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Effects of Process-Oriented and Product-Oriented Worked Examples and Prior Knowledge on Learner Problem Solving and Attitude: A Study in the Domain of Microeconomics

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EFFECTS OF PROCESS-ORIENTED AND PRODUCT-ORIENTED WORKED EXAMPLES AND PRIOR KNOWLEDGE ON LEARNER PROBLEM SOLVING AND ATTITUDE:
A STUDY IN THE DOMAIN OF MICROECONOMICS

By

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Tables</td>
<td>vii</td>
</tr>
<tr>
<td>List of Figures</td>
<td>ix</td>
</tr>
<tr>
<td>Abstract</td>
<td>x</td>
</tr>
</tbody>
</table>

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

- Statement of the Problem ........................................... 1
- Context of the Problem ............................................. 4
- Significance of the Study ........................................ 8
- Purpose of the Study .............................................. 10
- Research Questions ................................................. 10
- Hypotheses .................................................................. 11
- Summary ...................................................................... 16

## CHAPTER 2 REVIEW OF THE LITERATURE .............................. 20

- Cognitive Load Theory ........................................... 20
- Cognitive Load Theory and Conventional Problem Solving Strategies ........................................ 22
- Learning from Worked Examples .................................................. 24
- Worked Example Strategies: Product-Oriented and Process-Oriented .......................................... 29
- Worked Example Efficacy and Learner Prior Knowledge ........................................... 31
- Learner Attitude .................................................................. 32
- Summary ...................................................................... 34

## CHAPTER 3 METHOD ..................................................... 36

- Participants .......................................................... 36
- Instructional Environment ............................................ 37
- Instructional Materials ............................................. 39
- Variables ................................................................... 42
- Instruments ................................................................ 47
- Procedure .................................................................. 49
- Instructional Strategy ........................................... 50
- Research Design and Data Analysis ................................. 54

## CHAPTER 4 RESULTS ...................................................... 55

- Preliminary Analysis ........................................ 55
- Primary Data Analysis ........................................ 60
- Description of Groups ............................................ 60
- Tests of Hypothesis .............................................. 64
- Secondary Analysis ........................................... 76
LIST OF TABLES

Table 3.1: Descriptive Statistics on Instructional Strategy Conditions ............................ 37
Table 3.2: Differences Between Instructional Strategies ....................................................... 42
Table 3.3: Research Design of Instructional Strategy and Prior Knowledge ................. 54
Table 4.1: Tests of Normality of Instructional Strategy Conditions .................................. 56
Table 4.2: Tests of Normality of Instructional Strategy and Prior Knowledge .................. 57
Table 4.3: Test of Homogeneity of Variance ....................................................................... 58
Table 4.4: Performance Assessment Statistics for Individual Test Items ....................... 59
Table 4.5: Descriptive Statistics of Instructional Strategy on Dependent Measures ........ 61
Table 4.6: Descriptive Statistics for Prior Knowledge Assessment Scores ..................... 61
Table 4.7: Prior Knowledge Category Frequencies by Instructional Strategy ................. 62
Table 4.8: Descriptive Statistics of Prior Knowledge Levels on Dependent Measures ........ 62
Table 4.9: Frequency of Participants who Completed High School Economics ............. 63
Table 4.10: Frequency of Participants who Completed College Introductory Economics ............................................................... 64
Table 4.11: Frequency of Participants who Completed College-Level Economics with Course Instructor ............................................................... 64
Table 4.12: One-Way Analysis of Variance for Achievement Test Scores ....................... 65
Table 4.13: Two-Way Analysis of Variance for Instructional Strategy and Prior Knowledge Level on Achievement Test Scores ....................................................... 66
Table 4.14: Effect of Prior Knowledge Level on Transfer Test Scores within Instructional Strategy Groups ............................................................... 67
Table 4.15: Two-Way Analysis of Variance on Transfer Test Scores ............................... 68
Table 4.16: Effect of Prior Knowledge Level on Transfer Test Scores within Instructional Strategy Groups .......................................................... 69

Table 4.17: Descriptive Statistics for Instructional Strategy Mental Effort Ratings 70

Table 4.18: One-Way Analysis of Variance for Mental Effort Ratings .......... 70

Table 4.19: Descriptive Statistics for Learner Attitude by Instructional Strategy 72

Table 4.20: Univariate Analysis of Variance for Instructional Strategy on Attitude 72

Table 4.21: Univariate Analysis of Variance for Instructional Strategy and Prior Knowledge Level on Learner Attitude ............................... 74

Table 4.22: Descriptive Statistics for Confidence by Instructional Strategy and Prior Knowledge Level ................................................................. 74

Table 4.23: Descriptive Statistics for Attention by Instructional Strategy and Prior Knowledge Level ................................................................. 75

Table 4.24: Descriptive Statistics for Learner Attitude by Instructional Strategy and Prior Knowledge Level ................................................................. 75

Table 4.25: Descriptive Statistics for Learning Efficiency by Instructional Strategy .......................................................................................... 79

Table 4.26: Descriptive Statistics for Achievement and Mental Effort Z-scores by Instructional Strategy ................................................................. 81

Table 4.27: Descriptive Statistics for Learning Efficiency Z-scores by Instructional Strategy and Prior Knowledge Level.......................... 81

Table 4.28: Summary of Result Findings ............................................................. 82
LIST OF FIGURES

Figure 1.1: Graphical Display of Worked Example versus Conventional Problem Solving in Promoting Learning ................................................. 3

Figure 3.1: Display of a Process-Oriented Worked Example Incorporating both Procedural and Strategic Information ......................................... 44

Figure 3.2: Display of a Product-Oriented Worked Example with Procedural Steps .................................................................................................. 45

Figure 3.3: Illustration of Participant Categorization into Instructional Strategy and Prior Knowledge Groups.......................................................... 50

Figure 3.4: Overview of the Procedures ............................................................... 53

Figure 4.1: Efficiency Graph of Mean Achievement Z-Scores for Learning by Instructional Strategy ........................................................................ 80
ABSTRACT

The purpose of this study was to investigate the effectiveness of process-oriented and product-oriented worked example strategies and the mediating effect of prior knowledge (high versus low) on problem solving and learner attitude in the domain of microeconomics. In addition, the effect of these variables on learning efficiency as well as the influence of learner attitude on mental effort was explored as part of a secondary analysis.

Four-hundred fifteen undergraduate students enrolled in an introductory microeconomics course participated in the study. Participants were randomly assigned to one of three instructional strategies (process-oriented, product-oriented, or conventional problem solving) developed for this study. In addition, participants’ were classified during the analysis phase as either low prior knowledge or high prior knowledge groups based on scores from a prior knowledge assessment. In the process-oriented strategy condition, participants were exposed to a fully worked out example that presented both procedural “how” and strategic (principle-based) “why” information underlying the solution. Participants in the product-oriented strategy condition were presented a worked out example with procedural information showing the steps necessary to solve a problem. In both worked example strategy conditions, participants completed a series of four process-oriented worked examples and three practice problems. Participants assigned to the conventional problem solving condition were asked to complete seven practice-problems.

Regardless of the instructional condition, all participants received immediate feedback (i.e., correct answer) after the completion of a practice problem. The study included two instructional components: (1) a common lecture, and (2) completion of a print-based instructional activity. The twenty-minute lecture provided a conceptual overview of the impact of taxes on market activity. Two days later participants were assigned to one of the three instructional conditions and given fifty-minutes to complete the instructional activity. A performance assessment was administered four-days later to measure learning and transfer.

Results suggested that instructional strategy had a minimal affect on participant learning and transfer performance, mental effort, and attitude toward the instruction.
However, mean scores on the achievement test assessing student learning were found to be slightly higher for participants in either one of the worked example instructional strategies when compared to conventional problem solving. For mental effort, the findings indicated that participants, regardless of instructional strategy, invested a low amount of mental effort during the instructional tasks. Similarly, participants reported a relatively high (i.e., positive) attitude toward the instruction. In a post hoc analysis, participants in both the product-oriented worked example and the conventional problem solving groups that self-reported a higher level of confidence toward the instruction also invested a higher degree of mental effort during the instructional task. The study did support the mediating effect of prior knowledge on each dependent measure.

The results of the present study have implications for the design of example-based instruction and for further research exploration of instructional task sequencing. Based on the findings of the present study, it is recommended that instructional designers consider participants’ level of knowledge when designing learning strategies to teach complex problem solving skills. Furthermore, developing instructional methods or systems that adapt to a learner’s cognitive and motivational differences has implications for the measurement of mental efficiency and the design of instructional and feedback protocols. Consequently, the implications for the design and utilization of process-oriented worked examples as a component of a sequenced instructional strategy are discussed further.
CHAPTER 1

INTRODUCTION

This chapter presents the general problem of designing and developing instruction utilizing supportive worked example strategies to improve learning and transfer of problem solving skills in the domain of microeconomics. The use of process-oriented and product-oriented worked example instructional strategies is the specific design feature of interest. In addition, the mediating effects of participant levels of prior knowledge on learning, transfer, mental effort, and attitude will also be examined. In Chapter 1, the problem is stated, the context of the problem is described, and the significance of the study is presented. To conclude, the specific purpose of the study is presented along with statements of the research questions and the hypotheses guiding the study.

Statement of the Problem

The purpose of instruction is to prepare learners to acquire and transfer knowledge and skills to different environments (Nelson, 2006). However, learners are frequently unable to transfer learned knowledge and skills to novel situations or novel problems (van Gog, Paas, & van Merrienboer, 2004). The rationale behind transfer difficulty is that novice learners tend to form problem solutions in a series of linear steps or tasks (Catrambone, 1996) as opposed to developing an understanding of the principles underlying the problem (van Gog, Pass, & van Merrienboer, 2004). To overcome transfer difficulties, instruction should aim to enable the learner to draw inferences about the structure of the problem and the steps necessary to solve it based on an understanding of the rationale underlying the problem (Gerjets, Scheiter, & Schuh, 2008).

A compounding problem in educational and training settings is the limited instructional time afforded to learners. Consequently, Cognitive Load research has sought to examine instructional strategies that are more effective than more traditional or conventional problem solving strategies in terms of improving the problem-solving skill acquisition and transfer performance by optimizing the allocation of cognitive resources. This study uses two types of worked example instructional strategies to improve the learning and transfer performance of problem solving skills in the domain of
microeconomics. Specifically, this study will investigate the effects of two types of worked example strategies (i.e., process-oriented or product-oriented) and prior knowledge on various learning outcomes.

Since the 1960s, conventional problem solving strategies, based on discovery learning principles, have been widely applied as the prevailing method for problem solving in educational settings (Tuovinen, 1997). Many educators use conventional problem-solving strategies, based on the belief that providing learners the opportunity to solve a large number of whole-task problems will lead to effective domain-specific knowledge acquisition and transfer (Darabi, Sikorski, Nelson, & Palanki, 2006; van Merrienboer, 1997).

However, researchers examining the influence of the cognitive load of instruction on learner performance have criticized the use of a conventional problem-solving strategy (Darabi et al., 2006) as an ineffective instructional strategy. According to Cognitive Load Theory (Sweller, 1988), a learner’s working memory has a limited capacity (Clarke, Ayres, & Sweller, 2005) that can easily become overloaded during instructional activities, especially during the initial stages of learning. Conventional problem-solving strategies provide little instructional support (Tuovinen & Sweller, 1999), prompting novice learners to employ weak goal-directed problem solving strategies (i.e., means-end analysis) that can hinder the learning process by overwhelming working memory.

Contrary to conventional problem solving, the use of worked examples has been shown to improve transfer performance for novice learners by optimizing cognitive capacity (Cooper and Sweller, 1987; Paas, 1992; Kalyuga, Chandler, Tuovinen, and Sweller, 2001).

An instructional strategy that consists mainly of worked examples or worked examples with practice problems (known as worked example-problem pairs) provides learners with a structured approach to problem solving. Structurally, worked examples present learners with both the problem state and the goal state as conventional problems do. However, contrary to conventional problems, worked examples also provide the solution steps necessary to attain the goal state (van Gog et al., 2006). This eliminates learners’ unnecessary problem search activity by focusing their attention on tasks or activities relevant to solving the problem. By focusing the learners’ attention on the
structure of the problem and the steps necessary to solve it, worked examples actively promote schema construction (van Gog et al., 2004; Sweller, 1988; Sweller, van Merrienboer, & Paas, 1998). Figure 1.1 illustrates how worked examples, compared to conventional problem solving, manage cognitive load by optimizing working memory capacity and focusing on schema development as opposed to solving the problem.

![Figure 1.1. Graphical display of worked examples versus conventional problem solving in promoting learning](image)

Researchers have described two different worked example strategies, product-oriented and process-oriented that can enhance learning and bring about transfer performance (Paas & van Merrienboer, 1994; van Gog, Paas, & van Merrienboer, 2004). A product-oriented strategy provides the learner with the solution steps to solve the problem but not the rationale behind taking each step. On the other hand, a process-oriented strategy provides an explanation of why specific steps have been chosen or why the steps are appropriate for this particular problem. Recently, van Gog et al. (2004) proposed that adding process information to a worked example would increase a learner’s understanding of the principled knowledge underlying a domain by providing both the purpose of the steps and the strategic knowledge used to select the steps in a procedure.
More importantly, van Gog and her colleagues proposed that by increasing learner understanding, the transfer of the learned skill to novel problems would be improved.

In an effort to test these assumptions, van Gog et al. (2006) examined the use of process-oriented worked examples with electrical engineering students on troubleshooting tasks. The findings supported the “worked example effect” that states the studying of worked examples leads to better transfer performance than solving conventional problems. However, adding process information to worked examples did not result in higher transfer performance over traditional product-oriented examples. One possible explanation offered was that a learner’s prior knowledge strongly influences the effectiveness of worked examples resulting in expertise-reversal effect (Kalyuga, Ayres, Chandler, & Sweller, 2003; van Gog, Paas, & van Merrienboer, 2008). The findings suggest that adding process information to a worked example may be beneficial to a novice learner by imposing germane load. However, the same level of process information would be experienced as redundant information for a learner with high levels of prior knowledge imposing extraneous load that may impairment of learning. Consequently, the presentation of additional information, how this should be done, and the impact it has on learners are important issues in the instructional design field (Sweller, 2006). The present study will seek to understand the influence of additional process information has on learning and transfer of economic problem solving skills and learner attitude by comparing process-oriented and product-oriented worked example strategies and their interaction with the level of learner prior knowledge.

**Context of the Problem**

This study will examine a specific area of microeconomics, the impact of taxes, that requires the use of both declarative and procedural knowledge in the application of microeconomic principles to solve market analysis problems. The extension of worked example research into the domain of microeconomics and the examination of a worked example’s effect on learner motivation are unique to this line of research. As such, the findings of this study will contribute to the ongoing body of worked example literature about the effect of differences in worked example strategy on initial learning and transfer of problem solving skills.
Economists have stated that the primary goal of undergraduate economic principles courses is to enable students to think like economists (Becker, 2000). Perhaps a more realistic goal is that students should be able to acquire a greater understanding of the economic concepts and principles that govern market activity. Despite the primary goal of economic education, disagreements among instructors of economic principles over the most effective instructional approaches have recently dominated discussions in economic education literature (Becker, 2000; Jensen & Owen, 2003). For example, economic education researchers have begun to examine the benefit of various instructional approaches such as experimental games (Gremmen & Potters, 1997), case methods (Marks & Rukstad, 1996), and collaborative learning (Johnston, James, Lye, & McDonald, 2000) on improving economic problem solving skills. While disagreement will likely continue regarding the most effective instructional approach (Becker, 2000), the encouraging trend is that administrators and faculty are placing a greater emphasis on how economics is taught.

The English economist, Alfred Marshall, described the field of economics as, “a study of mankind in the ordinary business of life” (Britannica Online, 2008). As a social science, economics is a study of objective activities, such as how monetary and fiscal policies shape a country’s economic viability. However, economics is also a study of societal behavior and how changes in economic policy or activity affect interactions among consumers, markets, and nations. In other words, economics is not just the study of market forces but also an examination of societies through the prism of economic behavior. Consequently, economics is a complex discipline comprised of conceptual and technical content.

For learners to handle the complex nature of economics, instructional strategies must be oriented toward guiding the learner to understand and apply the various facts, rules, and principles on complex real world economic and social problems. For example, microeconomic students learning about the impact of taxation on market exchange learn how to adjust their understanding of the principle of supply and demand to incorporate the tax incidence or who bears the burden of a tax, the consumer or the producer/seller of the good or service. In order to solve a problem involving the impact of a tax, a learner must coordinate multiple informational elements such as the price and quantity
equilibrium, the elasticity of the good or service in question, and how the introduction of a tax changes the relationship between the consumer and the producer/seller. To solve a complex problem of this nature, learners may require the assistance of external instructional support in order to process the large amount of interacting information elements. Otherwise, the complexity of the problem can easily overwhelm a learner’s working memory capacity, especially in novices.

The lecture-practice problem-exam strategy represents a conventional approach to teaching problem solving skills commonly used in many higher education domains, including economics. Conventional problem solving approaches to instruction provide learners with minimal support in organizing the informational elements in a manner that facilitates learning and transfer. For example, in most introductory courses of microeconomics, the prevailing instructional strategy is the lecture/exam supplemented by large amounts of classroom or homework practice problems. Recently, Becker and Watts (2001) conducted a survey of introductory economics instructors at 50 academic institutions in the United States. The study found that a majority of the instructors spent 83% of class time in conventional instructional activities (i.e., lecture-practice problem-exam strategy).

From the perspective of the instructor, a conventional approach may be utilized on the basis of its perceived instructional efficiency. In other words, instructors are often constrained by limited instructional time and a large number of students to teach in auditorium style classrooms. For example, the proposed study was conducted in an auditorium style classroom with more than 400 students. The instructor was scheduled for three 50-minute class sessions per week over a thirteen-week semester to cover the requisite content. Considering the imposed environmental and time constraints, the instructor chose to use a lecture-based strategy supplemented by online homework assignments (i.e., conventional practice problems) as the primary instructional strategy to teach problem solving skills in microeconomics.

Problem solving by nature is a complex process that requires the processing of numerous information elements to reach a solution. Cognitive Load Theory suggests that the use of a weak problem-solving strategy such as conventional problem solving for complex topics requires the learner to exert a considerable amount of mental effort to
solve practice problems, especially for novices (Sweller, 1988; Paas & van Merrienboer, 1994; Paas, Renkl, & Sweller, 2004; van Gog, Paas, & van Merrienboer, 2004). In other words, requiring learners to work numerous practice problems imposes a significant amount cognitive load on working memory that can hinder the development of schemas and ultimately slow learning.

Research on the use of worked examples offers instructors an alternative approach to instruction that will promote learning through schema development. Contrary to conventional problem solving that presents learners with a problem to solve and the solution, worked examples provide learners with the problem and the solution but go further by providing the necessary steps to solve the problem. By studying a worked example, the learner is able to free up more of their cognitive capacity to constructing domain specific problem solving schema versus employing an inefficient problem-search strategy (i.e., means-end analysis) to solve the problem.

Numerous studies in the domains of mathematics, science, and engineering have demonstrated the effectiveness of worked examples over conventional problem solving at improving transfer performance and reducing a learner’s cognitive load (Paas & van Merrienboer, 1994; Clark, Nguyen, & Sweller, 2006). For example, Sweller and Cooper (1985) found that replacing algebra practice problems with worked examples resulted in students learning equal or more in significantly less time than students just using practice-problems. In a field trial using Chinese middle school students, Zhu and Simon (1987) demonstrated that the use of worked examples instruction in place of conventional problem solving reduced a three-year algebra/geometry curriculum to two years with equal to higher learning gains. Expanding on prior worked example research, Paas (1992) developed a subjective measure of mental effort that demonstrated that the use of worked example practice-pairs to learn statistical concepts resulted in higher scores on both near and far transfer tests than the use of conventional problem solving with less investment of mental effort.

Cognitive Load researchers have only recently to examine the effectiveness of worked example instruction to business and social science domains such as accounting (Halabi, Tuovinen, & Farley, 2005). This study will examine the effectiveness of worked example instructional strategies in a new domain – microeconomics. Solving complex
economic problems requires the application of both economic principles and rules to real world problems as opposed to a strictly rule-based activity common among more traditional lines of worked example research such as mathematics. Because of this complexity, numerous temporal and situational factors can influence the use of certain economic principles and rules. As a result, only well-defined and well-structured problems were presented to the learners during both the instructional and performance segments of the study.

**Significance of the Study**

This study extends and enhances the extant worked example literature by examining the effect of process-oriented and product-oriented worked example strategies on learning and transfer performance and learner attitude in the new domain area of microeconomics. As such, the study investigated whether worked example instructional strategies represent a potential alternative to conventional problem solving methods that have been part of the traditional approach to economics education (Becker & Watts, 2001) in many higher education settings. Previous Cognitive Load research has suggested that worked example research is of particular relevance for instructional programs aimed at promoting the learning and transfer of new skills in well-defined and well-structured domains (Atkinson, Derry, Renkl, & Wortham, 2000). Because economists use complex mathematical modeling based on well-established laws and principles to explain market behavior, microeconomics was seen as a domain potentially well-suited to benefit from the attributes of worked example instruction, especially in introductory courses.

The domain of microeconomics is a blend of laws that govern the behaviors of economies and complex algorithms used to predict economic trends. Consequently, the field by nature is complex requiring learners simultaneously process multiple interacting or converging elements that can easily overwhelm novices during problem solving activities. Hence, from an instructional design perspective, the capability of worked examples to reduce unproductive search activities becomes essential as the complexity or intrinsic load of economic problems increases. Moreover, research has shown that utilizing worked examples is an effective technique to optimize cognitive capacity during the performance of a problem-solving task (Atkinson et al., 2000; van Merrienboer, 1997; Paas & van Gog, 2006). For example, an instructional strategy consisting of
conventional problem solving, may require learners to employ weak problem-solving strategies (i.e., means-end analysis) that results in high levels of ineffective cognitive load and hampers learning. Conversely, a worked example strategy promotes learning by preventing random search activities thereby freeing cognitive capacity to attend to schema construction (Sweller, 2006; Sweller, 1998).

Early worked example research focused on reducing the extraneous or ineffective cognitive load imposed by poor instructional design as a way to manage complexity (Sweller, 1998) by utilizing worked examples (i.e., product-oriented worked examples) (van Gog et al., 2004). More recently, Cognitive Load research has shifted away from strategies aimed at reducing extraneous load toward the development of instructional strategies that promote higher levels of germane or effective cognitive load. Recently, van Gog et al., (2004; 2006; 2008) have argued that in order to improve learning and transfer a learner must understand why they are performing certain steps during the generation of a problem solution. Process-oriented worked examples represent a specific instructional strategy aimed at increasing germane load.

Process-oriented examples (also called modeling examples) are a form of worked example instruction that enhances learner understanding by presenting the underlying mental processes (i.e., the systematic approaches to problem solving and heuristics used to reason through problems) an expert goes through to solve a problem (van Merrienboer, 1997). Thus, van Gog et al. (2004; 2006) argued that process-oriented worked examples increase germane load by facilitating a learner’s understanding of the solution procedure. Moreover, van Gog and her colleagues have proposed that because of the depth of understanding gained from process-information, learners would also demonstrate increased transfer performance. Both of these propositions were examined in this study.

As the domain of interest in this study, introductory microeconomics requires participants to demonstrate their understanding of the principles of supply and demand, and elasticity, as well as the ability to determine who bears the monetary burden imposed on market participants. Hence, the present study compares the instructional effectiveness of two types of worked example instructional strategies (i.e., process-oriented and product-oriented). In addition, the study also examined the interaction of learner prior knowledge (i.e., low versus high) and worked example instructional strategies on learning
outcomes. Lastly, this study will also investigate how various worked example instructional strategies affected learner attitude toward the instruction. Ultimately, the goal of the study is to contribute to the identification of an optimally effective worked example strategy that, along with other effective strategies, could strengthen an instructional design approach to improve the development of economic skills and enhance learner attitude.

**Purpose of the Study**

The purpose of this study was to examine the effect of two types of worked example instructional strategies (i.e., process-oriented and product-oriented) on learning and transfer of problem solving skills in the complex domain of microeconomics. Additionally, the mediating effect of participant prior knowledge levels on learning outcomes defined in this study were also examined. Extending the research of van Gog et al. (2004; 2006; 2008), this study will apply the current understanding of the “worked example effect” (Sweller & Cooper, 1985; Sweller, 1988) to a new domain in Cognitive Load research, microeconomics.

