach, design and development of educational software, staff development (computers), teacher training, in-service training and assistance; curriculum development; database development and management; data analysis; software programming; courseware development; formative and summative evaluation of projects, and frequent presentations on computer-based education materials.