**Research Questions**

Cognitive Load researchers have suggested the need to “compare the effects of process-oriented [and product-oriented] worked examples for novice and more advanced learners” (Van Gog et al., 2006, p. 162). Consequently, this research will expand previous worked example research by examining the effect of process-oriented and product-oriented worked example strategies and prior knowledge on problem solving skill acquisition and transfer performance and learner attitude in the previously unexplored domain of microeconomics. In addition to comparing two types of worked example strategies in a new domain, this study will also investigate the effect of the two worked example strategies on learner attitude. To date, only the cognitive benefits of worked example instruction have been explored. The literature is devoid of research examining the influence of worked example instruction on learners’ attitude. This is a significant weakness in the literature and represents a distinctive feature of this study.
The general research questions guiding the study are:

1. What effect do different worked example strategies (i.e., process-oriented or product-oriented worked examples) have on (a) initial learning achievement and (b) transfer performance?
2. How does the interaction of a particular worked example strategy (i.e., process-oriented or product-oriented worked examples) and prior knowledge level affect learning and transfer?
3. How does the interaction of a particular worked example strategy (i.e., process-oriented or product-oriented worked examples) and prior knowledge level affect mental effort?
4. How does the interaction of a particular worked example strategy (i.e., process-oriented or product-oriented worked examples) and prior knowledge level affect learner attitude, in particular attention and confidence?

**Hypotheses**

This research will examine the effect of two independent variables, worked example strategy and learner prior knowledge on four dependent variables (i.e., learning, transfer, mental effort, and learner attitude). The research hypotheses and supporting rationales are presented in the following section.

**Learning**

**Hypothesis 1.** Participants presented with a worked example strategy (i.e., process-oriented or product-oriented) will score higher on an achievement test than participants presented with a conventional problem-solving strategy.

**Rationale.** Solving complex problems requires the learner to apply an appropriate cognitive strategy. Accordingly, worked examples provide the learner with the relevant domain specific knowledge and organize the information in a manner (Chi, Glaser, & Rees, 1982) that increases the probability of schema development and learner success in solving the problem. Numerous empirical studies have demonstrated that worked example instruction, especially on complex content (Halabi, Tuovinen, & Farley, 2005; Tuovinen & Sweller, 1999; Sweller & Cooper, 1985; Zhu & Simon, 1987) is a more effective strategy than conventional problem solving.
**Hypothesis 2.** Low prior knowledge participants presented a process-oriented worked example will score higher on an achievement test than low prior knowledge participants presented either a product-oriented worked example or a conventional problem solving strategy. In contrast, high prior knowledge participants presented with process-oriented worked examples will demonstrate no difference in achievement test scores than high prior knowledge participants presented with product-oriented worked examples or a conventional instructional strategy.

**Rationale.** A learner’s level of prior knowledge is a critical factor in determining a number of learning outcome factors, including performance. Individuals with low levels of prior knowledge lack internal cognitive mechanisms (i.e., case-based experience and schemas) to solve complex problems efficiently (van Gog et al., 2006). As a result, instruction provides the necessary external support mechanism to assist learners in developing the appropriate domain-specific schemas. Recently, researchers have argued that process-oriented worked examples provide learners with principled knowledge (“why”) and strategic information (“how”) similar to what experts use in solving problems (van Gog et al., 2004; Ohlsson & Rees, 1991). In a study of electrical troubleshooting, van Gog et al. (in press) showed that secondary physics students studying process-oriented worked examples had higher performance test scores on initial tasks than product-oriented worked examples (van Gog et al., in press). According to Cognitive Load Theory (Sweller, 1988), combining the “why” and “how” information in a worked example enhances learner understanding of both the domain specific knowledge and the rationale used to determine the proper operators required to solve a problem (van Gog et al., 2004; 2006).

Despite the benefit of process-oriented worked examples on learning for low prior knowledge students, the aforementioned studies of process-oriented worked examples have also found the presence of expert-reversal effect with high prior knowledge students (van Gog et al., in press; 2006). This effect would suggest that the addition of process information to worked examples may produce redundant information that increases extraneous instructional load that would interfere with a more knowledgeable learner’s previously developed schemas (Renkl & Atkinson, 2003). Consequently, the additional information provided by a process-oriented worked example would hamper learning for
more knowledgeable learners because some of the working memory capacity that could be allocated to problem solving is being utilized to reconcile redundant information. Hence, low prior knowledge participants were expected to benefit more from process-oriented worked examples whereas high prior knowledge participants would show no significant improvements in learning from process-oriented examples based on their scores on an achievement test when compared to scores of high prior knowledge participants in product-oriented and conventional instructional strategy groups.

**Transfer Performance**

**Hypothesis 3.** Low prior knowledge participants presented a process-oriented worked example will score higher on the transfer test than low prior knowledge participants presented with either a product-oriented worked example or a conventional problem-solving strategy. In contrast, high prior knowledge participants presented with the process-oriented worked example demonstrate no difference on transfer test scores than high prior knowledge participants presented with either product-oriented worked examples or the conventional problem-solving strategy.

**Rationale.** Transfer is defined as a learner’s ability to apply what was taught to a new situation (Mayer & Wittrock, 1996). Previous research has demonstrated that the use of worked examples is an effective instructional strategy that results in better transfer performance (Sweller & Cooper, 1985; Zhu & Simon, 1987) through the development of the appropriate domain-specific schema. Moreover, van Gog et al. (2004) argued that a process-oriented worked example strategy improves transfer by enhancing the learner’s understanding. Enhanced understanding is the result of presenting additional process information (i.e., “how” and “why”) to the learner (van Gog et al., 2006) during the initial phase of the learning process. Hence, it has been argued that low prior knowledge learners benefit from the addition of process-oriented worked examples more than high prior knowledge learners.

Conversely, high prior knowledge learners may experience the additional process information as redundant, imposing extraneous or unproductive load that may impede continued schema development (Kalyuga, Ayres, Chandler, & Sweller, 2003). Therefore, providing high prior knowledge learners with only the basic strategic (“how”) information found in a product-oriented worked example decreases the amount of
redundant or extraneous information presented during the instructional process. In a series of experiments examining learners’ ability to learn complex material, Pollock, Chandler, and Sweller (2002) demonstrated that learners’ with higher levels of prior knowledge required less explanation about the interaction of elements of complex materials during instruction than did novice learners. The findings appear to support the principle of redundancy.

**Mental Effort**

**Hypothesis 4.** Participants presented a worked example strategy (i.e., process or product-oriented) will report lower mental effort ratings on the 9-point mental effort rating scale developed by Paas (1992) than participants presented a conventional problem-solving strategy.

**Hypothesis 5.** Participants presented a process-oriented worked example strategy will report higher mental effort ratings on the 9-point mental effort rating scale developed by Paas (1992) than participants presented a product-oriented worked example strategy.

**Rationale.** Early Cognitive Load research demonstrated that by using well developed product-oriented worked examples instead of conventional problem solving strategies learners could improve test and transfer performance with lower investments in time and mental effort by reducing extraneous cognitive load on learners (Paas & van Merrienboer, 1994; Paas, 1992). In accordance with Cognitive Load research findings, several studies have shown the effectiveness of worked examples to teach operational rules in fields such as accounting (Bonner & Walker, 1994) and economics (Marks & Rukstad, 1996) by increasing learning while simultaneously reducing the amount of mental effort exerted during the learning process. More recently, research has begun to focus on ways to modifying traditional product-oriented worked examples by adding process information in order to improve learning performance and increase germane load. This is done by providing the learner with the knowledge to understand the rationale underlying the selection and utilization of a particular operator to solve a problem (Van Gog et al., 2006) based on how an expert would approach the problem. Process-oriented worked examples reduce extraneous load the same as product-oriented examples but simultaneously increases the germane or relevant cognitive load. Despite increasing
germane load, the addition of text to a worked example is likely to result in an overall increase in mental effort in learners.

However, as previously discussed, a learner’s level of prior knowledge is a critical factor in determining the efficacy of a particular instructional strategy. For example, when a learner has already acquired the necessary problem-solving schema to perform the task, providing a worked example with equal or greater amounts of information can be counterproductive. Process information added to a worked example strategy may be appropriate to support a novice during the initial stages of learning. Despite this benefit to a novice, a learner with higher levels of prior knowledge and therefore, a more developed schema may experience the addition of process information as redundant, thereby increasing extraneous load and interfere with the learning process (Kalyuga et al., 2001; van Gog et al., 2004; Sweller; 2006). Consequently, an instructional strategy can increase the cognitive load experienced by learners in different ways based on differences in their prior knowledge characteristic.

As such, this study proposes that process-oriented examples will present additional germane information that will result in an increase in cognitive load for learners with low prior knowledge. Similarly, the process-oriented examples will result in an increase in cognitive load in learners with high prior knowledge. However, because of advanced learners have previously developed domain-specific schemas, the additional information will be both extraneous and redundant potentially impeding the learning process.

**Learner Attitude**

**Hypothesis 6.** Participants receiving a worked example strategy (i.e., process or product-oriented) will report more positive attitude scores toward the instruction relative to attention and confidence than participants presented with a conventional problem solving strategy.

**Rationale.** Worked example research has primarily concentrated on the cognitive aspects of the learning process. However, questions about the motivational effect worked example strategies have on learner attitude have been noticeably absent from the cognitive load literature (Stark, Mandl, Gruber, & Renkl, 2002). Paas and van Merrienboer (1994) argued that instructional strategies designed to improve learning
based on cognitive load principles have little effect if the learner lacks the motivation or attitude to invest mental effort during the learning process. Cognitive load researchers have acknowledged the lack of research in motivation is due in part because most studies have been short in duration and conducted in control laboratory settings (Paas, Tuovinen, van Merrienboer, & Darabi, 2005). Under these conditions, learners may be more inclined to invest mental effort due to non-motivational factors (e.g., researcher presence) that are not common in a natural classroom situation. Despite the acknowledgement that more research is needed to understand the effects of learner attitude on mental effort investment and performance, there continues to be a deficiency in cognitive load literature directly examining questions relating to motivation (Paas & van Merrienboer, 1994).

Motivation has been considered one of the more challenging and important elements in teaching and in the design of instruction (Keller, 2006). In terms of a learner’s attitude, several important elements are considered contributors to a learner’s overall attitude toward a specific learning situation. Specifically, learner attention and confidence will be analyzed in this study. Attention deals with stimulating and sustaining attention (i.e., focus or engagement) to the concepts, rules, skills, or facts necessary to learn a new domain topic (Keller, 2006). Confidence draws on the concepts of locus of control (Rotter, 1966) and self-efficacy (Bandura, 1982). These two concepts emphasize the importance of a person’s belief that they have control over their cognitive behavior and that they can successfully learn a new skill.

In this study, it is expected that a worked example strategy will engage and sustain a learner’s attention during the learning task by organizing the instructional material in a manner that optimizes cognitive resources and aids in the development of the appropriate problem-solving schema. Furthermore, this study is expected to demonstrate that a learner’s confidence will be increased when given an instructional strategy, in particular worked examples, that provides direct instructional support (Choi and Hannafin, 1997) during the problem solving process.

**Summary**

More than two decades of Cognitive Load research has demonstrated the effectiveness of worked examples over conventional problem solving in improving
learning and transfer performance and reducing a learner’s extraneous cognitive load in well-structured domains such as algebra, geometry, and physics (Paas & van Merrienboer, 1994; Clark, Nguyen, & Sweller, 2006). Recently, interest has shifted toward examining instructional techniques, such as process-oriented worked examples, that increase germane load while simultaneously reducing extraneous load. This study will extend the research of van Gog and colleagues (2004; 2006; 2008) on the comparative effectiveness of process-oriented and product-oriented worked examples on learning and transfer in the new domain of microeconomics. Furthermore, the inherent complexity or intrinsic load of a task has been shown to be influenced by prior knowledge (Kalyuga et al., 2003; Pollock et al., 2002). As a result, the effectiveness of process-oriented or product-oriented worked example strategy to affect the learning outcomes examined in this study is expected to be mediated by the learners’ levels of prior knowledge. The present study will compare the effects of a process-oriented and product-oriented worked example strategy mediated by learner prior knowledge on learning, transfer performance, mental effort, and learner attitude. An additional distinctive feature of this study is the examination of the secondary effect of worked example strategies on learner attitude. The results of this study are intended to extend the knowledge of worked example design in order to better inform designers and instructors of how to use worked example strategies to create an effective instructional environment.
Definition of Key Terms

Worked Examples

Worked examples are a step-by-step model of how to perform a particular skill or task (Clark, Nguyen, & Sweller, 2006, p. 190). Typically, worked examples used in instruction consist of three elements: (1) a problem statement, (2) steps to solve the problem, and (3) the final solution to the problem (Renkl & Atkinson, 2003; Kalyuga, Chandler, Tuovinen, & Sweller, 2001; Renkl, 1997).

Product-Oriented Worked Example

Product-oriented worked examples show the learner how to solve a problem (the product) by providing the learner with the problem statement, the solution steps to solve the problem, and the final solution (van Gog et al., 2006).

Process-Oriented Worked Example

Process-oriented worked examples show the learner how to solve the problem but also explain why certain steps are chosen (i.e., strategic knowledge) and/or why the steps are appropriate (i.e., principled knowledge) in an effort to improve a learner’s understanding of the solution procedure (van Gog et al., 2006).

Conventional Problem Solving

Conventional problem solving provides the learner with practice problems to solve without any support or guidance (Paas, 1992) during the practice activity. In this study, conventional problems were given to learners after a common lecture provided to all participants.

Learning

Participants’ learning will be measured from their total scores on eleven achievement test questions developed jointly by the researcher and instructor.
Transfer

Applying what was learned during the instruction to a novel situation (Mayer & Wittrock, 1996). Transfer will be measured from transfer test scores developed jointly by the researcher and instructor.

Prior Knowledge

Existing domain-specific knowledge of the learner (Hannafin & Hooper, 1993).

Low Prior Knowledge

Low prior knowledge learners are those who have a limited level of knowledge or experience in a specific domain. In this study, low prior knowledge participants were categorized based on a pre-test score equal to or below 11 out of a possible score of 15.

High Prior Knowledge

High prior knowledge learners are those who have substantial previously acquired knowledge in a specific domain. In this study, high prior knowledge participants were categorized based on a pre-test score equal to or higher than 13 out of a possible score of 15.

Mental Effort

Investment of mental effort is a reflection of the actual cognitive load allocated to task performance. In this study, participant mental effort ratings were taken after the administration of the instructional condition using a 9-point scale self-reporting rating scale developed by Paas (1992).

Learner Attitude

Learner attitude is defined as the attitude of the participants toward the instructional material. In this study, attitude will be measured in terms of attention and confidence scores on Keller’s Instructional Materials Motivation Survey (IMMS). The survey will contain 21 items, twelve of the questions related to attention and nine of the questions related to confidence.
CHAPTER 2

REVIEW OF THE LITERATURE

Cognitive Load Theory

Cognitive load theory (Sweller, 1988) argues that learning a complex cognitive skill, such as problem solving, is often constrained by a learner’s limited processing capacity. Therefore, developing instruction that optimizes the allocation of cognitive resources is essential for learning to occur through the development of domain-specific schema. Cognitive load theory is based on the underlying assumptions that learners can only process a few pieces of information at one time (Miller, 1956; Moreno, 2006) and that long-term memory has an extensive cognitive capacity comprised of vast, hierarchically organized knowledge structures (Kalyuga, Ayres, Chandler, & Sweller, 2003). Hence, working memory is viewed as a transitory cognitive structure where the conscious processing of information occurs.

Information enters working memory through either the sensory memory or is retrieved from long-term memory (Sweller, 2004). Once in working memory, the information is structured and organized in a manner that allows the learner to store the information in long-term memory making the information available for retrieval from its long-term memory in the future. Thus, understanding the structural capacity limitations of working memory and the vast knowledge stores of long-term memory are essential to developing effective instruction. Instructional strategies that require learners to engage in learning activities that place excessive demands on working memory and are not effective in organizing information in manner that enhances schema development are likely to produce ineffectual results (Kirschner, Sweller, & Clark, 2006).

Cognitive demands placed on learners can be evaluated as excessive based on the level of element interactivity associated with a particular skill or task to be learned. Cognitive load researchers have proposed that the cognitive load associated with learning is related to the degree to which elements interact with each other (Sweller & Chandler, 1994). For example, consider a student learning the definition of a vocabulary word. If the focus is entirely on the vocabulary word and not the context the word is used then the
word can be learned without reference to other words. This represents low element interactivity and consequently low cognitive load.

On the contrary, learning complex tasks, such as economic problem solving, represents high element interactivity and therefore results in higher levels of cognitive load (Halford, Maybery, & Bain, 1986; Maybery, Bain, & Halford, 1986). For example, learners studying microeconomics must learn how to calculate tradeoff ratios by first determining various cost and gain measures based on analyzing an economy’s production possibilities for a particular pair of goods or services. In this example, Sweller and Chandler (1994) argue that in order to generate a problem solution, each step of the analysis is an element that must interact with other elements in order to arrive at a solution to the problem. Consequently, the analysis steps cannot be learned in isolation and must be learned simultaneously. Due to the high degree of element interactivity required in problem solving, the level of cognitive load will also be high resulting in some learners having difficulty in learning the material (Sweller & Chandler, 1994).

Cognitive load theory (Sweller, 1988) distinguishes cognitive load according to three distinct categories: (1) intrinsic, (2) extraneous, and (3) germane (Sweller, van Merrienboer, Paas, 1998). *Intrinsic* load is the cognitive load due to the complex nature or the inherent difficulty of instructional material. Complex tasks such as problem solving contain a high number of interacting elements that impose a high demand on working memory to process the information. One non-instructional variable that influences intrinsic load is a learner’s prior knowledge. Despite the high number of interacting elements in complex tasks, learners with higher levels of prior knowledge can combine complex informational elements with existing schemata and treat the expanded schemata as one element in working memory (van Gog, Paas, & van Merrienboer, 2007). Therefore, the greater a learner’s prior knowledge the less intrinsic load the learner experiences during a complex task.

*Extraneous* load or instructionally ineffective load (van Gog, Paas, & van Merrienboer, 2004) is caused by poorly designed instruction that fail to recognize the limits of working memory and the need to facilitate schema development and automation (Sweller, 2005). A conventional learning approach to problem solving is through means-ends analysis, often employed by novice learners (Sweller, van Merrienboer, Paas, 1998).
According to Sweller et al., (1998), means-ends analysis is a “slow and sub-optimal” approach to learning. Specifically, means-ends analysis places a high demand on working memory resources in order to solve the problem while simultaneously reducing the cognitive resources available for learning (i.e., schema development and automation). Worked examples have been shown to reduce extraneous load by focusing cognitive resources on studying the solutions and constructing and automating problem solving schema (van Gog, Paas, & van Merrienboer, 2007).

Lastly, *germane* load or effective instructional load (Paas & van Merrienboer, 1994) is concerned with capturing the relevant elements of the learning process through effective instructional design. Providing a learner an example of how to solve a complex problem may increase cognitive load but the increase in germane load facilitates schema development (van Gog, Paas, & van Merrienboer, 2004, 2006; Sweller, 2005) by focusing the learner’s attention on the salient steps or operators necessary for solving the particular problem. By engaging in this type of focused learning activity, learners are better able to develop the appropriate problem-solving schemas necessary for transfer and retention of information.

**Cognitive Load Theory and Conventional Problem-Solving Strategies**

In introductory economic principle courses, a conventional problem-solving approach is generally manifest in the form of a traditional lecture-based instructional strategy. In this approach, the standard instructional practice is to introduce the problem to the learner through a lecture and the presentation of a few examples, followed by extensive independent problem solving practice (Owen & Sweller, 1985; Sweller, 1988), either during class or as homework. Despite recent studies demonstrating the effectiveness of alternative approaches to economic instruction (Jensen & Owen, 2003; Marks and Rukstad, 1996), Becker and Watts (2001) found that the majority of introductory economics instructors spend 83 percent of the class time lecturing. Considering the complexity of economics, most instructors using a traditional lecture-based instructional strategy still assume that learners will acquire the appropriate domain specific problem solving skills and then correctly apply them during problem solving transfer activities (i.e., test) with limited instructional guidance. Cognitive load
researchers view this approach as ineffective for learning (Darabi et al., 2006) due to the instructional strategy’s lack of attention focused on schema development.

Instructional strategies requiring learners to engage in conventional problem-solving strategy, such as means-end analysis, requires the novice learner to carry out a series of “content-free” (Bhaskar & Simon, 1977) if-then action sequences (Anderson, 1982) designed to identify, and then limit possible paths to a solution (Zook & Di Vesta, 1989; Chi, Glaser, & Rees, 1982). Despite the fact that a means-end analysis approach can facilitate the attainment of a problem goal, numerous studies have demonstrated that a means-end analysis search has a detrimental effect on learning during problem solving activities (Cooper & Sweller, 1987; Owen & Sweller, 1985; Sweller & Cooper, 1985; Mawer & Sweller, 1982) because the approach does not focus on developing appropriate domain-specific schema. Furthermore, means-end analysis places a high extraneous load on a learner’s limited cognitive resources (van Gog, Paas, & van Merrienboer, 2006) thereby reducing the available resources necessary for learning. Sweller (2006) argues that learning occurs when long-term memory structures are transformed. Therefore, according to cognitive load theory, only through the development of schema or the modification of existing schema can learning actually occur.

Research in cognitive load theory suggests that a critical factor in developing problem solving skills is the “acquisition of domain-specific knowledge schemas” (Sweller & Cooper, 1985, p. 61). Domain specific schemas allow learners to recognize a particular problem as belonging to a category based on the salient structural features of the problem. In contrast to the schema-based approach, novices employing means-end search strategies tend to direct their attention toward reducing the discrepancies between the problem state and the goal state. The disadvantage of this approach to learning is the strategy attempts to reduce differences between problem and goal states without guiding the novice learner in recognizing the problem-state patterns and the associated steps to solve the problem (Sweller & Cooper, 1985; Sweller, 1988). Problem solving in this manner is inefficient often resulting in the random generation of solution possibilities (Sweller, 2006) that may overwhelm a learner’s working memory capacity. However, an instructional strategy, such as studying worked examples has been shown to reduce
extraneous cognitive load and increase learning by fostering the development of problem solving schema (van Gog, Paas, & van Merrienboer, 2006).

**Learning from Worked Examples**

Learning from worked examples is an alternative strategy to conventional problem solving that has shown to be effective in initial skill acquisition for novice learners (Renkl, 2002) in well-structured environments such as mathematics, computer programming, accounting, and physical science (Renkl & Atkinson, 2003). Because novice learners lack the appropriate problem-solving schema in long-term memory, learners often struggle to organize information in a manner that accurately represents the problem to be solved. A worked example instructional strategy is a more effective means of instruction for novice learners because it prevents the learner from having to rely on an unspecific problem-solving heuristic, such as means-end analysis, for the solution (Renkl, 2005). This is accomplished by directing the learner’s attention to essential relationships between the problem-solving steps (Kirschner et al., 2006). As a result, learners develop the appropriate problem schema required to solve a problem (van Gog, Paas, & van Merrienboer, 2006; Kirschner et al., 2006).

Worked examples are a step-by-step model of how to perform a particular skill or task (Clark, Nguyen, & Sweller, 2006, p. 190). Typically, worked examples used in instruction consist of three elements: (1) a problem statement, (2) steps to solve the problem, and (3) the final solution to the problem (Renkl & Atkinson, 2003; Kalyuga, Chandler, Tuovinen, & Sweller, 2001; Renkl, 1997). Thus, the presentation of the solution steps to the problem prior to their engagement of the problem-solving task differentiates a worked example strategy from a conventional problem solving strategy. Consequently, the purpose of using a worked example strategy is to prepare learners for “productive problem solving” by promoting a deep understanding of a domain skill during the initial stages of cognitive skill acquisition (Renkl, 2005).

The “worked example effect” can be described as the positive performance outcome of novices who study worked examples that make efficient use of limited cognitive resources. Moreover, by studying worked examples versus engaging in conventional problem solving to solve a problem, a novice learner is more able to filter out extraneous information, thereby optimizing the available cognitive resources to
induct problem-solving schemas (Moreno, 2006) in long-term memory. The “worked example effect” was originally demonstrated with novice learners studying algebra by Sweller and Cooper (1985) and Cooper and Sweller (1987). Since those early studies, the “worked example effect” has been replicated in numerous experimental domains (for overviews see Adkinson, Derry, Renkl, & Wortham, 2000; Sweller, van Merrienboer, & Paas, 1998).

According to Cognitive Load Theory (Sweller, 1988; Sweller, van Merrienboer, & Paas, 1998), a worked example strategy is based on the premise that worked examples optimize the learner’s processing capacity by reducing or eliminating random problem solving actions commonly associated with means-end analysis. Research in the field of expert-novice differences has shown that individuals with well-developed domain-specific problem solving schema (i.e., experts) have more efficient representations of their domain than novices do. Consequently, expert representations focus on the deep structure of a problem and ignore irrelevant surface details that tend to distract novices (Pretz, Naples, & Sternberg, 2003). Whereas the application of more conventional problem solving strategies require the learner to work backwards from a randomly generated goal followed by tests for effectiveness (Sweller & Sweller, 2006), a worked example requires the learner to study problem solutions prior to attempting to solve similar problems. Worked examples can organize and structure information in a manner that reduces extraneous load while simultaneously increasing germane load and facilitates the development of schema in long-term memory. Therefore, in order to develop effective instructional programs, it is critical to understand the interplay between working memory and long-term memory (Sweller et al., 1998).

Despite the benefits of utilizing worked examples or a combination of worked examples with practice problems versus conventional problem solving, there are some instances where the use of worked examples is detrimental to learning. Poorly designed worked examples can add extraneous load and thereby eliminate the benefit of using a worked example. Consequently, worked examples should be designed in a format that minimizes extraneous load by managing three potential design concerns: (1) split-attention effect, (2) modality effect, and (3) redundancy effect.
Split-attention effect (Chandler & Sweller, 1991) refers to the extraneous load imposed when a learner must integrate two or more sources of visual information that are physically or spatially separated (Clark et al., 2006, p.351). In domains such as economics, a learner is often required to simultaneously integrate textual information and a related diagram. Split-attention commonly occurs when a visual is explained by text that is distant from the visual such as a geometry problem with the step-by-step procedures required to solve it provided below the problem. In this scenario, in order to understand the solution to the problem the learner must read a particular step and search for the relevant section of the visual. The search process followed by the mental integration of the informational elements increases extraneous load on the learner and hampers learning. In order to integrate complex information, worked examples should be designed to focus the learner’s attention on the relevant content necessary to solve the problem. One way to do this is by integrating explanatory text close to the related visuals.

Several studies have demonstrated the split-attention effect in worked examples. Tarmizi and Sweller (1988) ran a series of experiments on high school geometry students comparing a worked example that integrated text within the visual with a conventional problem solving approach. The results supported their hypothesis that the worked example that integrated text within the visual was more instructionally effective at improving learner performance while reducing working memory load. In a similar study, Ward and Sweller (1990) replicated the findings of Tarmizi and Sweller (1988) with high school physics students providing further support that the use of an integrated worked example design was crucial to enhance learning and transfer. Research on split-attention effect suggests that worked example strategies that lead to split attention are quite common in instructional materials. To improve learning, designers should develop examples that limit split-attention effect and perform the integration for the learner by providing the text explanation of a visual in close proximity to the visual and using cues and identifiers such as arrows to focus the learner’s attention to the relevant part of the visual. In addition, where possible present all relevant text and visuals on the same page or screen (Clark et al., 2006).

The examination of split-attention effect, especially in multimedia environments, led to the discovery of the modality effect. The modality effect occurs when complex
visuals are more easily understood if the explanation is presented in an audio modality than if presented in text modality (Clark et al., 2006, p. 348). The influence of the modality effect and the split-attention effect on student performance was demonstrated in a study of trade school apprentices learning how to conduct electrical tests on appliances using one of three print-based instructional modules: (1) integrated text/visual, (2) separated text/visual with text presented underneath the visual, and (3) audio narration of the visual (Tindall-Ford, Chandler, and Sweller, 1997). The researchers found that learners studying the integrated text/visual module or the audio narration module scored twice as high on a performance test as learners in the separated text/visual module. In a similar study of multimedia learning, Moreno and Mayer (1990) compared the efficacy of integrated, separated, and audio worked example strategies in an animated multimedia lesson on the formation of lightning. The findings suggested that learners viewing the narrated version had more significant learning gains than learners studying either the integrated or the separated strategies.

Like the modality effect, the redundancy effect was discovered while researching the effect of split-attention on learning. The redundancy effect (Chandler & Sweller, 1991) occurs when the instruction provides more expressions of content than is necessary for a learner to gain understanding. For example, if a visual is self-explanatory because it provides all the information necessary for a learner to understand the content adding additional text may actually overload working memory capacity and hamper learning. The issue of redundancy becomes more critical when dealing with complex content that places high demands on a learner’s working memory (Clark et al., 2006). In a study of the effectiveness of worked examples that integrated text and visuals with physics students, Ward and Sweller (1990) found that while integration has a positive effect on learning and transfer, providing more explanatory information than was necessary was redundant and therefore counterproductive to learning. In other words, including redundant information placed greater demands on working memory capacity that can depress learning. Hence, removing redundant information is a necessary design consideration for the development of effective instruction.

Chandler and Sweller (1991) further examined the effect of redundant information and split-attention on instructional time and student learning. Students studying a biology
lesson on blood flow through the heart were presented with three versions of the instruction: (1) diagram only, (2) diagram plus embedded text, and (3) diagram plus separate text. Results showed that test scores were lower for students in the diagram plus separate text lesson than those in either the diagram plus embedded text or the diagram only lessons. Moreover, instructional time was longer for students in the diagram plus separate text lesson than the other two instructional lessons. Of particular interest is that students in the diagram only lesson significantly out performed students in the diagram plus embedded text lesson after less instructional time. The findings of this study suggest that by adding additional text instructional time was increased and student learning was reduced.

In addition, a series of experiments conducted by Sweller and Chandler (1994) and Chandler and Sweller (1996) extended our understanding of the redundancy effect by comparing different approaches to the instruction (i.e., conventional-manual, modified-manual only, and modified-manual plus a computer) of a computer program and the interaction of various approaches and content complexity. The researchers found that for content low in complexity there were no significant performance differences in the instructional approaches. However, as the complexity of the content increased, learners exposed to the modified-manual only approach showed higher performance scores, lower cognitive load, and spent less time evaluating the instruction than the other two instructional approaches.

In summary, over two decades of research has demonstrated that worked examples can effectively increase the likelihood of deeper cognitive processing (i.e., schema development) while simultaneously limiting the cognitive load imposed on a learners’ working memory. Consequently, it can be argued that an effectively designed worked example increases cognitive capacity by effectively managing working memory load in order to promote schema development and automation (Darabi, Nelson, & Palanki, 2007; Sweller, van Merrienboer, & Paas, 1998, Zhu & Simon, 1987). For example, contrary to novices, experts use previously acquired schemas to classify the problem, and apply the most effective solution to the problem (Sweller & Cooper, 1985). The contrast between novice and expert problem solving approaches demonstrates that a properly designed worked example should focus on assisting learners to develop domain-
specific schemas during the learning process, especially during the initial stages of skill acquisition.

**Worked Example Strategies: Product-Oriented and Process-Oriented**

Recently, two types of worked example strategies have been discussed in the literature: “product-oriented” and “process-oriented” (van Merrienboer, Kirschner, & Kester, 2003; Van Gog, Paas, & van Merrienboer, 2004, 2006). Product-oriented worked examples, also referred to as conventional worked examples, provide the learner with a problem solution step-by-step from the given state to goal state. This type of worked example presents the learner with the “product” an expert has produced at each stage of the problem-solving process (van Gog et al., 2004). A limitation of this form of worked example is that it fails to provide learners with the principled knowledge (domain specific knowledge) necessary for learners to appropriately represent the problem and make the correct selection and application of steps and operators to solve the problem. In other words, product-oriented worked examples do not explain “why” certain steps are taken during the problem solving process (van Gog et al., 2006). Since knowledge of a domain consists of principled knowledge and its teleology, students need to understand the principles underlying the solution, and why these steps are taken in a particular order (van Gog et al., 2004; Ohlsson & Rees, 1991).

Variations of worked examples have been tested as a means to compensate for the lack of principled and strategic knowledge incorporated in more traditional product-oriented examples. Specifically, worked examples with self-explanation prompts and instructional explanations that provide the rationale for solution steps are two worked example strategies that have been advocated as ways to provide principled information and enhance transfer performance (van Gog et al., 2006; Renkl, 2002). Despite the fact that learners who self-explain tend to demonstrate a greater level of understanding than learners who do not, research findings suggest that early in the learning process many learners are unable to generate the appropriate self-explanations independently (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Renkl, 1997).

Similarly, worked examples with instructional explanations have been examined as an alternative to worked examples with self-explanation prompts. According to van Gog et al. (in press; 2006), in this type of worked example, the information provided was
designed to assist the learner in developing the underlying principle behind each solution step but lack strategic information (heuristics and systematic approaches to solving problems). A worked example with instructional explanations is a more guided approach to example instruction than requiring learners to “self-generate” information. However, several studies have failed to find consistent positive effects from instructional explanations on learning and transfer performance (Gerjets, Scheiter, & Catrambone, 2006; Grobe & Renkl, 2006; Renkl, 2002).

Recently, van Gog et al. (2004; 2006) proposed that developing worked examples comprised of solution steps, and both strategic and principled (i.e., declarative) information would enhance learners’ understanding and transfer performance. This type of worked example has been described as a “process-oriented” worked example because it expands beyond the presentation of solution steps providing both the how (strategic) and why (principled) behind the problem steps. Several studies have examined the effect of worked examples designed with principled information to enhance learner understanding. Gerjets, Schieter, and Catrambone (2003) investigated the effect of worked examples and learner prior knowledge on transfer performance. The study found that transfer performance was improved with less study time when learners were provided with a worked example that combined the procedural steps necessary to solve the problem and the explanation underlying each step. A study by Singley and Anderson (1989) examined the role of declarative (i.e., principled) knowledge in the domain of calculus and logic and found that the use of declarative knowledge provides the basis for transfer performance. In addition, while the findings supported the use of principled knowledge the researchers noted that the benefit of using principled knowledge may be diminished as a learner’s knowledge level increases.

Despite the stated benefits of using process-oriented worked examples, the results of a recent study on troubleshooting revealed that the use of process-oriented worked examples had a limited positive effect on student learning (van Gog et al., 2006). Several factors are likely to have influenced the effectiveness of process-oriented worked examples, such as example design, timing of information presentation, learner attention to the information, and information integration. One of the most critical factors in determining the effectiveness of any instructional material is a learner’s prior knowledge.
The next section will provide an overview of the influence of prior knowledge on learner performance.

**Worked Example Efficacy and Learner Prior Knowledge**

The advantage of worked examples during the initial acquisition stage of learning for novice learners has been well documented in the Cognitive Load literature. Therefore, instructional designers should consider a learner’s level of prior knowledge when developing any instruction, particularly if the material has a high degree of complexity. Several empirical studies have provided strong evidence that novices learn differently than more advanced learners (Lim, 2006). Moreover, research has demonstrated that advanced learners organize their knowledge more effectively and access information more efficiently from long-term memory than novices (Chi, Glaser, & Farr, 1988). In other words, advanced learners have more developed schemas that allow them to access greater amounts of information while using less working memory capacity than novices. As a result, advanced learners require less external support to solve a problem or task. Kalyuga, Ayres, Chandler, & Sweller, (2003) described this phenomenon as the “expert-reversal effect”. The principle underlying the expert-reversal effect stipulates that learners with higher levels of prior knowledge may not benefit from the same level of instructional support required by novice learners.

Research on expertise-reversal effect has shown that a learner’s prior knowledge determines the effectiveness of the type of worked examples (Van Gog et al., 2006). For example, in a study of mechanical trade apprentices, Kalyuga, Chandler, Tuovinen, and Sweller (2001) found that apprentices’ learning about relay circuits benefited from worked examples in the initial stages of acquisition but the benefit diminished over time as the apprentices gained experience in the domain. In other words, an instructional approach that aided novice learners (i.e., low prior knowledge) in acquiring a skill yielded the opposite effect for learners with an already developed schema (i.e., high prior knowledge). Cognitive Load Theory (Sweller, 1988) explains this reversal by the redundancy effect (Renkl & Atkinson, 2003).

The redundancy effect occurs when non-essential information is presented to a learner that increases extraneous load that interferes with learning (Sweller, 2005). For example, in a study comparing the effectiveness of worked examples to problem-solving...
instructional strategies in accounting. Halabi, Tuovinen, and Farley (2005) found that low prior knowledge participants using worked examples scored significantly higher than low prior knowledge participants completing the problem-solving strategy on test performance and learning efficiency measures. In contrast, high prior knowledge participants showed little difference on test performance and learning efficiency between the two instructional strategies. (i.e., worked examples and problem-solving). It can be concluded that the efficacy of worked examples is largely effected by the learner’s prior knowledge. Hence, as expertise or proficiency increases during the learning process, providing the same level of instructional guidance can be counter-productive to learning gains. Consequently, extraneous load can be reduced by scaffolding the instructional support throughout the knowledge acquisition process from more guidance at the initial learning stage (i.e., process-oriented worked examples) to faded guidance (i.e., product-oriented worked examples) at later stages. Simultaneously, by reducing the instructional support in response to the knowledge proficiency of the learner germane load is increased resulting in a higher level of learning efficiency (van Gog et al, in press; Renkl & Atkinson, 2003).

More recently, van Merrienboer et al. (2003) argued that the sequencing of instructional information plays an important role in schema development and activation in novice learners. Consequently, van Gog et al., (in press; 2006) examined how variations in the sequencing of worked example conditions can affect learning efficiency. The study found that process-oriented worked examples initially foster learning, but subsequently hinder learning as expertise is gained by the learner during the learning process further supporting the expert-reversal effect. As a result, worked example research needs to further examine the effect of worked example strategies, particularly a process-oriented worked example strategy, and learner prior knowledge characteristics on learning, transfer, mental effort, and attitude toward the instructional material.

**Learner Attitude**

A learner’s acquisition of problem solving skills is of limited value if the individual is unmotivated to apply them. Consequently, solving complex problems requires more than domain knowledge (Zimmerman & Campillo, 2003). Problems of a complex nature place a heavy demand on a learner’s working memory capacity (Sweller,
1988) as well as on their motivational attitude toward the instruction (Paas, Tuovinen, van Merrienboer, & Darabi, 2005). In such instances, anxiety and fear of failure (Keller, 2006) can overwhelm a learner’s ability to effectively process the necessary solution steps. In fact, researchers have argued that a positive motivational attitude generates positive learning outcomes by giving the learner confidence to deal with the cognitive challenges associated with complex problems (van Merrienboer, Kirschner, & Kester, 2003). Hence, instruction should be developed in a manner that encourages both the development of the appropriate domain-specific schema and positively affecting the attitude of the learner.

According to Keller (2006), in order to develop effective instruction a designer should consider the attitude of the learner and its effect on their performance. However, in a natural classroom environment that imposes a variety of environmental and instructional distractions the challenge of addressing learner attitude becomes particularly problematic. In discussing Cognitive Load Theory and the role of motivation, Paas et al. (2005) argued that “non-laboratory” experimental settings represent an environment for which “cognitive load researchers need to determine the [attitudinal] effects of instructional conditions, and identify strategies that keep student attention on the learning materials” (p. 27). Consequently, instructional designers should seek ways to gain and maintain a learner’s attention on the essential processes necessary to solve the problem while simultaneously encouraging persistence by instilling confidence in their ability to solve complex problems. Worked examples may provide an instructional strategy that can effectively attend to both student attention and confidence.

Traditionally, worked example research has concentrated on the cognitive aspects of the learning process without considering the influence learner attitude has on learning (Paas et al., 2005). However, questions about the motivational effect worked example strategies have on learner attitude have been noticeably absent from the cognitive load literature (Stark, Mandl, Gruber, & Renkl, 2002). Paas and van Merrienboer (1994) argued that instructional strategies designed to improve learning based on cognitive load principles have little effect if the learner lacks the motivation or attitude to invest mental effort during the learning process. Cognitive load researchers acknowledge the lack of research in motivation is due in part because most studies have been short in duration and
conducted in control laboratory settings (Paas, Tuovinen, van Merrienboer, & Darabi, 2005). Under these conditions, learners may be more inclined to invest mental effort due to non-motivational factors (e.g., researcher presence) that are not common in a natural classroom situation. Recently, many CLT researchers have expanded their inquiry to include the mediating influence of prior knowledge and motivational attitude (Paas et al., 2005; Moreno, 2006; Paas & van Merrienboer, 1994). This study intends to “advance our understanding of who benefits from different worked example designs” (Moreno, 2006, p. 179) and the effect worked examples have on learner attitude.

**Summary**

Research on the worked example effect has provided instructional designers with a valuable source of information by advancing our understanding of human cognition (Sweller, 2006). Cognitive Load Theory (Sweller, 1988; Sweller et al., 1998; van Gog et al., 2006) clarifies the relationship between learning and effectively developed instructional material. Accordingly, Cognitive Load Theory argues that instructional materials pull on a learner’s cognitive resources based on the intrinsic, extraneous, and germane load the materials impose. Hence, the way a worked example is developed will influence the level of cognitive load experienced by the learner. Therefore, a designer should be cognizant of the impact cognitive load has on learning and develop materials that optimize a learner’s working memory capacity by providing the necessary instructional support throughout the learning process.

Worked example research has recently shifted its focus away from independently examining extraneous load toward investigating how variations in example strategy can increase germane load on learners. Most cognitive load effects from worked example instruction do not vary germane load directly. Instead, germane load is increased by reducing extraneous load that in turn frees up working memory capacity (Sweller, 2006). As a result, van Gog et al. (2004) proposed that providing learners process-information (i.e., principled and strategic information) relevant to understanding the will improve understanding and transfer because they will be “challenged to invest germane effort in studying the why and how information” (van Gog et al., 2004, p. 96).

However, contrary to expected findings van Gog et al. (2006) reported that learners in conditions with process-oriented worked examples had lower near and far
transfer scores, took longer to complete tasks during training and on transfer tests, and exerted more mental effort than those in conditions with product-oriented worked examples. A possible explanation for the contradictory findings was the level of learner prior knowledge and the amount of instructional support provided by the worked example. In a follow up study, van Gog and her colleagues (in press) explored the interaction of prior knowledge and worked example sequencing. The researchers found evidence that process-oriented worked examples can initially improve learning in novice learners but the additional process-information may become redundant and hamper learning for more proficient learners. The purpose of the proposed study is to extend this line of research by examining the effect different worked example strategies and prior knowledge have on learning and transfer of problem solving skills and learner attitude in the domain of microeconomics.
CHAPTER 3

METHOD

The present study investigated the effect of process-oriented and product-oriented worked example instructional strategies on learning and transfer performance in microeconomics. Specifically, participants were instructed on how to apply the microeconomic principles of supply and demand and elasticity to solve complex problems posed by the burden of taxes on the market behavior of buyers and sellers. In addition, the mediating effect of prior knowledge on learning and transfer was also investigated. This chapter describes the approach used to compare the effects of worked example strategies, process-oriented and product-oriented, and conventional problem-solving on participant learning and transfer performance, mental effort, and attitude based on factors attributable to the characteristics of the instructional strategies being examined.

Participants

The participants in this study included 415 undergraduate students enrolled in an introductory microeconomics course of a large southeastern United States public university. The study took place over the course of three regularly scheduled class periods in a large lecture hall located in a shared teaching facility in the center of campus. All participants involved in the study did so voluntarily, in full compliance with guidelines established by the University Human Subjects Committee. Each participant granted permission by signing an informed consent form (see Appendix A).

Available participant demographic data including gender, race, age, year in school, and academic major was obtained from the university registrar’s office through a formal request (see Appendix B). The average age of participants was 19.5 years (SD=1.803). Freshman and sophomores comprised 80.9% of the participants with 113 freshman, 188 sophomores, 55 juniors, and 16 seniors. Participant gender composition was 48.4% (n=198) female and 51.6% (n=211) male. The race/ethnicity of participants was mixed with the majority 76.9% (n=286) being white/Caucasian and 12.4% (n=46) of Hispanic descent. Participant academic majors were also mixed. The majority of
participants had identified a major as either business 49.5% (n=184), social science 12.9% (n=48) or merchandising 8.4% (n=35).

Three instructional conditions were created for the present study based on the type of strategy (i.e., process-oriented, product-oriented, and conventional problem solving). Participants were randomly assigned to one of the three conditions as they entered the lecture hall. Table 3.1 shows the number of participants assigned to each instructional condition. The number of participants assigned to each instructional condition was relatively equal.

Table 3.1. Descriptive Statistics on Instructional Strategy Conditions

<table>
<thead>
<tr>
<th>Instructional strategy</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>143</td>
<td>34.5</td>
</tr>
<tr>
<td>Product</td>
<td>146</td>
<td>35.2</td>
</tr>
<tr>
<td>Conventional</td>
<td>126</td>
<td>30.4</td>
</tr>
<tr>
<td>Total</td>
<td>415</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Instructional Environment**

The design and arrangement of the instructional environment can have significant affect on both student and instructor behavior. Educational psychologists have contented that the structure and organization of the environment in which instruction occurs can facilitate or inhibit learning (Johnson, Johnson, & Holubec, 1994). In many university settings, introductory courses are taught in lecture halls hosting large numbers of students that support a more traditional passive, instructor-centered learning environment. To evaluate both the environment factors and instructional approach of the course, three separate classroom observations were conducted over a four-week period prior to the study.

To guide the collection of data a classroom observation checklist was developed (see Appendix C) to collect information on four distinct elements: (1) variety and pacing of instruction, (2) organization and presentation of information, (3) instructional clarity, and (4) instructor-student interaction. In addition, environmental data was collected, such as number of students attending each class session, and potential extraneous factors such as distracting loud noises or activities during class time.
The present study was conducted in a lecture hall with a maximum seating capacity of 500 students. The layout of the room provided for student seating in a quadrant arrangement with seating sections in both the lower tier and the upper tier of the room. The instructor’s lectern was located at the front of the lecture hall. The lectern consisted of a large table equipped with multi-media devices such as a personal computer, audio and video devices, and touch screen command controls. Behind the instructor’s podium were two large projector screens for presentation of instructional material. The room was also equipped for wireless data transmission devices. The technology supported two essential pedagogical aspects of the course. First, it provided the instructor the ability to use a mobile notepad to control the instructional presentation and activities as well as the ability to roam freely around the room in an attempt to connect with the students. Second, all students enrolled in the course were required to use a PRS device (personal response system) to respond to questions, quizzes, and activities presented during the instruction.

In each of the pre-study classroom observations, the course instructor used a variety of methods such as knowledge check questions, demonstrations, and visuals to engage the students to verify their level of understanding of the material covered during the class period. For example, at the conclusion of a particular topic, the instructor would present students with a series of multiple choice questions using the large projector screen. Students would be given approximately two minutes to respond to the question using their electronic transmitting device (PRS) to record their response. Responses were then aggregated by the instructional software program and displayed as a bar graph on the screen. This mobile technology enabled the instructor to quickly assess the students level of understanding allowing for real-time instructional adjustments.

In addition to presenting lecture content, the course instructor used a variety of multimedia and other classroom activities to gain and maintain student engagement throughout the course period. It is common for music to be playing at the beginning of the course as students are entering the lecture hall. Throughout the lecture a video clips are use to elaborate or exemplify a particular point or concept.

In addition, student participation is actively solicited for periodic demonstrations. For example, during one class observation the instructor asked for 10 volunteers to come
to the front of the lecture hall with the instructor to demonstrate the principle of diminishing returns using two large buckets and twenty tennis balls. The demonstration showed that production, the movement of balls from one bucket to the other, increased as students were added to the exercise until the number of students reached 6 students. At this point, production significantly declined demonstrating that there is an optimal level of resources needed to obtain maximum output.

Throughout the class period, the instructor routinely used a variety of instructional techniques, tools, and activities to enhance the learning process. Moreover, classroom observations revealed that the instructor attempted to construct a learning environment that engaged students throughout the course while conveying the appropriate amount of content.

**Instructional Materials**

Participants in this study were expected to learn how to apply the microeconomic concepts of supply and demand, tax burden, tax incidences, price and quantity equilibrium, and elasticity to solve complex economic analysis problems. To apply these concepts, a participant’s cognitive ability to determine who bears the actual burden of tax increase, the buyer or the seller, was predicated on their understanding of how to calculate and interpret shifts in the supply and demand curve and the overall impact this movement has on the price and quantity equilibrium. In analyzing the impact of elasticity and taxes on market activity, the rules provide the necessary guidance to calculate gains or losses in the price and quantity of a product or service, whereas the principles provide the foundation for interpretation and application of the calculations.

The materials developed for this study consisted of a subject-specific prior knowledge assessment, three instructional packets, and a performance assessment. The fifteen-item subject-specific prior knowledge assessment was developed to assess participants’ level of knowledge of the basic principles of supply and demand and product elasticity. Similarly, a performance assessment was developed comprising eleven questions to assess participant learning and four questions to assess transfer of knowledge to novel domains. Both the prior knowledge and performance assessments were in a multiple choice format requiring participants to select the correct answer from four to five possible options provided. All participants included in the study were required to
complete both assessments. A detailed description of the subject-specific prior knowledge and performance assessments are provided in a subsequent section titled “Instruments”.

The instructional phase of the study was separated into two distinct segments. The first segment was an introductory lecture covering basic terms, concepts, and general examples of analyzing the impact of taxes on market activity. The materials used during the lecture were the instructor’s existing powerpoint slides and activity questions. The second instructional segment required participants to complete a print-based instructional packet developed specifically for this study. The packet was developed in order to provide participants the opportunity to apply the knowledge gained from the lecture. Each participant received one of the three instructional strategies, either the conventional problem solving, process-oriented worked example, or product-oriented worked example strategy.

The lecture was a 30-minute instructional presentation that included an overview of basic concepts and a general demonstration of how to analyze the impact of a tax on market activity. The instructor reviewed the basic concepts and computational underpinnings of a market equilibrium problem. Elements of the lecture included topics such as the (1) laws of supply and demand, (2) major determinants of supply and demand, (3) the law of elasticity and (4) how to determine the effect of taxes on the price and quantity of goods and services in a competitive market. The instructor concluded the lecture with a series of conceptual examples demonstrating how to represent tax problems graphically by plotting the changes in the supply and demand curve.

The instructional strategy conditions were presented to participants two days after the classroom lecture. Table 3.2 provides an overview of the structural differences between the three instructional strategies, (1) conventional problem solving, (2) process-oriented worked example-practice pair, and (3) product-oriented worked example-practice pair.

The self-paced instructional materials varied between 20 to 24 typed pages based on the type of instructional strategy. Specifically, the instructional strategy determined the type of information presented and how. For example, a conventional problem was comprised of a problem statement (i.e., question) and a problem goal (i.e., answer). The
participant was required to decide the most effective way to generate a solution to the problem by recalling the appropriate concepts, calculations, and steps and processing this information in the correct way. By design, this strategy provided minimal instructional support requiring the participant to work out the solution steps independently. Participants were provided space to work out the problem. Feedback on the correctness of the solution steps was provided only in terms of the correct answer. Participants were not prohibited from viewing the solution while working out the problem.

In contrast, the worked example strategies presented participants with the same information as in the conventional problem strategies a problem statement, and a problem goal. However, the worked example strategies added the solution steps necessary to solve the problem. The degree of information provided differed among the worked example strategies. In each worked example strategy, the example was followed by an opportunity for the participant to complete a practice problem with no instructional support provided. The example-practice approach was designed to allow the participant to study an example of how to work through a problem correctly before attempting a similar problem independently. As described in Table 3.2, the difference between the two work example strategies was the inclusion of the underlying principles supporting each step in the process-oriented example strategy. All problem scenarios, regardless of the problem type were the same. The only difference was the amount and type of instructional support provided in the scenarios. All practice problems were the same across all instructional strategy conditions.
### Table 3.2. Differences Between Instructional Strategies

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>Process-Oriented</th>
<th>Product-Oriented</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategy</strong></td>
<td>Conventional practice problems</td>
<td>Process-oriented worked examples; emphasizing both procedural steps and underlying principles of the problem (strategic knowledge)</td>
<td>Product-oriented worked examples emphasize the procedural steps of solving the problem</td>
</tr>
<tr>
<td><strong>Rule/Principle</strong></td>
<td>Principle and example problem with solution presented during the instructor-led lecture</td>
<td>Principle(s) provided with procedural steps and equations, definition of the concepts involved and how the steps are related to one another</td>
<td>Procedures provided with each required step in order to find the correct solution to the problem</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>No worked examples were provided during the treatment condition activity</td>
<td>4 examples provided to learners covering the burden of a tax and the effects of elasticity on supply and demand</td>
<td>4 examples provided to learners covering the burden of a tax and the effects of elasticity on supply and demand</td>
</tr>
<tr>
<td><strong>Practice</strong></td>
<td>7 conventional practice problems</td>
<td>3 practice problems</td>
<td>3 practice problems</td>
</tr>
<tr>
<td><strong>Practice Feedback</strong></td>
<td>Final answer provided</td>
<td>Final answer provided</td>
<td>Final answer provided</td>
</tr>
</tbody>
</table>

### Variables

**Independent Variables**

The two independent variables used in the present study were the type of instructional strategy and learner prior knowledge. The instructional strategy type used in this study had three levels: (1) the conventional practice of solving problems, (2) the process-oriented worked example strategy, and (3) the product-oriented worked example strategy. The second independent variable, learner prior knowledge, comprised two levels: (1) low prior knowledge, and (2) high prior knowledge.
Instructional strategy. The conventional problem solving instructional strategy consisted of seven conventional practice problems requiring a completion time of approximately 30-minutes (see Appendix D for the complete packet). The participants receiving conventional practice received only the correct answer to the problem. No additional feedback or instructional support was provided to assist participates in this condition to generate a problem solution. For example, participants completing a conventional problem would be required to determine the amount of tax a producer and seller would bear based on a scenario such as the following:

Scenario: The seller of used cars is interested in selling a used car for any price over $6,000. However, a recent $1,000 tax has been placed on the sale of used cars. The seller would prefer to pass the tax increase on to buyers but recognizes that the higher price may result in fewer car sales. As a result, the seller and the buyer have to share the burden of the new tax. Assume the before-tax price of a used car is $7,000 resulting in the sale of 750 units. Used car prices increase by $400 which reduces demand by 250 units.

The participant was required to use the information provided in the scenario and draw on their knowledge from the lecture provided two days earlier in order to work out the solution to the problem. Participants were asked to show their work. For each of the seven practice problems, ample space was provided to work out the problem, including graphing the problem as it was demonstrated during the lecture. The answer to the problem was provided to the participant on the next page. For example, participants working out the problem listed above were given the following answer:

Answer: In this scenario, the government passed a $1,000 tax on the seller of used cars. Despite the imposed tax on the seller, both the seller and buyer share the actual tax burden. Each $1,000 of tax revenue paid to the government imposes a burden of $400 on the buyer in the form of higher used-car prices and a $600 burden on the seller in the form of lower net revenue received from the sale of a used car.

The process-oriented worked example instructional strategy presented the learner with four worked examples and three practice problems requiring a completion time of approximately 30-minutes (see Appendix E for the complete packet). The worked example provided the participant with the necessary procedural steps required to perform
the analysis process as well as the underlying principle or the “why” behind the step or task being performed. Figure 3.1 illustrates the procedural and strategic or principle-based information provided in a process-oriented worked example.

Figure 3.1. Display of a process-oriented worked example incorporating both procedural and strategic information.

The practice problems were the same problems as those provided in the other instructional conditions. These problems required the participant to work through a solution without external instructional support. The feedback provided for all practice problems consisted of the correct answer to the problem.

The product-oriented worked example instructional strategy also presented the learner with four worked examples and three practice problems requiring a completion time of approximately 30-minutes (see Appendix F for the complete packet). However, this worked example strategy provided participants with only the necessary procedural steps to solve the problem. Using the same scenario as in the previous examples, Figure 3.2 illustrates the procedural steps provided to a participant in a product-oriented worked example.
The practice and feedback strategy of the product-oriented worked examples is the same as the approach used in the process-oriented strategy and conventional problem-solving strategy.

Prior Knowledge. The variable learner prior knowledge was comprised of two levels, (1) low and (2) high. A fifteen-question multiple choice subject-specific prior knowledge assessment was used to assess participants level of prior knowledge. Items were designed to assess participants knowledge proficiency in the laws governing supply and demand, and elasticity. For each question, participants were asked to select the correct answer from one of four or five possible answers. Participants recorded their responses on a scantran form for scoring. The creation of prior knowledge categories was based on the participant’s number of correct responses.

Dependent Measures

Learning. Two days after completing the two instructional segments (i.e., lecture and instructional conditions), participants were asked to complete an achievement test as
part of an overall performance assessment to measure learning. Learning was measured by a participant’s score on a print-based multiple choice test consisting of eleven knowledge assessment items that were developed by the instructor with input from the researcher. Overall learning achievement was measured based on the number of correct responses to each assessment question (e.g., 7 out of 11 correct). Responses were captured on a scantran form.

Transfer. Transfer performance was measured based on the results from four item multiple choice transfer test developed by the instructor with input from the researcher. The assessment examined whether or not participants were able to apply the relevant schema (i.e., tax impact analysis) acquired during the instruction to a novel domain (i.e., labor markets and health care). Transfer was measured based on the number of correct responses selected. Responses were captured on a scantran form.

Mental effort. Mental effort was measured using the subjective rating scale based on a 9-point scale developed by Paas (1992), ranging from 1 “very, very low effort” to 9 “very, very high effort” (see Appendix G). Participants completed the mental effort rating by indicating the amount of mental effort they exerted after completing the instruction (i.e., worked examples or conventional lecture). Responses were recorded on the instructional packet.

Learner attitude. Learner attitude was measured in terms of attention and confidence scores on Keller’s Instructional Materials Motivation Survey (IMMS). The survey contained 21 items, eleven of the questions relate to attention and ten of the questions relate to confidence. Responses to the items were in the form of a five-point Likert-type scale. The IMMS was administered at the end of the instructional lesson and responses were captured on the instructional packet. Participants required between 5 and 10 minutes to complete the survey based on individual differences.

Pre-Treatment Condition Classroom Observations

In addition to the aforementioned quantitative measures, the researcher captured field notes from three classroom observations in order to gain a deeper understanding of the contextual and/or environmental factors that affect participants. The purpose of the observations was two-fold: (1) to identify pertinent behavioral patterns of participants
while engaged in an instructional activity, and (2) to identify any events during the instruction that may be problematic to the study outcomes.

**Instruments**

The primary instruments used to collect data in the present study were the prior knowledge assessment, the mental effort rating scale, the learner attitude survey, and the performance assessment that is the combination of an achievement test and transfer test. Each of the instruments is described in the following sub-sections.

**Subject-Specific Prior Knowledge Assessment**

The levels of prior knowledge were assessed by participant responses to specific questions from the first exam of the course. The prior knowledge assessment comprised fifteen multiple-choice items specifically developed to determine classification as either a low or high prior knowledge participant. The questions assessed the participants’ level of knowledge proficiency on the relationship between product and resource markets, price controls, supply and demand, and elasticity. Participants were asked to select the correct answer from among either four or five choices. The assessment score was based on the number of correct answers selected.

The prior knowledge assessment was developed by the instructor with input from the researcher. The items selected for the assessment were generated on the basis of their applicability to the content being examined by the study. After items are developed by the instructor they were reviewed by the researcher for analysis and suggested revision. The resulting items were revised on the basis of appropriateness and clarity. The final revised assessment questions are presented in Appendix H.

**Mental Effort Rating Scale**

After completing the instructional activity, participants were instructed to indicate how much mental effort they invested after completing the instructional packet on a 9-point rating scale (Paas, 1992), ranging from 1 “very, very low effort” to 9 “very, very high effort”.

**Learning Attitude Survey**

The attitude of the participants toward the instruction was measured by a 21-item five-point Likert-type questionnaire (see Appendix I) adapted from the Instructional Material Motivational Survey (IMMS) to measure attitude, attention, and confidence
The IMMS instrument was developed to provide a situational measure of participants’ motivational response to instructional materials and included in the instructional packet that was provided to participants. The survey was developed on the basis of Keller’s ARCS model (1987a; 1987b) and required participants to record their degree of agreement with a variety of statements concerning their attention (e.g., “the variety of reading passages, exercises, and illustrations helped keep my attention on the lesson”), and confidence (e.g., “as I worked on the lesson, I was confident that I could learn the content”).

Participants responded to these statements on a five-point Likert scale (1 = not true, 5 = very true). Of those 21 items, eleven of the items pertained to attention and ten pertained to confidence. Based on Cronbach’s alpha coefficient, the overall learner attitude questionnaire had a reliability of .80. Moreover, questions relating to attention had a reliability measure of .73 and those relating to confidence had a reliability measure of .74.

**Performance Assessment**

The performance assessment comprised fifteen multiple-choice items on a print-based assessment. The assessment comprised two parts: an achievement test and a transfer test (see Appendix J). The achievement test was developed to assess recall of general knowledge relating to the content area. The transfer test was used to assess a participant’s ability to apply acquired knowledge to a new domain problem.

**Achievement Test.** Learning achievement, defined as the ability of the participant to apply the learning from the instruction on the performance assessment questions. The achievement portion of the performance assessment consisted of eleven-items designed to assess participants’ application of their knowledge of (1) supply and demand curve shifts, (2) the impact of the tax burden on market activity, and (3) the influence of product elasticity on the allocation of the tax burden among buyers and sellers. Participants received one point for each correct answer selected.

**Transfer Test.** Transfer, defined as the ability of the participants to apply the knowledge learned from the instruction to a novel problem. The transfer test consisted of four-items that differed in the domain of focus. Participants received one point for each
correct answer selected. The transfer test was developed by the instructor with input from the researcher.

Procedure

The procedure for the present study involved completion of three phases: (1) a prior knowledge assessment to determine participants' level of prior knowledge, (2) a common lecture presented two days prior to the administration of the instructional conditions, the administration of instructional strategy conditions via a print-based instructional packet, and (3) a performance assessment developed to assess participant knowledge recall and transfer ability. These phases of the procedure are described below.

Phase One: Prior Knowledge Assessment

In this phase of the study, participants completed a 25-question exam as part of their normal course requirement. Fifteen questions of the exam were specifically developed to assess a participant’s prior knowledge level (i.e., low or high) for the present study. In this study, a participant’s prior knowledge level was determined by calculating the number of questions answered correctly. Figure 3.3 illustrates how participants were categorized by prior knowledge.

Phase Two: Instructional Segments

Lecture. One week after the prior knowledge assessment was administered, participants were presented a lecture titled, “Supply and Demand: Application and Extensions”. The 30-minute lecture introduced participants to (1) the relationship between resource and product markets, (2) analyzing the impact of government policy on market activity, and (3) the effects of tax incidence and elasticity on market activity between buyers and sellers. The presentation covered general concepts and principles associated with the lecture topics.

The instructor used supportive instructional techniques to improve participant understanding of the content. Conceptual examples were shown as part of the lecture to demonstrate how to plot shifts in the supply and demand curve resulting from the imposition of taxes on goods and services. Due to the relationship among three critical elements prices, taxes, and elasticity, three examples were presented showing the impact of a tax increase on the cost of a product and based on the elasticity of the product (i.e., non-elastic, inelastic, and elastic). To encourage student participation in the instructional
phase of the study, prior to the end of class the course instructor announced that participants attending class and completing the instructional activity during the next class would receive double class participation points for that day.

Figure 3.3. Illustration of participant categorization into instructional strategy and prior knowledge groups

*Instructional Strategy.* Two days after the lecture, students who agreed to participate in the instructional condition phase of the study were asked to complete one of the three possible versions of a self-paced instructional packet (i.e., instructional condition). To ensure random assignment of the instructional conditions, three graduate students and the researcher were each stationed at the one of the four entry points to the classroom with a pre-sorted mixture of instructional packets. As participants entered the lecture hall, they were randomly handed one of three instructional packets (i.e., conventional problem solving, process-oriented, and product-oriented).

After the materials were distributed, the researcher spent the first 10-minutes of the course period to provide instructions for the activity. The researcher stated that the activity was not a test and explained that the purpose of the activity was to evaluate the effectiveness of different instructional strategies (see Activity Leaders Guide in Appendix K). Participants were also informed that since data was being collected, if they chose to
participate, they would need to read and sign the Research Study Participant Consent form included in the instructional packet.

Instructions described the tasks participants were required to complete during the activity (i.e., answer all questions, complete the mental effort rating and the instructional materials survey). Specific attention was given to describing the particular sections of the instructional packet. Participants were informed that the activity was comprised of two sections, one instructional and one evaluation. The instructional section contained either a series of conventional practice-problems or a series of worked out examples and practice problem-pairs to solve. The difference in the strategy was the amount of instructional assistance provided to participants as they worked through the problems. The distinguishing features of each instructional strategy are described below.

Participants receiving the **process-oriented worked example strategy** received four worked examples and three practice problems to complete. Participants were provided with a worked out example followed immediately by a practice problem similar to the worked example. The process-oriented example strategy included information that emphasized both the procedural steps necessary to solve the problem as well as the underlying principles of the problem.

Participants receiving the **product-oriented worked example instructional strategy** also received four worked examples and three practice problems to complete. The worked out example was followed by a practice-problem similar to the worked example previously reviewed. The product-oriented example strategy differed from the process-oriented strategy in that it only provided the necessary procedural steps required to solve the problem. No principle information was presented in these examples.

In both instructional strategies, each worked example was followed by a practice-problem to solve. Practice-problems were presented without any instructional support. Feedback (i.e., the correct answer) to the practice-problem was available on the next page.

Participants receiving the **conventional problem solving instructional strategy** were presented with seven practice-problems to solve. The practice-problems were presented one at a time and required the participants to work out the problem in the space provided. As in the worked example strategies, the feedback (i.e., the correct answer) to
the practice-problem was available on the next page. No additional elaboration or informational cues about how to solve the problem was provided. Participants were instructed they would have 40-minutes to complete both sections of the activity. Figure 3.4 provides an overview of the procedures used in the study.

The evaluation section required participants to (1) rate the amount of mental effort they exerted while completing the problems and (2) evaluate the motivational or attitudinal influence of the instructional materials used in the activity. In order to ensure the same information covered during the instructions was provided to participants arriving late an overhead with the activity instructions was displayed during the session (see Appendix L for Overhead Instructions).

**Phase Three: Performance Assessment**

The performance assessment was conducted four days after the administration of the instructional conditions. Four days after participating in the instructional phase of the study, participants were asked to complete a fifteen-item multiple-choice assessment. The performance assessment comprised two parts, (1) an eleven-item achievement test and (2) a four-item transfer test. The performance assessment procedures were identical for all participants in the present study. Participants were given a maximum of 50-minutes to complete the assessment. Responses to the assessment were captured on a scantran form.
### Phase I

**Prior Knowledge Assessment**

- 50 Minutes
- One Week Before Instructional Conditions
- Fifteen multiple choice questions

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### Phase II

**Instructional Segment One:**

- Lecture
- 20 Minute
- Two Days Before Instructional Conditions
- Lecture Topic: Application of Supply and Demand: The Impact of a Tax
  - How does a tax affect the market?
  - What determines the distribution of the tax burden between buyers and sellers?

**Instructional Segment Two:**

- Instructional Strategy Conditions, Mental Effort Rating, and Attitude Survey
- 50 Minutes
- Process-Oriented Example
  - Process-oriented worked examples emphasize both procedural steps and underlying principles of the problem (strategic knowledge)
  - Four worked examples, three practice problems
- Product-Oriented Example
  - Product-oriented worked examples emphasize the procedural steps of solving the problem
  - Four worked examples, three practice problems
- Conventional Problem-Solving
  - Seven conventional practice problems presented to the learners to solve
  - Feedback consists of answers to practice problems provided to the learners

1. Rating of Mental Effort on a 9-Item Scale
2. 21-question Attitude Survey measuring attention and confidence

---

### Phase III

**Performance Assessment:**

- Achievement Test and Transfer Test
- 50 minutes
- Four Days after Instructional Conditions
- Eleven Achievement test questions
- Four Transfer test questions

Figure 3.4. Overview of the Procedures.
Research Design and Data Analysis

The research design for the present study was quasi-experimental in nature due to the assignment of intact groups to treatment conditions and a three (instructional strategy) x two (level of learner prior knowledge) factorial design. Table 3.3 provides an overview of the study’s research design.

Table 3.3. Research Design of Instructional Strategy and Prior Knowledge

<table>
<thead>
<tr>
<th>Instructional Strategy</th>
<th>Low Prior Knowledge (LPK)</th>
<th>High Prior Knowledge (HPK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process-Oriented</td>
<td>LPK/ Process-Oriented</td>
<td>HPK/ Process-Oriented</td>
</tr>
<tr>
<td>Product-Oriented</td>
<td>LPK/ Product-Oriented</td>
<td>HPK/ Product-Oriented</td>
</tr>
<tr>
<td>Conventional</td>
<td>LPK/ Conventional</td>
<td>HPK/ Conventional</td>
</tr>
</tbody>
</table>

To test the proposed hypotheses (see Chapter 2), quantitative data was collected on each of the following outcome measures: (1) learning, (2) transfer, (3) mental effort, and (4) learner attitude. A detailed description of the data analyses that were conducted for the present study appears in the next chapter.
CHAPTER 4

RESULTS

The results of this study are presented in three sections: (1) preliminary data analyses, (2) primary data analyses, and a (3) secondary data analysis. The first section of this chapter reports the tests of assumptions that were required for the statistical tests used to test hypotheses and an item analysis of the achievement and transfer test items used in the study. The second section presents an analysis of results for each of the hypotheses tested. The final section presents the results of secondary analyses inspired by the findings of the primary analysis.

Preliminary Analysis

Prior to conducting the primary analysis of the hypotheses a preliminary analysis was performed on the tests of assumptions associated with the statistical tests used for the analysis. In addition, an item analysis was conducted on the performance assessment. In general, tests of assumptions conducted for analysis of variance (ANOVA) with instructional conditions indicated that the assumptions were not violated beyond the degree to which the statistical tests were sufficiently robust to handle minor to moderate variations.

Tests of Assumptions

Preliminary data analyses were conducted to test the assumptions associated with the various parametric statistical tests that were performed. These tests of assumptions included: (1) normal distribution assumption, (2) independence assumption, (3) interval scale assumption, and (4) homogeneity of variance assumption. The test results for each assumption are discussed next.

Normal distribution assumption. In parametric tests it is assumed that the data from the population are normally distributed. To detect violations of this assumption visual inspection of graphical representations of the data (i.e., histogram and Q-Q plot) and an examination of formal statistical analyses were conducted for each dependent variable and instructional condition. The Kolmogorov-Smirnov normality test was used to analyze the distribution of the dependent variable measures. Results indicated that
overall scores showed a non-normal distribution of the instructional conditions for all the dependent variables with the exception of Learner Attitude and the attitude sub-scale of attention. The results likely reflect the negative skewness found on achievement and transfer scores as well as the positively skewed scores found on mental effort and learner attitude scores. For example, examination of the learner attitude results indicated a normal distribution $D(393)=.033, p \geq .200$ (see Table 4.1). Moreover, the attention sub-scale of the learner attitude scores also indicated a normal distribution for each instructional condition. The Kolmogorov-Smirnov test for attention scores for the process-oriented strategy was $D(135)=.069, p \geq .200$, the product-oriented strategy $D(140)=.064, p \geq .200$, and for the conventional strategy $D(118)=.068, p \geq .200$. The confidence sub-scale of Learner Attitude scores for the process-oriented strategy was also not significant indicating a normal distribution, $D(135)=.073, p \geq .074$.

Table 4.1. Tests of Normality of Instructional Strategy Conditions

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Instructional Strategy</th>
<th>Kolmogorov-Smirnov Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement Test Scores</td>
<td>Process</td>
<td>.182</td>
<td>135</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.122</td>
<td>140</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.144</td>
<td>118</td>
<td>.000</td>
</tr>
<tr>
<td>Mental Effort Rating</td>
<td>Process</td>
<td>.131</td>
<td>135</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.126</td>
<td>140</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.140</td>
<td>118</td>
<td>.000</td>
</tr>
<tr>
<td>Transfer Test Scores</td>
<td>Process</td>
<td>.199</td>
<td>135</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.250</td>
<td>140</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.247</td>
<td>118</td>
<td>.000</td>
</tr>
<tr>
<td>Learner Attitude</td>
<td>Process</td>
<td>.057</td>
<td>135</td>
<td>.200(*)</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.065</td>
<td>140</td>
<td>.200(*)</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.062</td>
<td>118</td>
<td>.200(*)</td>
</tr>
</tbody>
</table>

* This is a lower bound of the true significance.

Table 4.2 shows similar results from examining normality based on instructional conditions and segregated by participant prior knowledge. Despite the findings that some of the dependent measures were not normally distributed, the normal distribution
assumption was regarded to be satisfied since ANOVA, the primary statistical technique utilized to analyze the data in the present study, is robust enough to withstand minor to moderate violations of this assumption.

Table 4.2. Tests of Normality of Instructional Strategy and Prior Knowledge

<table>
<thead>
<tr>
<th>Prior Knowledge Category</th>
<th>Instructional Strategy</th>
<th>Kolmogorov-Smirnov Statistic</th>
<th>df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Achievement Test Scores</td>
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<td>56</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.141</td>
<td>36</td>
<td>.067</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.182</td>
<td>49</td>
<td>.000</td>
</tr>
<tr>
<td>Mental Effort Rating</td>
<td>Process</td>
<td>.130</td>
<td>56</td>
<td>.019</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.183</td>
<td>36</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.133</td>
<td>49</td>
<td>.029</td>
</tr>
<tr>
<td>Transfer Test Scores</td>
<td>Process</td>
<td>.221</td>
<td>56</td>
<td>.000</td>
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<tr>
<td></td>
<td>Product</td>
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<td>36</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
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<td>49</td>
<td>.000</td>
</tr>
<tr>
<td>Learner Attitude</td>
<td>Process</td>
<td>.101</td>
<td>56</td>
<td>.200(</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.060</td>
<td>36</td>
<td>.200(</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.081</td>
<td>49</td>
<td>.200(</td>
</tr>
<tr>
<td><strong>High</strong></td>
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<td></td>
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<tr>
<td>Achievement Test Scores</td>
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<tr>
<td></td>
<td>Product</td>
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<td>.000</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.171</td>
<td>43</td>
<td>.003</td>
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<tr>
<td>Mental Effort Rating</td>
<td>Process</td>
<td>.150</td>
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<td>.003</td>
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<tr>
<td></td>
<td>Product</td>
<td>.148</td>
<td>68</td>
<td>.001</td>
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<tr>
<td></td>
<td>Conventional</td>
<td>.183</td>
<td>43</td>
<td>.001</td>
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<tr>
<td>Transfer Test Scores</td>
<td>Process</td>
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<td>57</td>
<td>.000</td>
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<tr>
<td></td>
<td>Product</td>
<td>.242</td>
<td>68</td>
<td>.000</td>
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<tr>
<td></td>
<td>Conventional</td>
<td>.244</td>
<td>43</td>
<td>.000</td>
</tr>
<tr>
<td>Learner Attitude</td>
<td>Process</td>
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<td>57</td>
<td>.200(</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.101</td>
<td>68</td>
<td>.084</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.074</td>
<td>43</td>
<td>.200(</td>
</tr>
</tbody>
</table>

* This is a lower bound of the true significance.

*Independence assumption.* This assumption requires that the observation or score of a participant must not be influenced by the observation or score of another participant.
(Field, 2005). To satisfy the assumption of independence, a logical study design was conducted to ensure that all observations and scores were independent. All attempts were made to control the interactions among participants. Moreover, individual learning tasks were assigned to each participant particular to their instructional strategy. Consequently, the assumption of independence was satisfied.

*Interval-scale assumption.* The dependent variables in the present study were measured at the interval level using a continuous scale. As a result, the interval-scale assumption was satisfied.

*Homogeneity of variance assumption.* The Levene’s test was conducted to test the assumption of homogeneity of variance for each dependent variable to determine whether or not the variances in the groups were equal. The results of the test indicated that the assumption of homogeneity for each dependent variable was not violated (see Table 4.3).

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
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<tr>
<td>Achievement Test Scores</td>
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<td>2</td>
<td>306</td>
<td>.083</td>
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<tr>
<td>Mental Effort Rating</td>
<td>2.433</td>
<td>2</td>
<td>306</td>
<td>.089</td>
</tr>
<tr>
<td>Transfer Test Scores</td>
<td>1.526</td>
<td>2</td>
<td>306</td>
<td>.219</td>
</tr>
<tr>
<td>Learner Attitude</td>
<td>.024</td>
<td>2</td>
<td>306</td>
<td>.976</td>
</tr>
</tbody>
</table>

**Item Analysis**

An item analysis was performed on both the achievement and transfer portions of the performance assessment. Results are presented in Table 4.4. The difficulty index for the assessment ranged from .67 to .74. The items with the lowest ratings on the difficulty index were transfer question number two and four with ratings of .67 and .69 respectively. The data reflected on the difficulty index suggests that most of the participants had little difficulty correctly answering the assessment questions. The narrow range of index percentages seems to indicate that the knowledge of participants’
exceeded the complexity of the performance assessment items. In addition, the limited number of achievement and transfer items that comprised the performance assessment are suggested to have influenced the Cronbach alpha coefficients (Fields, 2005; Cortina, 1993) that are presented in this section. The next chapter will discuss in more detail the impact of these issues on the study result.

In addition to analyzing item difficulty, reliability measures were produced to assess the internal consistency of the performance assessment items. The internal consistency of the fifteen-item assessment was calculated from the performance assessment scores as a Cronbach’s alpha coefficient of .416. A separate analysis was conducted for each subscale (i.e., achievement test and transfer test). The internal consistency for the eleven-item achievement test scores had a Cronbach’s alpha coefficient of .340. The reliability analysis for the four-item transfer test had a Cronbach’s alpha coefficient of .023.

Table 4.4. Performance Assessment statistics for Individual Test Items

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Difficulty Index</th>
<th>Scale Mean if Item Deleted</th>
<th>Scale Variance if Item Deleted</th>
<th>Corrected Item-Total Correlation</th>
<th>Squared Multiple Correlation</th>
<th>Cronbach's Alpha if Item Deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement 1</td>
<td>.72</td>
<td>9.94</td>
<td>4.514</td>
<td>.175</td>
<td>.066</td>
<td>.389</td>
</tr>
<tr>
<td>Achievement 2</td>
<td>.70</td>
<td>9.96</td>
<td>4.703</td>
<td>.070</td>
<td>.049</td>
<td>.418</td>
</tr>
<tr>
<td>Achievement 3</td>
<td>.70</td>
<td>9.96</td>
<td>4.581</td>
<td>.131</td>
<td>.051</td>
<td>.401</td>
</tr>
<tr>
<td>Achievement 4</td>
<td>.74</td>
<td>9.92</td>
<td>4.590</td>
<td>.142</td>
<td>.064</td>
<td>.398</td>
</tr>
<tr>
<td>Achievement 5</td>
<td>.72</td>
<td>9.94</td>
<td>4.566</td>
<td>.148</td>
<td>.073</td>
<td>.396</td>
</tr>
<tr>
<td>Achievement 6</td>
<td>.70</td>
<td>9.96</td>
<td>4.571</td>
<td>.138</td>
<td>.037</td>
<td>.399</td>
</tr>
<tr>
<td>Achievement 7</td>
<td>.73</td>
<td>9.93</td>
<td>4.548</td>
<td>.161</td>
<td>.062</td>
<td>.393</td>
</tr>
<tr>
<td>Achievement 8</td>
<td>.72</td>
<td>9.94</td>
<td>4.518</td>
<td>.172</td>
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<td>.389</td>
</tr>
<tr>
<td>Achievement 9</td>
<td>.72</td>
<td>9.94</td>
<td>4.651</td>
<td>.102</td>
<td>.034</td>
<td>.409</td>
</tr>
<tr>
<td>Achievement 10</td>
<td>.71</td>
<td>9.95</td>
<td>4.572</td>
<td>.141</td>
<td>.035</td>
<td>.398</td>
</tr>
<tr>
<td>Achievement 11</td>
<td>.72</td>
<td>9.94</td>
<td>4.561</td>
<td>.151</td>
<td>.057</td>
<td>.395</td>
</tr>
<tr>
<td>Transfer 1</td>
<td>.70</td>
<td>9.96</td>
<td>4.569</td>
<td>.138</td>
<td>.047</td>
<td>.399</td>
</tr>
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<td>Transfer 2</td>
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<td>9.99</td>
<td>4.548</td>
<td>.141</td>
<td>.076</td>
<td>.398</td>
</tr>
<tr>
<td>Transfer 3</td>
<td>.71</td>
<td>9.95</td>
<td>4.638</td>
<td>.106</td>
<td>.041</td>
<td>.408</td>
</tr>
</tbody>
</table>
In addition to the achievement and transfer test item analysis, two subscale analyses were conducted. The focus of the performance assessment was to identify general knowledge and transfer ability on student understanding of elasticity and the impact of taxes on market behavior. Subscale items examining elasticity were achievement items 1-4 and transfer items 6 and 7. The internal consistency for the six-item subscale had a Cronbach’s alpha coefficient of .182. The impact of taxes on market activity was examined by achievement items 6, 8-11 and transfer items 3 and 4. The Cronbach’s alpha coefficient for the seven-item subscale was .242.

**Primary Data Analysis**

Primary data analyses were conducted to test the hypotheses derived from the four research questions. For the present study, analysis of variance (ANOVA) was used to examine the effect of (1) instructional strategy on learning and transfer performance, (2) the interaction between instructional strategy and prior knowledge level on learning and transfer, (3) the interaction of instructional strategy and prior knowledge level on mental effort, and (4) the interaction of a instructional strategy and prior knowledge on learner attitude. A significance level of .05 was used for the analyses reported in the present study. The results are presented below under each corresponding hypotheses.

**Descriptions of Groups**

The means and standard deviations for the instructional strategies on the dependent measures of learning, transfer, mental effort, and attitude are presented below in Table 4.5. As discussed in the previous chapter, the present study examined the effect of prior knowledge on the dependent measures. Hence, prior knowledge categories (i.e., low prior knowledge and high prior knowledge) were created based on the number of items correctly answered by a participant on the fifteen-item prior knowledge assessment. The mean score of the assessment was 12.01 (SD=1.928). Based on work by Mahan (2007), the original research design called for the prior knowledge assessment mean score to be used as the cut point to classify participant prior knowledge. However, due to the clustered nature of prior knowledge scores in the upper range of scores, it was determined prior to running any outcome analyses to use scores falling in the 25th and 75th percentile range as cut points for determining a participant’s prior knowledge. Table 4.6 shows the prior knowledge scores and the associated quartile.
Table 4.5. Descriptive Statistics of Instructional Strategy on Dependent Measures

<table>
<thead>
<tr>
<th>Instructional Strategy</th>
<th>Dependent Measures</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Achievement Test Scores</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Process</td>
<td>7.74</td>
<td>1.74</td>
<td>142</td>
<td>2.70</td>
<td>0.95</td>
<td>142</td>
<td>3.78</td>
<td>1.95</td>
</tr>
<tr>
<td>Product</td>
<td>8.03</td>
<td>1.87</td>
<td>143</td>
<td>2.81</td>
<td>0.92</td>
<td>143</td>
<td>4.13</td>
<td>1.92</td>
</tr>
<tr>
<td>Conventional</td>
<td>7.8</td>
<td>2.04</td>
<td>123</td>
<td>2.78</td>
<td>0.95</td>
<td>123</td>
<td>4.06</td>
<td>2.10</td>
</tr>
<tr>
<td>Total</td>
<td>7.86</td>
<td>1.88</td>
<td>408</td>
<td>2.76</td>
<td>0.94</td>
<td>408</td>
<td>3.99</td>
<td>1.99</td>
</tr>
</tbody>
</table>

Note: Ranges for scores on dependent measures: Achievement test score 1 to 11; Transfer test score 1 to 4; Mental effort rating 1 to 9; Learner attitude ratings 1 to 5.

Table 4.6. Descriptive Statistics for Prior Knowledge Assessment Scores

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Participants</td>
<td>415</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Prior Knowledge Assessment Score</td>
<td>12.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Error of Mean</td>
<td>.095</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Prior Knowledge Score</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Prior Knowledge Score</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentiles of Prior Knowledge Scores</td>
<td>25</td>
<td>11.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>12.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>13.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Participants with a score equal to or less than eleven were classified as low prior knowledge whereas high prior knowledge participants had scores equal to or greater than thirteen. Participants with scores equal to twelve (n=87) were excluded from use in analyses of prior knowledge. Table 4.7 shows the number of participants assigned to a particular instructional strategy that were categorized as either low or high prior knowledge.

Finally, the means and standard deviations are presented in Table 4.8 for each instructional strategy condition grouped by prior knowledge level categories on the dependent measures of learning, transfer, mental effort, and attitude.
Table 4.7. Prior Knowledge Category Frequencies by Instructional Strategy

<table>
<thead>
<tr>
<th>Prior Knowledge</th>
<th>Process</th>
<th>Product</th>
<th>Conventional</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (score of ≤ 11)</td>
<td>58</td>
<td>37</td>
<td>51</td>
<td>146</td>
</tr>
<tr>
<td>High (score of ≥ 13)</td>
<td>61</td>
<td>72</td>
<td>49</td>
<td>182</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>109</td>
<td>100</td>
<td>328</td>
</tr>
<tr>
<td>Excluded Value</td>
<td>24</td>
<td>37</td>
<td>26</td>
<td>87</td>
</tr>
<tr>
<td>Total</td>
<td>143</td>
<td>146</td>
<td>126</td>
<td>415</td>
</tr>
</tbody>
</table>

Table 4.8. Descriptive Statistics of Prior Knowledge Levels on Dependent Measures

<table>
<thead>
<tr>
<th>Instructional Strategy/ Prior Knowledge Level</th>
<th>Achievement Test Scores</th>
<th>Transfer Scores</th>
<th>Mental Effort Rating</th>
<th>Learner Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Process</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>7.47</td>
<td>1.79</td>
<td>57</td>
<td>2.49</td>
</tr>
<tr>
<td>High</td>
<td>8.21</td>
<td>1.53</td>
<td>61</td>
<td>2.98</td>
</tr>
<tr>
<td>Product</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>7.59</td>
<td>1.61</td>
<td>37</td>
<td>2.76</td>
</tr>
<tr>
<td>High</td>
<td>8.16</td>
<td>2.18</td>
<td>70</td>
<td>2.86</td>
</tr>
<tr>
<td>Conventional</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>7.36</td>
<td>2.07</td>
<td>50</td>
<td>2.54</td>
</tr>
<tr>
<td>High</td>
<td>8.47</td>
<td>2.09</td>
<td>47</td>
<td>2.96</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>7.47</td>
<td>1.84</td>
<td>144</td>
<td>2.58</td>
</tr>
<tr>
<td>High</td>
<td>8.26</td>
<td>1.95</td>
<td>178</td>
<td>2.93</td>
</tr>
</tbody>
</table>

*Note:* Ranges for scores on dependent measures: Achievement test score 1 to 11; Transfer test score 1 to 4; Mental effort rating 1 to 9; Learner attitude ratings 1 to 5.
In addition to traditional demographic information and separate from the subject-specific prior knowledge assessment, each participant’s previous experience of economics course work was also collected (see Appendix M for the Economic Experience Survey). The collection of previous experience was sought to provide additional explanatory data relating to the possibility of some participants having partially formed basic schemas (Pollock, Chandler, & Sweller, 2002) of the content prior to exposure to the instruction. This is an important factor to consider considering the existence of partial schema may not have been apparent from prior knowledge assessment scores but could have affected dependent outcomes. To collect this information, a three-question in-class survey was conducted at the beginning of the term. Participants were ask to indicate whether or not they had (1) completed a high school economics course, (2) completed a college level introductory economics course, and (3) completed a college level economics course with the instructor in the present study.

Three hundred and forty participants responded to the question asking if participants had previously taken high school economics. Table 4.9 shows that more than eighty-five percent (n=291) of participants indicated they had previously taken a high school economics course. Moreover, more than fourteen percent (n=49) indicated they had not taken economics in high school.

<table>
<thead>
<tr>
<th>Valid</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>291</td>
<td>85.6</td>
</tr>
<tr>
<td>No</td>
<td>49</td>
<td>14.4</td>
</tr>
<tr>
<td>Total</td>
<td>340</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.9. Frequency of Participants who Completed High School Economics

Table 4.10 shows that forty-three percent (n=147) of the participants responded that they had previously taken a college-level introductory economics course whereas fifty-seven percent (n=195) indicated they had not. Lastly, Table 4.11 shows that of three hundred
and fifty-one respondents, almost eighteen percent (n=62) indicated they had previously taken a college-level economics course with the instructor of the course.

Table 4.10. Frequency of Participants who Completed College Introductory Economics

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Yes</td>
<td>147</td>
</tr>
<tr>
<td>No</td>
<td>195</td>
</tr>
<tr>
<td>Total</td>
<td>342</td>
</tr>
<tr>
<td>Missing</td>
<td>73</td>
</tr>
<tr>
<td>Total</td>
<td>415</td>
</tr>
</tbody>
</table>

Table 4.11. Frequency of Participants who Completed a College-Level Economics Course with this Course Instructor

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Yes</td>
<td>62</td>
</tr>
<tr>
<td>No</td>
<td>288</td>
</tr>
<tr>
<td>Total</td>
<td>351</td>
</tr>
<tr>
<td>Missing</td>
<td>64</td>
</tr>
<tr>
<td>Total</td>
<td>415</td>
</tr>
</tbody>
</table>

Tests of Hypotheses

*Learning.* The first hypothesis predicted that participants completing a worked example strategy (i.e., process-oriented or product-oriented) would score higher on the achievement test than participants completing a conventional problem solving strategy. Results did not support the hypothesis. Mean achievement scores for the instructional strategy conditions showed that participants in the product-oriented strategy had higher scores (M=8.03, SD=1.869) than participants in either the process-oriented strategy (M=7.74, SD=1.737) or the conventional strategy (M=7.8, SD=2.036). As evidenced by the results, participants completing the two strategies providing the least amount of instructional support (i.e., product-oriented and conventional problem solving strategies) had slightly higher scores than participants completing the process-oriented strategy.
Contrary to expectations, a one-way ANOVA revealed no significant difference, $F(2, 405)=.935, p=.393, \omega^2=.001$ (see Table 4.12) in achievement scores between the three instructional strategies.

Table 4.12. One-Way Analysis of Variance for Achievement Test Scores

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>\omega^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>6.589</td>
<td>2</td>
<td>3.294</td>
<td>.935</td>
<td>.393</td>
<td>.001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>1427.166</td>
<td>405</td>
<td>3.524</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1433.755</td>
<td>407</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition, a planned contrast was conducted on mean achievement scores to examine differences between worked example strategies and conventional problem solving. Results showed no difference, $t(405)=.429, p=.668$, between worked example strategies and the conventional problem solving strategy.

The second hypothesis examined the interaction effect of prior knowledge and instructional strategy on achievement scores. The hypothesis was not supported. The first part of the hypothesis predicted that low prior knowledge participants completing a process-oriented worked example strategy would score higher on the achievement test than low prior knowledge participants completing either a product-oriented worked example strategy or a conventional problem solving strategy. In contrast, the second part of the hypothesis predicted that participants with high prior knowledge who were presented with process-oriented worked examples would demonstrate no significant difference in achievement test scores than high prior knowledge participants presented with product-oriented worked examples or conventional problem solving strategy.

To test this hypothesis, achievement test scores were analyzed using a two-way ANOVA. The interaction effect of instructional strategy and prior knowledge level was not significant, $F(2, 316)=.517, p=.597, \omega^2=.003$ (see Table 4.13). This was counter to the expectation that low prior knowledge participants would score higher than low prior knowledge participants in other strategy conditions (see Table 4.8 for mean scores).
addition, the results failed to reject the null hypothesis of no difference in achievement test scores. Although no difference in achievement scores was revealed across instructional strategies for high prior knowledge participants, the failure to reject the null hypothesis does not provide support of the hypothesis. As a result, the second part of the hypothesis was not supported. However, analysis of the mean scores did reveal that high prior knowledge participants in the conventional problem solving strategy group demonstrated slightly higher mean achievement scores, possibly indicating the presence of expertise reversal effect.

An analysis of the main effect of prior knowledge on achievement scores showed a significant difference on achievement scores, F(1, 316)=13.675, p<.000, ŵ²=.07 (medium association). Consequently, a simple effect analysis was performed to further examine the effect of prior knowledge level on individual levels of each instructional strategy condition on achievement scores. The results in Table 4.14 show a significant difference in mean achievement scores between participants with high-levels and low-levels of prior knowledge in both the process-oriented strategy, F(1, 318)=4.42, p=.036, ŵ²=.02 and the conventional problem solving strategy, F(1, 318)=8.18, p=.005, ŵ²=.04.

Table 4.13. Two-Way Analysis of Variance for Instructional Strategy and Prior Knowledge level on Achievement Test Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>ŵ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>.265</td>
<td>2</td>
<td>.133</td>
<td>.036</td>
<td>.964</td>
<td>.01</td>
</tr>
<tr>
<td>Prior Knowledge Level</td>
<td>49.846</td>
<td>1</td>
<td>49.846</td>
<td>13.675</td>
<td>.000</td>
<td>.07</td>
</tr>
<tr>
<td>Instructional Strategy X Prior Knowledge Level</td>
<td>3.772</td>
<td>2</td>
<td>1.886</td>
<td>.517</td>
<td>.597</td>
<td>.003</td>
</tr>
<tr>
<td>Error</td>
<td>1151.853</td>
<td>316</td>
<td>3.645</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R Squared = .045 (Adjusted R Squared = .030)
Table 4.14. Effect of Prior Knowledge Level on Transfer Test Scores within Instructional Strategy Groups

<table>
<thead>
<tr>
<th>Prior Knowledge Level within Specified Instructional Strategy</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>ω²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>16.03</td>
<td>1</td>
<td>16.03</td>
<td>4.42</td>
<td>.036</td>
<td>.02</td>
</tr>
<tr>
<td>Product</td>
<td>8.20</td>
<td>1</td>
<td>8.20</td>
<td>2.26</td>
<td>.133</td>
<td>.01</td>
</tr>
<tr>
<td>Conventional</td>
<td>29.64</td>
<td>1</td>
<td>29.64</td>
<td>8.18</td>
<td>.005</td>
<td>.04</td>
</tr>
</tbody>
</table>

R Squared = .045 (Adjusted R Squared = .030)

Transfer Test. The third hypothesis predicted that low prior knowledge participants completing a process-oriented worked example strategy would score higher on transfer test performance than low prior knowledge participants completing either a product-oriented worked example or a conventional problem-solving strategy. In contrast, high prior knowledge participants completing a process-oriented worked example strategy would demonstrate no significant difference on transfer test scores than high prior knowledge participants completing either product-oriented worked examples or the conventional problem-solving strategy on a transfer test. Findings did not support the stated hypothesis.

To test this hypothesis a two-way ANOVA was conducted to analyze the interaction effect of instructional strategy and prior knowledge on transfer test scores. Results (see Table 4.15) show that instructional strategy had no significant main effect on transfer test scores, F(2, 316)=.172, p=.842, ω²=.001. Moreover, results showed that the interaction effect of instructional strategy and prior knowledge was not significant, F(2,316)=1.1341, p=.263, ω²≤.001. This finding was contrary to the predicted outcome that low prior knowledge participants receiving the process-oriented strategy would score higher than participants in either the product-oriented or conventional problem solving conditions.
Table 4.15. Two-Way Analysis of Variance of Transfer Test Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>$\hat{\omega}^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>.284</td>
<td>2</td>
<td>.142</td>
<td>.172</td>
<td>.842</td>
<td>.001</td>
</tr>
<tr>
<td>Prior Knowledge Level</td>
<td>8.758</td>
<td>1</td>
<td>8.758</td>
<td>10.606</td>
<td>.001</td>
<td>.01</td>
</tr>
<tr>
<td>Instructional Strategy X Prior Knowledge Level</td>
<td>2.215</td>
<td>2</td>
<td>1.108</td>
<td>1.341</td>
<td>.263</td>
<td>.004</td>
</tr>
<tr>
<td>Error</td>
<td>260.946</td>
<td>316</td>
<td>.826</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R Squared = .044 (Adjusted R Squared = .029)

Similar to the achievement score findings, the results failed to reject the null hypothesis of no difference in transfer test scores across instructional strategies. Consequently, the second part of the hypothesis was not supported. However, comparable to the findings on achievement scores, further analysis of the mean scores did reveal that high prior knowledge participants in the conventional problem solving strategy group demonstrated slightly higher mean transfer test scores, possibly indicating the presence of expertise reversal effect.

ANOVA results indicated that a participant’s level of prior knowledge was a significant factor in transfer test scores. Consequently, a further examination of the effect of participant prior knowledge level on transfer scores within each instructional strategy was conducted using a simple effect analysis. Table 4.16 shows the results of the analysis of prior knowledge levels within each instructional strategy. Specifically, prior knowledge showed the strongest affect within the process-oriented strategy $F(1,318)=8.64, p=.004, \hat{\omega}^2=.01$ and the conventional problem solving strategy, $F(1,318)=5.16, p=.024, \hat{\omega}^2=.001$. Similar to the results for achievement, the findings for transfer test performance may indicate that participant domain knowledge was at a level high enough to render the additional support provided in the worked example conditions nominal. Specifically, mean transfer scores across all treatment groups were virtually
identical indicating that participants were able to obtain the same level of domain understanding regardless of the instructional condition.

Table 4.16. Effect of Prior Knowledge Level on Transfer Test Scores within Instructional Strategy Groups

<table>
<thead>
<tr>
<th>Prior Knowledge Level within Specified Instructional Strategy</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>£²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>7.10</td>
<td>1</td>
<td>7.10</td>
<td>8.64</td>
<td>.004</td>
<td>.01</td>
</tr>
<tr>
<td>Product</td>
<td>.42</td>
<td>1</td>
<td>.42</td>
<td>.51</td>
<td>.474</td>
<td>.001</td>
</tr>
<tr>
<td>Conventional</td>
<td>4.24</td>
<td>1</td>
<td>4.24</td>
<td>5.16</td>
<td>.024</td>
<td>.01</td>
</tr>
</tbody>
</table>

R Squared = .043 (Adjusted R Squared = .034)

Mental Effort. The fourth hypothesis predicted that participants presented with a worked example strategy (i.e., process or product-oriented) would report lower mental effort ratings than participants presented with a conventional problem-solving strategy. In addition, hypothesis five predicted that participants presented with a process-oriented worked example strategy would report higher mental effort ratings than participants presented a product-oriented worked example strategy. Neither hypothesis was support.

Mean scores of mental effort among the three instructional strategy conditions showed that participants receiving the product-oriented (M=4.13, SD=1.924) strategy reported exerting higher levels of mental effort during the instructional activity than did either conventional problem solving (M=4.06, SD=2.097) or process-oriented (M=3.78, SD=1.954) strategy participants (see Table 4.17). A one-way analysis of variance showed that instructional strategy had no effect on the degree of mental effort exerted by participants during the instructional activity, F(2, 412)=1.222, p=.296, £²=.002 (see Table 4.18).
Planned contrasts were run on the mental effort ratings of participants receiving one of the worked example strategies (i.e., process-oriented or product-oriented) versus those with a conventional problem solving strategy, $t(412)=.503, p=.615$. Results indicated no significant difference. Furthermore, results from a planned contrast comparing the mental effort ratings of participants receiving a process-oriented strategy with participants receiving a product-oriented strategy indicated there was no significant difference in mental effort rating, $t(412)=1.483, p=.139$.

**Table 4.18. One-way Analysis of Variance for Mental Effort Ratings**

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>9.662</td>
<td>2</td>
<td>4.831</td>
<td>1.222</td>
<td>.296</td>
<td>.002</td>
</tr>
<tr>
<td>Within Groups</td>
<td>1628.299</td>
<td>412</td>
<td>3.952</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1637.961</td>
<td>414</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Learner Attitude.* Learner attitude, specifically the individual subscales of confidence and attention, towards the instructional materials were examined in the present study. Attitude was measured based on subjective ratings on a five-point Likert-type scale ranging from 1 (not true) to 5 (very true) on a twenty-one item questionnaire adapted from the Instructional Materials Motivation Survey (Keller, 1993). Hypothesis six predicted that participants receiving a worked example strategy (i.e., process or product-oriented) would report higher attitude scores on attention and confidence than
participants presented with conventional problem solving. The hypothesis was not supported.

To test participant attitude toward the instruction, a one-way MANOVA was performed to analyze the main effects of instructional strategy on overall learner attitude, and the attitude sub-scales of confidence and attention. In addition, a follow-up two-factor MANOVA was conducted to examine the main effect of participant prior knowledge level on attitude as well as any interaction effects of instructional strategy and prior knowledge level. Table 4.19 shows the means and standard deviations of learner attitude, including sub-scales, by instructional condition. The one-way MANOVA indicated no difference in attitude toward the instructional material based on instructional strategy, Wilks’ Lambda=.991, F(4, 395)=.869, p=.482, η²=.004. The one-way univariate ANOVA results, F(2, 395)=.373, p=.689, η²=.002, showed that attitude ratings were similar between instructional strategies.

The sub-scales of confidence and attention were analyzed using univariate test statistics. Mean rating scores (see Table 4.19) revealed that the conventional instructional strategy had higher confidence scores (M=3.52, SD=.67) than either the process strategy (M=3.42, SD=.62) or the product strategy (M=3.40, SD=.67). Attention mean rating scores showed that worked example strategies (process-oriented M=2.67, SD=.53; product-oriented M=2.66, SD=.59) produced slightly higher scores than the conventional problem solving strategy (M=2.65, SD=.60).

Overall, attitude mean scores, the combination of the two sub-scale scores, indicated that the conventional problem solving strategy (M=3.06, SD=.54) produced slightly higher attitude scores than either the process strategy (M=3.03, SD=.50) or the product strategy (M=3.01, SD=.50). In addition, the sub-scale measures results displayed in Table 4.20, confidence, F(2, 395)=1.304, p=.273, and attention, F(2, 395)=.038, p=.962, indicated that none of the instructional strategies utilized in the study produced differences, as predicted by the hypothesis. Thus, the analyses of attitude scores indicated that the hypothesis that worked example participants would have higher attitude scores (i.e., confidence and attention scores) was not supported. In general, attitude scores suggested that participants had a positive view of the instructional materials. Attention scores were slightly lower than confidence scores possibly indicating that either the
material lacked enough variation in the presentation of the content to stimulate learner inquiry arousal or participants’ prior knowledge level influenced their level of interest or attentiveness to the activity. Consequently, the interaction effect of instructional strategy and prior knowledge was examined further.

Table 4.19. Descriptive Statistics for Learner Attitude by Instructional Strategy

<table>
<thead>
<tr>
<th>Instructional Strategy</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>3.03</td>
<td>.50</td>
<td>136</td>
</tr>
<tr>
<td>Product</td>
<td>3.01</td>
<td>.50</td>
<td>143</td>
</tr>
<tr>
<td>Conventional</td>
<td>3.06</td>
<td>.54</td>
<td>119</td>
</tr>
<tr>
<td>Total</td>
<td>3.03</td>
<td>.51</td>
<td>398</td>
</tr>
<tr>
<td>Confidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>3.42</td>
<td>.62</td>
<td>136</td>
</tr>
<tr>
<td>Product</td>
<td>3.40</td>
<td>.67</td>
<td>143</td>
</tr>
<tr>
<td>Conventional</td>
<td>3.52</td>
<td>.67</td>
<td>119</td>
</tr>
<tr>
<td>Total</td>
<td>3.44</td>
<td>.65</td>
<td>398</td>
</tr>
<tr>
<td>Attention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>2.67</td>
<td>.53</td>
<td>136</td>
</tr>
<tr>
<td>Product</td>
<td>2.66</td>
<td>.59</td>
<td>143</td>
</tr>
<tr>
<td>Conventional</td>
<td>2.65</td>
<td>.60</td>
<td>119</td>
</tr>
<tr>
<td>Total</td>
<td>2.66</td>
<td>.58</td>
<td>398</td>
</tr>
</tbody>
</table>

Note. The total number of items for the learner attitude was 21 and represented the aggregate of subscale scores. The confidence subscale comprised 10 items; the attention subscale comprised 11 items. Participants rated their attitude toward the instruction on a five-point Likert-type scale ranging from 1 (not true) to 5 (very true).

Table 4.20. Univariate Analysis of Variance for Instructional Strategy on Attitude

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent Variable</th>
<th>Type III</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Sum of Squares</td>
<td>df</td>
<td>Mean Square</td>
<td>F</td>
<td>Sig.</td>
<td></td>
</tr>
<tr>
<td>Instructional</td>
<td>Confidence</td>
<td>110.971</td>
<td>2</td>
<td>55.485</td>
<td>1.304</td>
<td>.273</td>
<td></td>
</tr>
<tr>
<td>Strategy</td>
<td>Attention</td>
<td>3.088</td>
<td>2</td>
<td>1.544</td>
<td>.038</td>
<td>.962</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attitude</td>
<td>86.113</td>
<td>2</td>
<td>43.057</td>
<td>.373</td>
<td>.689</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>Confidence</td>
<td>16811.213</td>
<td>395</td>
<td>42.560</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attention</td>
<td>15881.517</td>
<td>395</td>
<td>40.206</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attitude</td>
<td>45562.721</td>
<td>395</td>
<td>115.349</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
An analysis of the main effect of prior knowledge level on learner attitude was also examined. Tables 4.22, 4.23, and 4.24 show the means and standard deviations of the confidence and attention sub-scale scores, and the learner attitude scores by instructional strategy condition and prior knowledge level. The two-way MANOVA reveal that prior knowledge had a significant effect on attitude scores, Wilks’ Lambda=.936, F(2, 306)=10.441, p<.000, η²=.064. Examination of the interaction effect between instructional strategy and prior knowledge level failed to show significant findings, Wilks’ Lambda=.993, F(2, 612)=.574, p=.682, η²=.004.

However, a univariate analysis (see Table 4.21) indicated that prior knowledge did influence participant perceptions of the instruction in terms of their general attitude and confidence rating scores. Prior knowledge levels failed to show a significant effect on participant attention rating scores. Not surprisingly, the results seem to support that prior knowledge level did affect participants’ self reported levels of confidence as well as their overall attitude toward the instructional material.

In conclusion, the primary analysis of data was conducted to examine the effect of process-oriented and product-oriented worked example strategies on (1) learning and transfer performance, (2) mental effort, and (3) learner attitude. In addition, the study explored how the effectiveness of a particular instructional strategy was mediated by the prior knowledge level of participants. Table 4.28 provides a summary of the result findings. The next chapter will discuss the findings in context of extant research and provide an interpretation of the study’s results.
Table 4.21. Univariate Analysis for Instructional Strategy and Prior Knowledge Level on Learner Attitude

<table>
<thead>
<tr>
<th>Source</th>
<th>Dependent Variable</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Strategy</td>
<td>Attitude</td>
<td>9.207</td>
<td>2</td>
<td>4.603</td>
<td>.042</td>
<td>.959</td>
</tr>
<tr>
<td></td>
<td>Confidence</td>
<td>43.273</td>
<td>2</td>
<td>21.637</td>
<td>.554</td>
<td>.575</td>
</tr>
<tr>
<td></td>
<td>Attention</td>
<td>14.447</td>
<td>2</td>
<td>7.224</td>
<td>.180</td>
<td>.836</td>
</tr>
<tr>
<td>Prior Knowledge Level</td>
<td>Attitude</td>
<td>1088.749</td>
<td>1</td>
<td>1088.749</td>
<td>9.899</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Confidence</td>
<td>778.075</td>
<td>1</td>
<td>778.075</td>
<td>19.932</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Attention</td>
<td>26.032</td>
<td>1</td>
<td>26.032</td>
<td>.648</td>
<td>.421</td>
</tr>
<tr>
<td>Instructional Strategy X</td>
<td>Attitude</td>
<td>151.311</td>
<td>2</td>
<td>75.656</td>
<td>.688</td>
<td>.503</td>
</tr>
<tr>
<td>Prior Knowledge</td>
<td>Confidence</td>
<td>69.613</td>
<td>2</td>
<td>34.806</td>
<td>.892</td>
<td>.411</td>
</tr>
<tr>
<td></td>
<td>Attention</td>
<td>28.073</td>
<td>2</td>
<td>14.037</td>
<td>.349</td>
<td>.705</td>
</tr>
<tr>
<td>Error</td>
<td>Attitude</td>
<td>33764.671</td>
<td>307</td>
<td>109.983</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Confidence</td>
<td>11984.416</td>
<td>307</td>
<td>39.037</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attention</td>
<td>12333.127</td>
<td>307</td>
<td>40.173</td>
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<td></td>
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</tbody>
</table>

Table 4.22. Descriptive Statistics for Confidence by Instructional Strategy and Prior Knowledge Level

<table>
<thead>
<tr>
<th>Measure</th>
<th>Instructional Strategy</th>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidence</td>
<td>Process</td>
<td>Low</td>
<td>3.27</td>
<td>.64</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>3.48</td>
<td>.58</td>
<td>57</td>
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<tr>
<td></td>
<td></td>
<td>Total</td>
<td>3.37</td>
<td>.62</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>3.17</td>
<td>.71</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>3.61</td>
<td>.55</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>3.46</td>
<td>.64</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>3.30</td>
<td>.72</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>3.62</td>
<td>.58</td>
<td>44</td>
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<td></td>
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<td>3.45</td>
<td>.67</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>3.25</td>
<td>.69</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>3.57</td>
<td>.57</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>3.42</td>
<td>.64</td>
<td>313</td>
</tr>
</tbody>
</table>

*Note.* The confidence subscale was comprised of 10 items. Participants rated their level of confidence of understanding the content after receiving the instruction on a five-point Likert-type scale ranging from 1 (not true) to 5 (very true).
Table 4.23. Descriptive Statistics for Attention by Instructional Strategy and Prior Knowledge Level

<table>
<thead>
<tr>
<th>Measure</th>
<th>Instructional Strategy</th>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attention</td>
<td>Process</td>
<td>Low</td>
<td>2.63</td>
<td>.54</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>2.67</td>
<td>.54</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>2.65</td>
<td>.54</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>Low</td>
<td>2.57</td>
<td>.60</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>2.69</td>
<td>.62</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>2.65</td>
<td>.62</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>Low</td>
<td>2.60</td>
<td>.71</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>2.60</td>
<td>.37</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>2.60</td>
<td>.57</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Low</td>
<td>2.60</td>
<td>.54</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>2.66</td>
<td>.54</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>2.64</td>
<td>.57</td>
<td>313</td>
</tr>
</tbody>
</table>

*Note.* The attention subscale was comprised of 11 items. Participants rated the instructional materials effectiveness in gaining and maintaining their attention during the activity on a five-point Likert-type scale ranging from 1 (not true) to 5 (very true).

Table 4.24. Descriptive Statistics for Learner Attitude by Instructional Strategy and Prior Knowledge Level

<table>
<thead>
<tr>
<th>Measure</th>
<th>Instructional Strategy</th>
<th>Prior Knowledge</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learner Attitude</td>
<td>Process</td>
<td>Low</td>
<td>2.93</td>
<td>.50</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
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<td>Total</td>
<td>2.99</td>
<td>.49</td>
<td>114</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>Low</td>
<td>2.85</td>
<td>.52</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>3.13</td>
<td>.46</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>3.04</td>
<td>.50</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>Low</td>
<td>2.94</td>
<td>.63</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>3.08</td>
<td>.39</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>3.01</td>
<td>.53</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Low</td>
<td>2.91</td>
<td>.55</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>3.09</td>
<td>.45</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>3.01</td>
<td>.51</td>
<td>313</td>
</tr>
</tbody>
</table>

*Note.* Twenty-one items adapted from Keller’s IMMS (1993) were used to measure learner attitude. The overall attitude score represents the aggregate scores of both sub-scales.
Secondary Analysis

Prior to testing the hypotheses, several other analyses were planned to examine the data for evidence that would further illuminate the findings and were conducted after testing the hypotheses. First, the effect of learner attitude on the amount of mental effort participants reported exerting during the instructional activity was examined with a one-way ANOVA. Second, the effect of each of the attitude sub-scales, confidence and attention, on mental effort ratings were examined using separate one-way ANOVAs. Finally, an analysis of the effect of instructional strategy on participant instructional efficiency was conducted using a two-way ANOVA to examine strategy and prior knowledge level.

Effect of Learner Attitude on Mental Effort. During the completion of the instructional activity, participants self-reported ratings on (1) their attitude toward the instruction, and (2) the amount of mental effort they exerted during the instructional activity. The analysis results revealed a significant main effect of overall attitude on mental effort ratings, F(52, 345)=1.756, p=.002, $\omega^2=.002$. The results indicated a correlation between a participant’s attitude toward the instructional material and the amount of effort they invest on the learning activity. Further analysis examined whether the effect of a learner’s attitude on mental effort was influenced by the particular instructional strategy condition a participant was assigned. Interestingly, only product-oriented strategy showed significant a significant main effect, F(44, 98)=1.665, p=.019, $\omega^2=.005$. Both the process-oriented strategy, F(41, 94)=1.042, p=.425, $\omega^2=.0004$ and the conventional strategy, F(44, 74)=1.361, p=.120, $\omega^2=.003$ showed no significant main effect on a participant’s attitude affecting their mental effort investment. However, results indicated that high prior knowledge participants, F(42, 128)=1.497, p=.045, $\omega^2=.003$, with a more positive attitude toward the instruction were more likely to invest more mental effort during the instruction than did those with low prior knowledge participants, F(45, 96)=1.046, p=.418, $\omega^2=.0003$.

Both sub-scales of learner attitude, confidence and attention, were analyzed separately using a one-way ANOVA to determine if differences existed between the subscale relationships with a participant’s investment of mental effort during the instructional activity. The analysis of confidence scores revealed a significant main effect
suggesting that a participant’s confidence was related the amount of mental effort invested by a participant during the instructional task, F(30, 367)=3.320, p<.000, \( \omega^2 = .006 \). Additionally, comparing confidence scores across instructional strategies showed significant differences with the product-oriented strategy group, F(28, 114)=2.566, p<.000, \( \omega^2 = .01 \), and the conventional strategy group, F(27, 91)=2.337, p=.001, \( \omega^2 = .01 \), but not for the process-oriented strategy group, F(24, 111)=1.266, p=.205, \( \omega^2 = .002 \). Furthermore, participant prior knowledge level was shown to be a significant factor in determining a participants attitude and the amount of mental effort invested during the instructional activity, regardless of their knowledge category, low prior knowledge, F(29, 114)=1.920, p=.008, \( \omega^2 = .01 \), and high prior knowledge, F(25, 145)=2.043, p=.005, \( \omega^2 = .01 \). Despite the findings, it must be acknowledged that both attitude and mental effort can be influenced by various environmental or situational factors and learner characteristics, such as prior knowledge level. The results suggest only that a correlational relationship was found between attitude and mental effort with participants examined in this study. Analysis of the attention subscale revealed no significant findings.

**Instructional Efficiency.** Cognitive load theory is fundamentally about learning efficiency (Clark et al., 2006). However, in order to determine efficiency researchers needed to develop a way to measure it. Accordingly, Paas and van Merrienboer (1993, 1994) devised a formula that combined performance measures with the mental effort ratings to examine the efficiency of instructional conditions (Pollock et al., 2002). To determine instructional efficiency, learner performance and mental effort ratings must be captured, then converted to standardized z-scores. The objective test scores of a particular learning task are used to measure learner performance. However, mental effort ratings necessitate learners to convert the mental effort requirements of a task to a numerical value. Once this is accomplished the mental effort values are converted to standardized z-scores. The standardized z-scores are then combined in the following formula:

\[
\text{Instructional Efficiency} = \frac{(\text{Performance} - \text{Mental Effort})}{\sqrt{2}}
\]
To interpret efficiency appropriately depends on understanding the relationship between performance and mental effort. For example, if performance and mental effort are equal (P=ME) then efficiency would be zero. However, if performance z-scores are higher than mental effort z-scores (P>ME), then efficiency will be higher suggesting higher performance scores with lower mental effort invested. Similarly, if mental effort z-scores are higher than performance z-scores (P<ME), then efficiency will be lower.

In the present study, instructional efficiency was visually represented by an efficiency graph. To create the graph, mean z-scores for achievement and mental effort were plotted on a Cartesian graph. The horizontal axis of the graph represents the range of mental effort scores and the vertical axis represents the range of achievement test scores. In addition, a theoretical reference line is included that indicates the performance and mental effort equal zero. An instructional strategy with a reference point that demonstrates high achievement scores and simultaneously low mental effort will fall into the upper left quadrant indicating high efficiency. A strategy with a reference point showing low achievement scores and high mental effort will fall in the lower right quadrant indicating low efficiency.

This study compared the instructional efficiency of each instructional strategy through statistical testing and plotting standardized performance and mental effort z-scores efficiency graph. Table 4.25 shows the mean instructional efficiency scores and standard deviation for achievement test scores. A one-way analysis of variance showed no significant difference in mean learning efficiency scores between instructional strategies, F(2,407)=.261, p=.771, ō²=.002. Detailed examination of means efficiency scores shows that the process-oriented instructional strategy had slightly higher overall efficiency score. Further analysis was conducted by plotting the z-scores for achievement and mental effort (see Figure 4.1).

The learning efficiency graph showed the results of mean z-score plots based on instructional strategy. Participants in the process-oriented strategy group showed lower achievement test scores and mental effort ratings. Product-oriented strategy participants showed the opposite results with higher achievement test scores but higher levels of mental effort. The conventional problem-solving strategy fell in the low efficiency quadrant showing both low performance scores and higher levels of mental effort.
Table 4.25. Descriptive Statistics for Instructional Efficiency by Instructional Strategy

<table>
<thead>
<tr>
<th>Instructional Strategy</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process</td>
<td>142</td>
<td>.0346</td>
<td>.97607</td>
<td>.08191</td>
</tr>
<tr>
<td>Product</td>
<td>143</td>
<td>.0259</td>
<td>.97688</td>
<td>.08169</td>
</tr>
<tr>
<td>Conventional</td>
<td>123</td>
<td>-.0496</td>
<td>1.14124</td>
<td>.10290</td>
</tr>
<tr>
<td>Total</td>
<td>408</td>
<td>.0062</td>
<td>1.02702</td>
<td>.05085</td>
</tr>
</tbody>
</table>

Additionally, a two-way ANOVA was used to analyze the interaction effect of instructional strategy and prior knowledge on instructional efficiency. Table 4.26 shows the mean z-scores for achievement and mental effort and Table 4.27 shows the learning efficiency scores and standard deviation segregated by instructional strategy and prior knowledge level. No significant interaction effect was found between instructional strategy and prior knowledge level, $F(2, 316)=.213$, $p=.808$, $\omega^2=.003$. However, the main effect of prior knowledge was shown to influence instructional efficiency, $F(1, 316)=18.339$, $p<.000$, $\omega^2=.03$. As expected, participants with higher levels of prior knowledge tended to operate more efficiently than those of lower prior knowledge.
Figure 4.1. Efficiency Graph of Mean Achievement Z-Scores for Learning by Instructional Strategy
Table 4.26. Descriptive Statistics for Achievement and Mental Effort Z-scores by Instructional Strategy

<table>
<thead>
<tr>
<th>Instructional Strategy</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement Z-scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>142</td>
<td>-.06</td>
<td>.93</td>
<td>.08</td>
</tr>
<tr>
<td>Product</td>
<td>143</td>
<td>.09</td>
<td>.10</td>
<td>.08</td>
</tr>
<tr>
<td>Conventional</td>
<td>123</td>
<td>-.03</td>
<td>1.10</td>
<td>.10</td>
</tr>
<tr>
<td>Total</td>
<td>408</td>
<td>.00</td>
<td>1.00</td>
<td>.05</td>
</tr>
<tr>
<td>Mental Effort Z-scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td>143</td>
<td>-.10</td>
<td>.98</td>
<td>.08</td>
</tr>
<tr>
<td>Product</td>
<td>146</td>
<td>.07</td>
<td>.97</td>
<td>.08</td>
</tr>
<tr>
<td>Conventional</td>
<td>126</td>
<td>.04</td>
<td>1.10</td>
<td>.09</td>
</tr>
<tr>
<td>Total</td>
<td>415</td>
<td>.00</td>
<td>1.00</td>
<td>.05</td>
</tr>
</tbody>
</table>

Table 4.27. Descriptive Statistics for Learning Efficiency Z-scores by Instructional Strategy and Prior Knowledge Level

<table>
<thead>
<tr>
<th>Prior Knowledge Category Scores</th>
<th>Instructional Strategy</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Process</td>
<td>-.17</td>
<td>.99</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>-.28</td>
<td>.78</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>-.31</td>
<td>1.10</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>-.25</td>
<td>.96</td>
<td>144</td>
</tr>
<tr>
<td>High</td>
<td>Process</td>
<td>.24</td>
<td>.88</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.22</td>
<td>1.04</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>.28</td>
<td>1.30</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>.24</td>
<td>1.10</td>
<td>178</td>
</tr>
<tr>
<td>Total</td>
<td>Process</td>
<td>.04</td>
<td>.96</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>Product</td>
<td>.05</td>
<td>.98</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Conventional</td>
<td>-.03</td>
<td>1.21</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>.03</td>
<td>1.05</td>
<td>322</td>
</tr>
</tbody>
</table>
Table 4.28. Summary of Results

<table>
<thead>
<tr>
<th>Dependent Measure</th>
<th>Hypotheses</th>
<th>Data Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td><strong>Hypothesis 1:</strong> Participants who are presented with a worked example strategy (i.e., process-oriented or product-oriented) will perform better on an achievement test than participants presented with a conventional problem solving strategy.</td>
<td>Hypothesis was not supported; Null hypothesis of no significant difference is retained.</td>
</tr>
<tr>
<td></td>
<td><strong>Hypothesis 2:</strong> Low prior knowledge participants presented a process-oriented worked example will perform better on an achievement test than low prior knowledge participants presented either a product-oriented worked example or a conventional problem solving strategy. In contrast, high prior knowledge participants presented with process-oriented worked examples will demonstrate no significant difference in achievement test scores than high prior knowledge participants presented with product-oriented worked examples or a conventional instructional strategy.</td>
<td>Hypothesis was not supported. High prior knowledge participants showed no difference on achievement scores across instructional strategy conditions. Contrary to prediction, low prior knowledge participants demonstrated no difference on achievement scores across instructional strategy conditions.</td>
</tr>
<tr>
<td>Transfer</td>
<td><strong>Hypothesis 3:</strong> Low prior knowledge participants presented a process-oriented worked example will perform better on a transfer test performance than low prior knowledge participants presented with either a product-oriented worked example or a conventional problem-solving strategy. In contrast, high prior knowledge participants presented with the process-oriented worked example will demonstrate no significant difference on transfer test performance than high prior knowledge participants presented with either product-oriented worked examples or the conventional problem-solving strategy on a transfer test.</td>
<td>Hypothesis was not supported. High prior knowledge participants showed no differences on transfer test scores across instructional strategy conditions. Contrary to prediction, low prior knowledge participants demonstrated no difference on transfer test scores across instructional strategy conditions.</td>
</tr>
</tbody>
</table>
## Table 4.28. Summary of Results (Continued)

<table>
<thead>
<tr>
<th>Dependent Measure</th>
<th>Hypotheses</th>
<th>Data Analysis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Effort</td>
<td><strong>Hypothesis 4.</strong> Participants presented a worked example strategy (i.e., process or product-oriented) will report lower mental effort ratings than participants presented a conventional problem-solving strategy.</td>
<td>Hypothesis was not supported; Null hypothesis of no significant difference is retained.</td>
</tr>
<tr>
<td></td>
<td><strong>Hypothesis 5.</strong> Participants presented a process-oriented worked example strategy will report higher mental effort ratings than participants presented a product-oriented worked example strategy.</td>
<td>Hypothesis was not supported; Null hypothesis of no significant difference is retained.</td>
</tr>
<tr>
<td>Learner Attitude</td>
<td><strong>Hypothesis 6.</strong> Participants receiving a worked example strategy (i.e., process or product-oriented) will report higher attitude scores on attention and confidence than participants presented with conventional problem solving.</td>
<td>Hypothesis was not supported; Null hypothesis of no significant difference is retained.</td>
</tr>
</tbody>
</table>
CHAPTER 5

DISCUSSION

This chapter (a) summarizes the study’s key findings in context of extant research, and (b) presents an interpretation of the results and examines possible reasons for the findings. The results of the study are discussed in a sequential manner based on the order of the hypotheses presented in chapter four. In addition to the primary findings, other notable analysis results are discussed (e.g., instructional efficiency). The limitations of the study, implications for instructional design practice, and recommendations for future research are presented in the concluding sections of the chapter.

Summary of Findings in Context

The effect of process-oriented and product-oriented worked examples strategies reported in the literature was not observed in the present study. More specifically, the study showed that the instructional strategy had a minimal affect on participant performance, mental effort, and attitude toward the instruction. Overall, worked example participants (M=7.89, SD=1.80) scored higher than conventional problem solving participants (M=7.80, SD=2.04). Furthermore, for both learning and transfer performance, a review of the mean scores showed slightly higher scores for the product-oriented worked example strategy group compared to the process-oriented strategy group. For mental effort, most participants self-reported a mental effort rating of “rather low” to “average”. These findings suggest that participants, regardless of the instructional strategy, invested a low amount of mental effort during the instructional tasks. This may be due to either a personal choice not to expend effort or because participants prior knowledge level reduced the complexity of the task, thereby reducing the cognitive load imposed on the learner. The prior knowledge principle offers a possible explanation for these findings.

The prior knowledge principle is concerned with the integration of instructional information held in working memory and information held in long-term memory (Kalyuga, 2005). High prior knowledge learners have previously acquired information that can be retrieved from existing domain-specific schemas to solve a problem. Novices
lack the relevant domain knowledge and therefore benefit from direct instructional support. Conversely, advanced learners benefited less from additional instructional support because the additional information presented in worked examples is redundant information that interferes with efficient processing. As a result, designers and instructors need to recognize that as the level of learner knowledge changes the relative effectiveness of a particular instructional strategy may reverse, a principle known as the expert-reversal effect (Kalyuga et. al., 2003).

In addition to learning and transfer performance, the study investigated whether or not learner attitude was affected by differences in instructional strategy. Learner attitude was examined relative to overall attitude and two-subscapes, confidence and attention. Results indicated that most participants had a relatively positive attitude toward the instruction. More specifically, mean scores showed that participant attitude and confidence scores in both the conventional problem solving and product-oriented worked example conditions were slightly more positive than those in the process-oriented group. Factors such as the novelty of the instructional strategies used for in this study and the level of learner prior knowledge may have affected learner attitude toward the instruction. The next section of the chapter will discuss in more detail possible explanations for the findings of the present study.

**Interpretation of Results**

The present study examined the effects of worked example strategies (i.e., process-oriented and product-oriented) on learning and transfer of problem solving skills and learner attitude of undergraduate students in the complex domain of microeconomics. In addition, the study examined the mediating effects of participant levels of prior knowledge on learning, transfer, mental effort, and attitude. This section discusses the interpretation of the findings and offers possible explanations for each dependent outcome measure.

**Effect of Instructional Strategy on Learning Performance**

The first hypothesis predicted that participants presented with a worked example strategy (i.e., process-oriented or product-oriented) would score higher on the achievement test than those completing a conventional strategy. The findings of the study did not support the stated hypothesis.
A possible explanation may be due to the lack of congruence between the cognitive tasks participants were required to complete during the instructional activity and the tasks they were required to complete during the performance assessment. The performance assessment comprised fifteen items, eleven of which measured learning (i.e., achievement questions) and four items measured transfer of learning to novel problems. Both the assessment format and the items used were selected by the course instructor. The assessment items were presented in a multiple-choice format whereas the instructional activity required the participants to work out a solution to either a series of practice problems or a series of worked example-practice problem pairs using only the information presented in a problem scenario. As a result, the performance assessment examined the participants’ conceptual understanding of the topic rather than their ability to apply the principles and procedures learned during the instruction to a realistic economic problem. In other words, the assessment questions did not require learners to fully activate knowledge acquired during the learning process to generate the solution to a complex problem.

Another possible explanation is the amount of learner practice provided in the study. Cognitive Load researchers have argued that worked examples alone are not a sufficient instructional strategy for learning complex skills (Darabi, Nelson, & Palanki, 2007). Accordingly, the design of the instructional materials in this study included either three practice problems for the worked example groups or seven practice problems for the conventional problem solving group.

The practice problems used in this study were developed to allow participants to apply the knowledge acquired during the instructional segments (i.e., lecture or lecture and worked examples). For example, both of the worked example strategies were designed with four worked examples and three practice problems with feedback, whereas the conventional problem strategy presented participants with seven practice problems with feedback. Considering eight-six percent of the participants (n=291) had previously completed at least a high school economics course and forty-three percent (n=147) completed a college-level course, it can be argued that participants were not novices and entered the course with at least a partially developed basic schema (Pollock et al., 2002).
As a result, simply having the opportunity to practice an authentic problem task may have been sufficient to promote learning with these participants.

A related explanation deals with the effectiveness of the practice feedback. As previously stated, all three instructional strategy conditions provided practice problems with feedback to participants. In each case, the solution feedback was provided on the page subsequent to the problem. Recently, in a study of principled-based and procedure-based instructional conditions, Mahan (2007) argued that the availability of feedback limited the learner’s use of an inefficient search process (i.e., means-end analysis). The study concluded that the feedback acted as an instructional prompt to encourage the generation of self-explanations, which is a form of mental dialog learners have when studying a worked example (Clark et al., 2006) that have been linked to improved learning. Similarly, several studies that evaluated the effectiveness of different combinations of instructional text and diagrams on learning found that if the text alone is self-explanatory then it may be more beneficial to drop diagrams or other visual and text combinations for experienced learners (Mayer & Gallini, 1990; Kalyuga et al., 1998, 2000). Based on these assertions, the detailed feedback received by participants in the conventional problem solving strategy group may have acted as a sufficient prompt to encourage self-explanation behavior. Therefore, the practice feedback may have had a greater influence on learning than the type of instructional strategy. Consequently, if the feedback provided to conventional problem solving participants enhanced their self-explanation behavior similar to those in a worked example strategy, then the practice feedback may have limited the potential benefit of the worked example strategies with these participants.

**The Expertise Reversal Effect on Learning and Transfer Performance**

A critical design factor in determining what information is relevant and how information should be presented is a learner’s level of prior knowledge and experience. Surprisingly, many design recommendations “proceed without an explicit reference to learner knowledge levels” (Kalyuga, Ayres, Chandler, & Sweller, 2003, p.23). The design principle of prior knowledge, in the context of Cognitive Load Theory, offers an explanation of the underlying cognitive mechanisms that impact the effectiveness of a particular instructional strategy. Specifically, the principle of prior knowledge states that
the level of learner prior knowledge influences how information is processed, organized, and retrieved during the learning process (Kalyuga, 2005). For example, novices lack the domain-specific schemas necessary to handle the multiple elements associated with a complex task or problem. As a result, the learner’s cognitive capacity may become overloaded. For this reason, instructional guidance in the form of worked examples is an instructional method designed to improve learning by freeing cognitive capacity that can be allocated to attend to the principles and procedures necessary to solve a problem.

Conversely, advanced learners possess more well-developed schemas that allow them to assimilate new information as well as access stored information more efficiently. Consequently, they require less external support (e.g., instructional guidance) to solve a complex problem. Kalyuga et al. (2003) argued that when advance learners are confronted with instruction that may be redundant to their existing schema, they may disregard the external support. Furthermore, researchers suggested that as the knowledge level of the learner increases during the learning process they require less support. As a result, the relative usefulness of the instructional material declines or reverses, an effect known as the *expertise-reversal effect* (Kalyuga et al., 2003).

In chapter four, participants previous economic course demographic data and scores on the prior knowledge assessment (M=12, SD= 1.98) established that a majority of students in this study possessed at least a basic understanding of economic principles. Consequently, it is argued that few of the participants in the study were novice learners and, therefore, did not require the additional supportive information provided by worked examples. This is a critical factor since earlier research has established that a worked example strategy is superior for novice learners but that a worked examples advantage over conventional problem solving quickly erodes as a learners knowledge increases (Kalyuga, Chandler, Tuovinen, & Sweller, 2001; Kalyuga, Chandler, & Sweller, 2001).

In the present study, hypotheses two and three predicted that participants with lower prior knowledge in the process-oriented strategy would perform better on both the achievement test and the transfer test than those in either the product-oriented or the conventional problem solving strategy. The findings did not support the expected outcome. In addition, the prediction that high prior knowledge participants in the process-oriented strategy would show no significant difference on achievement test and transfer
test performance was inconclusive. However, examination of achievement and transfer test mean scores of high prior knowledge participants did show higher scores from the conventional problem solving group when compared to participants in both worked example strategy groups. More specifically, the use of process-oriented or product-oriented worked example strategies had a negligible affect on learning and transfer outcomes, in part, because many of the participants appeared to have developed schema relevant to the domain that allowed them to manage the learning process without requiring additional instructional support. The author contends that because of their higher level of knowledge participants may have chosen to eliminate the redundant information by focusing only on either the visual diagram or textual practice feedback (Kalyuga, Chandler, & Sweller, 1998), thus skipping the additional information provided by the worked examples, relying instead on their existing schema to solve the problem. Hence, no differences were obtained between instructional strategies on learning and transfer.

**Effect of Instructional Strategy on Mental Effort**

*Extraneous Load.* Previous research on worked examples has demonstrated their effectiveness in improving learning outcomes while limiting the amount of mental effort invested in solving a problem (Paas, 1992; Paas & van Merrienboer, 1994). Accordingly, hypothesis four predicted that participants in a worked example strategy would report lower mental effort ratings than those in a conventional problem solving strategy. Analysis results revealed that participants across all three instructional conditions reported exerting “rather low mental effort” (equivalent to an approximate rating of four on a nine-point scale). Specifically, mean mental effort rating scores ranged from a low of 3.78 (process-oriented) to a high of 4.13 (product-oriented). Two possibilities may offer an explanation for the generally low mental effort reported by participants. First, the instructional materials were designed to minimize extraneous load by managing (1) split-attention effect, (2) modality effect, and (3) redundancy effect (refer to Chapter Two for an overview). By limiting the amount of extraneous load imposed on a participant, more of their cognitive capacity could be used to construct a schema of how to solve a problem (Clark et al., 2006). Perhaps, as a result of the effective design of the materials, the mental load place on the participants was minimized.
A second possible explanation relates to participant prior knowledge. As previously discussed, many of the participants had prior economic course work and scored relatively high on the prior knowledge assessment (M=12, SD=1.98). Thus, prior knowledge may have mediated the complexity of the instructional activity, thereby reducing the participants’ intrinsic load. In other words, the participants’ level of prior knowledge allowed them to operate more efficiently by activating relevant domain-specific information to the problem as well as focus their attention on the key visual and textual information necessary to solve the problem with minimal instructional support.

_Germane Load._ More recently, Cognitive Load researchers have focused their attention toward strategies that increase germane or effective load on learners by the use of process-oriented worked examples. Process-oriented worked examples provide learners with the steps, the “how”, necessary to solve a problem as traditional worked examples do. In addition, process-oriented examples also provide the underlying principles and heuristics or the “why” behind the problem solution. Previous research has shown that the processing of the additional information can increase mental load (van Gog et al., 2006). Consequently, hypothesis five predicted that participants in the process-oriented worked example strategy would report higher mental effort ratings than those in the product-oriented worked example strategy. Contrary to expectations, the hypothesis was not supported.

A possible explanation may be that participants have already developed the necessary schemas to solve the problems presented during the learning tasks. In other words, participants experienced a lower intrinsic cognitive load (Sweller, 2006); therefore, any additional information presented to a participant by the process-oriented strategy had a minimal or neutral additive effect on overall cognitive load. As a result, no differences were found between the process-oriented and product-oriented worked example strategies.

**Effect of Instructional Strategy on Learner Attitude**

Cognitive Load research has traditionally examined the cognitive processes and structures that comprise the human architecture as the essential factors in the design of effective and efficient learning and training programs. However, an increasing number of studies are beginning to explore the importance of improving a learner’s attitude (i.e.,
motivation) toward the instruction as a desirable outcome goal. In fact, Paas, Tuovinen, van Merrienboer, and Darabi (2005) argued that “meaningful learning” (pp.26) can occur only if learners are motivated to do well. As such, creating materials that positively influence learner attitude toward the learning process should be an essential aspect of instructional design.

In the present study, worked example strategies (i.e., process-oriented and product-oriented) were predicted to promote more positive attitudes toward the instruction than those in the conventional problem solving strategy group. The results indicated that all participants had a generally positive overall attitude toward the instruction. As a result, no differences were found between instructional strategy groups. Findings for attitude sub-scales, based on a five-point Likert-type scale, showed that ratings of confidence were the most positive with the product-oriented worked example group exhibiting the highest mean rating score (M=3.84), followed by the conventional problem solving group (M=3.83), and the process-oriented group (M=3.75). Conversely, attention ratings were comparatively low to the confidence sub-scale and overall learner attitude (process-oriented: M=2.65; product-oriented: M=2.65; conventional: M=2.60).

The fact that strategies comprising minimal instructional support had higher confidence scores and all participants reported low attention scores may indicate the presence of an important relationship between a learner’s level of prior knowledge and confidence toward the instruction. Accordingly, Cognitive Load Theory suggests that as learners become more knowledgeable during the learning process the instructional strategy must change to accommodate the change in knowledge. As a learner’s expertise increases the influence of a particular instructional strategy on the components that make up their attitude toward instruction also change. For example, Alexander, Jetton, and Kulikowich (1995) proposed a motivational stage model that describes the link between knowledge and interest, a component factor of attitude. The model suggests that as a learner’s level of expertise increased from novice to expert their interest shifted from situational interest (extrinsic factors) to individual interest (intrinsic factors).

The motivation literature defines situational interest as interest elicited by various aspects of a situation. Individual interest refers to individual preferences for different topics, tasks, or contexts and how they influence learning. In the context of this study,
situational interest would likely be elicited by the instructional material design. As such, for novice learners worked examples may draw a learner’s interest (i.e., attention) more effectively. However, as the learner gains expertise their individual interest (i.e., intrinsic motivation) may supplant the need for external motivational forces. Consequently, the prior knowledge level of participants in the present study may have contributed to the relatively low attention scores. This is because their individual interest level in the domain area did not require additional stimulation by the material to gain or maintain their attention during the instruction.

The influence of prior knowledge may also offer a plausible explanation for the lack of difference in confidence rating scores between instructional strategies. As previously discussed, novices and high-knowledge learners learn differently based on how they process information, a principle called the “individual difference principle” (Mayer, 2001). Because learners with more prior knowledge can learn more efficiently, instruction that presents additional information creates redundancy that may compete with existing schemas imposing greater extraneous cognitive load (Kalyuga et al., 2003). As a result, high prior knowledge learners may find that the additional process information presented in a process-oriented worked example interferes with the learning activity. In a recent commentary, Sweller (2006) offered that the researchers reconsider when it is appropriate to provided additional information while studying worked examples. Therefore, in this study, the use of an instructional strategy that limits the amount of information for learners to process, such as product-oriented and conventional problem solving strategies, may have contributed to slightly higher confidence and overall attitude scores among these participants.

Incidental Findings

Effect of Learner Attitude on Mental Effort

As part of an exploratory secondary analysis, the impact of a learner’s attitude on their investment of mental effort was examined. The results showed a correlational relationship between a participant’s attitude toward the instruction and the amount of mental effort they exerted during the instructional activity (i.e., treatment condition). In other words, participants reporting a more positive attitude toward the instruction were
more likely to invest a greater amount of mental effort during the instructional activity. In particular, the product-oriented strategy elicited the most positive attitude scores, as did high prior knowledge participants. Because the product-oriented example provided minimal instructional guidance in a visual form, participants with high prior knowledge found this format easier to integrate information into their existing schemas because it was similar to the example presented during the lecture.

For most participants, a more confident attitude was correlated with an increased investment of mental effort on the instructional activity. This is not surprising considering the ability of a participant to effectively assimilate information into existing schema may have increased their self-efficacy (Holladay & Quinones, 2003; Bandura, 1982) toward the content, thereby, positively affecting their confidence toward the instruction. As a result, the participant is willing to invest more effort to work through the instructional activity.

**Effect of Instructional Strategy on Instructional Efficiency**

An additional exploratory analysis was conducted to investigate the influence of instructional strategy on instructional efficiency. Accordingly, the present study examined the instructional efficiency data of participants in the various instructional strategies by comparing and then plotting their achievement test scores and their self-reported ratings of mental effort. Findings revealed that the product-oriented group had higher relative achievement scores while reporting higher mental effort ratings. Conversely, the process-oriented group had lower relative achievement scores and reported lower mental effort ratings. In addition, the effect of prior knowledge on instructional efficiency was examined. Not surprisingly, results showed that participants with higher prior knowledge performed the learning task more efficiently.

In explaining the importance of examining instructional efficiency, Paas et al. (2003) argued that learners tend to balance their cognitive capacity limits by adjusting the level of mental effort exerted on a complex task. This allows them to maintain a constant level of performance. In other words, as the complexity of a task increases the cognitive load, the learner must manage the complexity by investing more mental effort to complete the learning task. For example, to understand the influence an instructional strategy can have on instructional efficiency one must recognize that two learners can
achieve the same level of performance yet one learner invests more or less effort than the other. Consequently, determining the most appropriate strategy that will improve learning efficiency for a particular learner becomes an essential consideration for designers.

The worked example strategies used in the present study failed to demonstrate differences in efficiency outcomes between instructional strategy groups because no differences were found between strategy groups in both achievement scores and mental effort ratings. Differences in efficiency results between groups mediated by the level of participant prior knowledge reaffirmed that high prior knowledge participants operate at higher levels of efficiency due to their more highly developed schemas.

**Limitations of the Study**

In review of the study results, it would be easy to infer that prior knowledge accounted for outcome differences. However, to suggest that participant prior knowledge alone accounts for the learning outcomes reported in the study with no influence by the type of instructional strategy employed would overextend the inferences from these results. Several reasons other than participant prior knowledge that might account for the outcome results deserve discussion. The reasons include: (a) extraneous interference of participant attendance and environmental factors, (b) brevity of the instructional intervention, (c) use of a structured multiple-choice question format to assess problem solving performance, (d) lack of participant pre-training to promote learning and transfer, and (e) the inability to accommodate unmotivated learners.

**Extraneous Interference Factors**

Several factors inherent in classroom-based research bring in abnormalities that may have resulted in extraneous interference in the study’s outcomes. In this study, participants were enrolled in a classroom environment of approximately 500 students. As a result, the researcher had limited control over participant attendance. Because the study was conduct over a period of several weeks, the level of participant attendance fluctuated on a regular basis. Although measures were taken to improved attendance, such as offering additional participation points for students that attended the sessions, purposely scheduling the data collection around university events (e.g., sporting events and university required exams) that may significantly disrupt attendance, participation still varied from session to session. Regardless of the researcher’s attempts to encourage
attendance, the lack of control over this facet of the study remained a limitation throughout the data collection process.

Additionally, during the administration of the instructional conditions some participants arrived late to the session while others either progressed through the activity more quickly or simply chose not to participate. The resulting disruption occurred as a consequence of the ebb and flow of students entering and exiting the classroom. For example, one participant commented to the researcher that she could not “concentrate” due to the noise level. Lastly, some participants did not follow the proper instructions required to complete the instructional activity. For example, some participants failed to provide the appropriate identification necessary to match them to their completed instructional packet. A few other participants failed to complete either the mental effort ratings or the attitude survey. However, none of these factors should have imposed a greater impact on one group more than another. Any factors that may have contributed to errors in the instructional conditions should have been distributed randomly across all groups.

**Brevity of the Instructional Intervention**

Another limitation was the brevity of the instructional intervention. For the purpose of this study, instructional time includes two instructional segments, (1) the course instructor-led lecture, approximately 20 minutes, and (2) the instructional strategy condition (i.e., instructional activity), approximately 50 minutes. The available total instructional time was approximately 70 minutes. However, the actual time required to complete the instructional activity varied by participant. Even though participants were asked to record their start and stop time manually at specific points during the instructional packet, the prior knowledge level of many of the participants may have rendered any increase in instructional time inconsequential. More specifically, the content may not have been at the level of complexity that would have required extended time to assimilate the material into existing schemas or require the development of new schemas.

**Use of a Structured Multiple-Choice Question Format to Assess Problem Solving Performance**

The structure of the performance assessment in comparison to the instructional tasks practiced by participants during the instructional activity (i.e., treatment condition)
was a significant limitation in the present study. The items used in the performance assessment were multiple-choice questions selected from a test bank constructed by the course instructor. The main limitation of the assessment was that the performance assessment did not present participants the problem tasks in a way that required them to explicitly demonstrate the solution steps necessary to arrive at the correct solution. More specifically, the multiple choice format of assessment questions required the participants to recall declarative knowledge of the content rather than demonstrating procedural knowledge by the application of the principles and procedures learned during the instruction on a complex problem. In other words, the assessment questions may not have required the participants to fully activate the knowledge acquired during the learning process. In addition, the preliminary item analysis and the subsequent analysis of the performance assessment scores revealed that participants had little difficulty with successfully answering the questions. As a result, determining the actual effectiveness of a particular instructional strategy on learning and transfer performance was problematic at best.

**Lack of Participant Pre-Training to Promote Learning and Transfer**

Participants in the present study were expected to learn how to apply their knowledge of microeconomic principles of supply and demand and the impact of taxes on market behavior from an introductory lecture and a subsequent in-class instructional activity in which participants were assigned to a particular instructional strategy. Worked examples have been well established as a technique to improved learning performance by reducing extraneous load (Sweller et al., 1998). However, some researchers have argued that learning from worked examples is a suboptimal technique when taking into consideration learner differences in processing example-based material (Renkl & Atkinson, 2003). In fact, in an earlier study, Renkl (1997) found that many learners studying worked examples do not optimize their available cognitive capacity on the appropriate [germane] information through self-explaining. In a follow up study, researchers found that self-explanation behavior was significantly enhanced by providing a short training immediately prior to studying worked examples designed to ensure optimization of cognitive capacity during example study (Renkl, Stark, Gruber, & Mandl, 1998).
Participants in the present study had no benefit of pre-training prior to utilizing any one of the worked example strategies. It could be argued that participants were not aware of how to utilize the materials in a manner that would promote learning. In future studies on process-oriented example strategies, the use of pre-training should be examined as a mediating variable of participant learning. Considering the use of real world problems and examples (e.g., supply and demand curve graphs), the domain of economics provides a viable discipline in which to further explore the use of worked examples as an effective instructional technique.

**Inability of the Design to Accommodate Unmotivated Learners**

The underlying assumption of the design of the materials is that the participants have a desire to learn and perform well. However, some participants may have chose to pay cursory attention to the requirements of the instructional activity, such as reading the directions, completing each section, showing their work, and recording start and stop times. As indicated earlier, some participants worked more expeditiously through the instructional activity. In a post-treatment condition review of completed activity packets some participants’ work products showed minimal effort on the practice problems. For example, one participant wrote the numeric answers to the practice problems without showing the steps or calculations used to arrive at the answer. This would suggest the individual either copied the answer from the feedback page or was able to solve the problem without the benefit of working it out on paper. In either instance, the solution to the problem was derived without devoting study time to the worked example. The inability of the researcher to directly observe each participant during the completion of the activity as well as the lack of consequences for non-compliance, such as a poor grade, may have provided the an opportunity for some participants not to invest their full effort during the activity. Thus, it is important for designers, instructors, and researchers to take motivational attributes and self-regulation factors (Nelson, 2006) into account during the design of instruction.

There are multiple factors that have contributed to the result findings of the present study. It is important to note that the results of the study cannot be generalized beyond the investigated population of undergraduate students with similar individual and class characteristics. By recognizing and adjusting for the limitations described above,
the hypothesized effects might be found with the same learning objectives. Consequently, the limiting factors should be readdressed during the planning process in a follow-up study.

**Implications for Instructional Design Practice**

The purpose of the present study was to examine the effect of process-oriented and product-oriented worked examples as viable instructional strategies for improving problem solving and learner attitude. The results showed no difference in the learning outcomes between the three instructional strategies. The initial impressions of an experimental study that produces non-significant results would be that it has no substantive implications for instructional design practice. However, the findings do provide insight that can inform practitioners of essential elements to consider during the design process.

For each dependent measure as well as learning efficiency, the prior knowledge level of the participant was a significant predictor. Likewise, analysis of the prior knowledge effect within instructional strategies showed that prior knowledge had a significant influence on the learning outcomes examined by the present study. While other factors were likely contributors to the study’s results, the influence of prior knowledge was an essential element that affected performance scores and contributed to differences in attitude toward the instruction.

For practitioners this finding is of particular importance. In certain scenarios, an instructor may be presented with all novice learners. Similarly, they may find themselves in a scenario with more advance participants. In either one of these scenarios, because of the homogenous composition of the class, the instructor can more easily adjust the structure of content and the delivery of information. A more likely situation, however, is that learners will comprise a mixture of novice and more experienced participants. This potentially increases the complexity required in the instructional design. Accordingly, the designer will need to conduct a more detailed learner analysis in order to develop a comprehensive instructional strategy.

Cognitive load research has argued that when developing instruction for novices it is important to include supportive information, such as process-oriented worked examples, that aid the learner in developing relevant schemas while managing cognitive
(i.e., extraneous and germane load) capacity (van Gog et al., 2004). In contrast, advanced learners require less instructional support, often preferring more opportunity to engage in actual problem solving in order to strengthen previously developed schemas. Moreover, when learners are either more experienced, as was the case in the present study, or will increase their competency during the instructions, adjustments need to be made in the amount of instructional support provided in a dynamic way that considers the characteristics and needs of the learners.

Despite the present study findings that worked example strategies had no significant effect on learning or transfer, Clark et al. (2006; p. 295) suggested that if prior knowledge is low, a designer should seek to minimize extraneous load due to the learner’s lack of developed schemas. On the contrary, for high prior knowledge participants, alternative instructional approaches that avoid presenting redundant information (e.g., practice problems or guided discovery as opposed to worked examples) should be used. In instances that the prior knowledge level of the learners is mixed, the instructional strategy should seek to accommodate differences, where possible, through the development adaptive instructional systems that make use of multiple instructional techniques, such as measuring the level of learner knowledge with a pre-work or pre-tests and modularized instructional sessions that can present basic and advanced lessons.

Another implication from this study is the use of a sequenced strategy that fades the use of worked examples in stages toward problem-solving with no external support. At each stage, supportive information is removed in conjunction with an increase in knowledge level obtained by the learner. Recently, van Gog, Paas, & van Merrienboer (2008) proposed that an optimal training sequence for novices would progress from initially studying process-oriented examples, to studying product-oriented examples (with self explanation prompts), to completing problems with an increasing number of blanks, and to finally solving a conventional problem. More research needs to examine the most effective use of process-oriented and product-oriented worked examples in the delivery of an effective sequencing strategy for learners of all knowledge levels.

Recently, researchers have begun to acknowledge the need to expand the conceptualizations of CLT to include the influence of the motivational attributes of a particular strategy in the development of an efficient and effective learning environment.
The findings in this study presented correlational evidence that a participant’s attitude toward the instruction influences the amount of effort they are willing to invest. More specifically, an instructional design that focuses on increasing the learner’s confidence in their ability to perform a learning task may enhance learning and ultimately improve performance outcomes. For practitioners, this means developing instructional materials that help a learner maintain a high level of mental investment during a learning activity. Maintaining a sufficient amount of mental effort is even more critical when learning tasks that are high in complexity.

Another implication for instructional design practice relates to the motivational and cognitive benefits of feedback. The design of feedback can play an essential role in influencing learner attitude. As previously suggested, participants in the present study received detailed feedback in the form of a correct answer for each practice problem presented. As a product of the structure and detail of the feedback as well as their prior knowledge, participants in the present study may have been able to develop the necessary cognitive connections between the content principles to perform sufficiently on the performance assessment without the need of additional instructional support. A secondary effect of studying the feedback may have been an increase in learner confidence toward the material. These factors point to the connection between motivation and effort. Hattie and Timperley (2007) suggested that a learner’s use of “error correction strategies” was dependent on their motivation to diminish the gap between their existing knowledge and the learning goal. If this assumption is correct, then practitioners need to incorporate sufficient time and effort to develop feedback in the context of its motivational and cognitive benefits to the learner.

Lastly, results of the present study showed that prior knowledge had a significant effect on the learning outcomes. Since prior knowledge influences the complexity of the task to be learned as well as the amount of support the learner needs there are practical benefits for developing adaptive instructional systems. These systems have shown to be more effective and efficient than fixed sequenced instructional systems (Salden, Paas, & van Merrienboer, 2006). The value of an adaptive system is that the sequence of tasks, the level of complexity, and pace of the instruction adjust to the needs of the learner.
More research is needed in this area to determine the viability of adaptive systems in a variety of learning settings and the role worked examples will take within these emerging forms of instructional systems.

**Future Research**

The findings of this study offer several possible directions for future research. One direction would be to continue to expand research on the effect of worked example sequencing on learner knowledge progression. While various factors in the present study revealed non-significant findings related to the effectiveness of a process-oriented and a product-oriented instructional strategy, recent studies have found that process-oriented worked examples initially foster higher levels of efficiency in novice learners (van Gog et al., 2006; 2008), based on equal performance with lower mental effort investment. Researchers have also found that the benefit of a process-oriented worked example quickly dissipates as the learner’s level of knowledge increases (van Gog et al., 2008). These findings support the general principle of expert-reversal effect (Kalyuga et al., 2003) and suggest the need to advance the fields understanding of how to effectively integrate instructional techniques and methods in a manner that optimizes knowledge progression.

A similar area for future research is investigating how to enhance instructional guidance through the use of adaptive instructional systems that base task selection on a learners performance and mental effort ratings (van Gog et al., 2006; Kalyuga, 2006; Salden et al., 2006). Research has already begun exploring instructional models that adapt the level of instructional support and difficulty for the learning task on the basis of assessing the learner’s expertise (Kalyuga & Sweller, 2004).

Recently, Cognitive Load researchers have identified three types of task selection models that provide adaptive instructional approaches based on the learner’s level of expertise (van Merrienboer, Sluijsmans, Corbalan, Kalyuga, Paas, & Tattersall, 2006). The identified models are: (1) systems-controlled models for task selection (Camp, Paas, Rikers, & van Merrienboer, 2001), which determined task selection on the basis of the learner’s performance of the previous task, (2) shared responsibility models (Corbalan, Kester, & van Merrienboer, 2006) in which the instructional system selects the next learning task from an available set of tasks but the learner has the control over final
selection of the learning task, and (3) advisory models (Kicken, Brand-Gruwel, & van Merrienboer, 2008) which act as an advisor to the learner on the recommended task to select but the learner has full control over task selection. Research will likely continue to explore the uses of adaptive systems, in parallel with new advances in technology, in both educational and organizational settings.

Future research efforts need to advance our understanding and measurement of mental efficiency. The present study explored instructional efficiency. This approach was adapted form of the original efficiency model (Paas & van Merrienboer, 1993) that captured both mental effort and performance scores during the testing phase. In the present study’s instructional efficiency model, mental effort ratings were capture during the instructional phase while performance scores were captured during the test phase. Van Gog and Paas (2008) argued that the original efficiency model (Paas & van Merrienboer, 1993), now referred to as either performance or mental efficiency, is the most effective measure of efficiency because it examines performance and mental effort during the test phase. They suggest that because a learning environment is usually designed to minimize cognitive load and optimize learning, taking mental load ratings during the learning process will result in mental effort ratings that do not accurately reflect the cognitive load experienced during a performance assessment (e.g., test). Contrary to learning efficiency, mental efficiency measures performance and mental effort based on the learner’s ability to recall information on a real assessment. Future research should consider investigating the effect of process-oriented strategies on a novice learner’s mental efficiency.

Finally, future studies should include the collection of more qualitative data. The results of the study left many questions unanswered about the effectiveness of a process-oriented instructional strategy. At the conclusion of the instructional activity phase, participant feedback to both the researcher and course instructor was positive. For example, one participants expressed to the researcher that, “the material [a process-oriented instructional packet] really helped me put everything together”, referring to improving his understanding of the effect of taxes on market activity. However, despite positive feedback, it was difficult to gain explanatory insight into what the participants really learned from the materials. In the future, using small groups and qualitative
techniques such as think-aloud protocol and individual interviews may provide additional information on the effects worked example strategies have on the learning outcomes examined in the present study and offer further direction for Cognitive Load research.

**Conclusion**

The purpose of this study was to explore the effect of worked example instructional strategies on problem solving and learner attitude as well as the mediating effect of prior knowledge on the stated learning outcomes. Findings failed to support the prediction that worked example strategies would enhance learning and transfer, particularly for low prior knowledge participants. Although the results failed to reject the null hypothesis, a review of the mean scores of high prior knowledge participants showed slightly higher achievement test scores for conventional problem solving participants compared to participants in either of the two worked example groups. The results may indicate the presence of *expertise reversal effect*. Contrary to expectations no differences were found in performance scores and mental effort ratings between instructional strategies with low prior knowledge participants. However, analysis results indicated that the mediating effect of prior knowledge was found to be a significant factor that affected learner performance and mental effort as well as attitude and learning efficiency.

Incidental findings showed that motivational factors, such as a learner’s attitude and confidence to complete a task, can have a significant effect on the level of mental effort a participant will invest on an instructional activity. Several areas of future research have been discussed that will expand our knowledge of the potential benefit of a worked example instructional strategy. The implications for instructional design practice and future research offer suggestions to move cognitive load research in a direction the leverages several decades of research in order to enhance learning effectiveness and efficiency for learners across a wide-spectrum of educational and organizational contexts.
APPENDIX A

HUMAN SUBJECTS COMMITTEE APPROVAL MEMORANDUM

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8633· FAX (850) 644-4392

REAPPROVAL MEMORANDUM

Date: 8/7/2008

To: Christopher Brooks
1125 Sandler Ridge Road
Tallahassee, Florida 32317

Dept.: EDUCATIONAL PSYCHOLOGY AND LEARNING SYSTEMS

From: Thomas L. Jacobson, Chair

Re: Reapproval of Use of Human subjects in Research
   Effects of Process-Oriented and Product-oriented Worked Examples on Learner Problem Solving and Attitude: A Study in the Domain of Microeconomics

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by 8/5/2009 please request renewed approval.

You are reminded that a change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must report to the Chair promptly, and in writing, any unanticipated problems involving risks to subjects or others.

By copy of this memorandum, the Chairman of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols of such investigations as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

Cc: Dr Aubteen Darabi
HSC No. 2008.0546-R
Research Study Participant Consent

Dear Student,

I am a doctoral student under the direction of Professor A. Aulteen Darabi of the College of Education, Department of Educational Psychology and Learning Systems at Florida State University. I am conducting a study to investigate the effectiveness of the use of learning strategies aimed at improving problem solving skills in some topic areas of instructions in this course.

In this research, you may be asked to study a series of worked out examples and complete a few practice activities as part of a regularly scheduled 50-minute classroom lesson as part of the normal instruction activity for this course. In addition, you will also be asked to evaluate the amount of mental effort you invested during these activities: studying the worked out examples and completing the practice activities. At the end of the session, you will be asked to complete a 21-question survey designed to evaluate the instructional materials influences of the use of these strategies.

Your participation in this study is voluntary; you must be at least 18 years of age to participate. If you choose not to participate or to withdraw from the study at any time, there will be no penalty, and it will not affect your grade. This study is not a test or an evaluation of your course performance. The results of this activity will only be used to assess the efficiency and effectiveness of the instructional strategies used in the study. The data from this research may be published in aggregate form and by no means would you be individually identified in a publication.

There are no risks to you if you agree to participate in this study.

Microeconomics is a new area for conducting this type of research. By your participation you are contributing to the development of instructional strategies designed to improve student learning and understanding of microeconomics.

If you have any questions concerning this research study, please call me at (850) 878-3085 or email me at dbrooks615@comcast.net or the faculty member supervising the research A. Aulteen Darabi at 850-644-5652.

Sincerely,

C. Darren Brooks

******

By signing below, I acknowledge that I am at least 18 years of age and I give my consent to participate in the study described above.

_____________________________ (student signature) ______________________ (date)

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at (850) 644-8633.
APPENDIX B

REQUEST FOR STUDENT DEMOGRAPHIC DATA

November 3, 2008

University Registrar
Florida State University
Office of the Registrar
282 Champions Way
P.O. Box 3062480
Tallahassee, Florida 32306-2480

Re: Request for ECO2023-01 Student Demographic Information

Dear University Registrar:

Per your instructions, I am requesting the following demographic information on students enrolled in the fall 2008, ECO2023 section 01 Principles of Microeconomics course at Florida State University under the following column headers:

- Student name
- Blackboard Username
- Gender
- Race/ethnicity
- Student date of birth
- FSU student classification (e.g., freshman, sophomore, junior)
- Academic major

The requested information will be used during the analysis phase of my dissertation project under the direction of Associate Professor Aubteen Darabi, College of Education, Department of Educational Psychology and Learning Systems. The study examines the effectiveness of example-based instructional strategies on student performance and motivation. I have enclosed a more detailed summary for your review.

All necessary precautions will be taken to protect the privacy of student information. Once received from the Registrar, the data will be secured as a password protected file. For analysis purposes, student performance indicators and motivation ratings will be matched with demographic data based on student name and blackboard username. The results will be reported in aggregate form to discuss the students’ performance and motivation as a group. No individual student will be identified and no information of any individual will be revealed. At the completion of the study, the individual identifiers including names and usernames will be destroyed.

If you need additional information or have questions about the study, please contact me. Thank you for your assistance.

C. Darren Brooks
Doctoral Candidate

A. Aubteen Darabi
Dissertation Chair
APPENDIX C

CLASSROOM OBSERVATION FORM

<table>
<thead>
<tr>
<th>Instructor: ________________</th>
<th>Date: ________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course No. ________________</td>
<td>Start Time: __________</td>
</tr>
<tr>
<td>Course Title: ______________</td>
<td>End Time: ______________</td>
</tr>
<tr>
<td>Class session Topic: _______</td>
<td>Number of Students: _______</td>
</tr>
</tbody>
</table>

Directions: In each of the following sections indicate the presence of the following actions and behaviors with a check mark or + mark. Leave unobserved items blank. In the space provided below document any examples or observations of the actions or behaviors that occur during the instructional period.

**Variety and Pacing of Instruction**

The instructor:

___ Uses more than one form of instruction
___ Pauses after asking questions
___ Encourages student responses
___ Demonstrates active listening
___ Specifies how learning tasks will be evaluated (if at all)
___ Allows sufficient time for students to complete tasks
___ Provides opportunities and time for students to practice

Examples and observations of instructor and student behaviors relating to the above ratings.

**Organization and Presentation of Instruction**

The instructor:

___ Begins on time
___ Relates the content of the lecture to previous information
___ Provides instructional goals or objectives for the class session
___ Utilizes various media forms during the class session
___ Makes transitional statements between instructional segments
___ Follows the stated structure of the class section
___ Conveys purpose of each activity
___ Periodically summarizes content and emphasizes important topics

Examples and observations of instructor and student behaviors relating to the above ratings.
Presentation and Clarity of Instruction
The instructor:
___ Reviews new terms and concepts
___ Elaborates and/or simplifies complex information
___ Uses examples to explain content
___ Uses visual aids effectively to reinforce or explain concepts or complex content
___ Makes explicit statements or uses cues to draw student attention to certain ideas
___ Pauses during explanations to ask and answer questions
___ Communicates the reasoning process behind operations and/or concepts

Examples and observations of instructor and student behaviors relating to the above ratings

Instructor-Student Interaction
The instructor:
___ Invites student participation and comments, when possible
___ Provides periodic feedback
___ Uses positive reinforcement

The students:
___ Ask questions
___ Engage in instructor-led activities

Examples and observations of instructor and student behaviors relating to the above ratings

Describe the general classroom setting and features
APPENDIX D

CONVENTIONAL PROBLEM SOLVING INSTRUCTIONAL ACTIVITY MATERIAL

Note: This appendix contains only the instructional portion of the activity. The Mental Effort Rating and Learner Attitude Survey are displayed in separate appendices.

SUPPLY AND DEMAND APPLICATION AND EXTENSIONS:

THE IMPACT OF A TAX

Student Name (Print): _____________________________
(Last name, first initial)

Blackboard Username: ____________________________
Introduction

Taxes affect how the market exchanges goods and services. When governments tax goods and services, who bears the burden or incidence? Economists use the term **tax incidence** to indicate how the burden of a tax is actually shared between the buyer and seller. While the government can impose a tax statutorily on either the buyer or seller, the individual paying the tax is not always the one who ultimately bears the burden of the tax. Recall from the lecture that the burden of the tax is shared between the buyer and the seller according to the elasticity of supply and demand.

This activity provides you with the opportunity to apply the knowledge you learned from the lecture by completing seven practice problems.

Learning Goals

Following the completion of this instructional activity, you will be able to:

- Determine the effects of a tax in a market
- Calculate the tax incidence of buyers and sellers
- Analyze the effects of supply and demand elasticity on the tax incidence between buyers and sellers

Activity Material

This self-guide instructional activity includes the following material:

- Seven Practice Problems
- Mental Effort Rating Scale
- Instructional Materials Survey
Activity
Instructions

This activity will comprise two sections.

Section One:

In Section One, you will work through seven practice examples that require you apply the information you learned by solving economic impact analysis problems that require the application of the following concepts and principles:

- Principles of supply and demand
- Tax incidence
- Supply and demand elasticity

As you work through the practice problems you may use a calculator, if needed, to complete the calculations. You may not use your notes or other lecture material during the activity. You must show all your work.

Section Two:

In Section Two, you will complete two surveys designed to evaluate the effectiveness of the activity.

- On the first survey, Mental Effort Scale, you will rate the amount of mental effort you exerted while studying the worked out examples and completing the practice problems.
- The second survey, Instructional Materials Survey, will require you answer questions about the effectiveness of the activity materials on a 5-point scale. Record your answers on the scantron form.

You must complete both sections of this activity. If you have questions about any of the tasks you are performing, raise your hand for a Teaching Assistant to assist you. After completing both sections of the activity, turn in your booklet to the Instructor.

Getting Started

In the next section you will be presented with seven practice problems. On the first three problems, you will determine the impact of a tax on both the seller and the buyer. On the remaining four problems, you will determine the effect of supply and demand elasticity on the tax incidence. Remember, you must show all your work.

Continue to Section 1 on the next page
SECTION ONE

Record Start Time: __________
List of Key Concepts

The following is a list of the relevant key concepts and principles underlying tax incidence and supply and demand elasticity.

- **Law of Demand** – The principle that states there is an inverse relationship between the price of a good or service and the quantity of it that the buyers are willing to purchase. In other words, as the price of a good increase, buyers will wish to purchase less of it.

- **Law of Supply** – The principle that states there is a direct relationship between the price of a good or service and the quantity of it that sellers are willing to supply.

- **Equilibrium** – The state in which the conflicting forces of supply and demand are in balance. At this point, the decisions of consumers and producers are brought into harmony with one another, and the quantity supplied will equal the quantity demand.

- **Tax burden (incidence)** – The incidence describes the actual burden of who bears the burden of a tax, buyers or sellers.

- **Demand Elasticity** – The degree of responsiveness to a change in price is demonstrated by the steepness of the demand curve. The more responsive buyers are to a change in price, the flatter or more elastic the demand curve will be. Conversely, the less responsive to price changes, the steeper or inelastic the demand curve will be.

- **Supply Elasticity** – The responsiveness to a change in price is shown by the steepness of the supply curve. The more willing sellers are to alter the quantity supplied in response to a change in price, the flatter or more elastic the supply curve. Conversely, the less willing sellers are to alter the quantity supplied in response to a price change, the steeper or inelastic the supply curve will be.

Review of the Impact of a Tax

Economic analysis indicates that the actual burden of a tax does not depend on whether the tax is statutorily placed on either the buyer or the seller. The true burden of the tax is shared between the buyer and the seller according to the elasticity of supply and demand.

**What determines the incidence or burden of the tax?** The incidence of a tax depends on the responsiveness of buyers and sellers to a change in price. When buyers respond to changes in price by leaving the market and buying other things, they will not be willing to accept a price that is higher than it was prior to the tax. Similarly, if sellers respond to a reduction in what they receive by shifting their goods and resources to other markets, or by going out of business, they will not be willing to accept a smaller payment net of taxes. Therefore, the burden of a tax tends to fall more heavily on the side of the market that is less sensitive to price changes.

*Continue to Practice Problem 1 on the next page*
Practice Problem 1: The Impact of a Tax Imposed on the Seller

Scenario: The seller of used cars is interested in selling a used car for any price over $6,000. However, a recent $1,000 tax has been placed on the sale of used cars. The seller would prefer to pass the tax increase on to buyers but recognizes that the higher price may result in fewer car sales. As a result, the seller and the buyer have to share the burden of the new tax. Assume the before-tax price of a used car is $7,000 resulting in the sale of 750 units. Used car prices increase by $400 which reduces demand by 250 units.

Determine the amount of the tax burden each party will bear because of the new tax.

Show YOUR work in the space provided below.

________________________________________________________________________________________

Continue the next page to check the answer for Practice Problem 1
Solution to Practice Problem 1

Answer: In this scenario, the government passed a $1,000 tax on the seller of used cars. Despite the imposed tax on the seller, both the seller and buyer share the actual tax burden.

Each $1,000 of tax revenue paid to the government imposes a burden of $400 on the buyer in the form of higher used-car prices and a $600 burden on the seller in the form of lower net revenue received from the sale of a used car.

Continue to Practice Problem 2 on the next page
Practice Problem 2: The Impact of a Tax Imposed on the Buyer

Scenario:  Continuing with the automobile scenario, a buyer is interested in purchasing a used car. However, recently the government placed a $1,000 tax on the buyer of used cars. Assume the before tax price of a used car is $7,000 which results in the sale of 750 units. Used car prices increase by $400 for the buyer causing demand to drop by 250 units.

Determine the amount of the tax burden each party will bear because of the new tax.

Show YOUR work in the space provided below.

____________________________________________________________

Continue the next page to check the answer for Practice Problem 2
Solution to Practice Problem 2

Answer: In this scenario, the government imposed a $1,000 tax on the buyers of used cars. Despite the imposed tax on the both, both the seller and buyer share the actual tax burden.

Each $1,000 of tax revenue paid to the government imposes a burden of $400 on the buyer in the form of higher used-car prices and a $600 burden on the seller in the form of lower net revenue received from the sale of a used car.

The result is the same whether the government places the tax on the buyer or seller.

Continue to Practice Problem 3 on the next page
**Practice Problem 3: The Impact of a Tax Imposed on the Seller**

**Scenario:** The seller of laptop computers sells computers for $1,000 each. A tax of $200 has been imposed on the sale of computers. This raises the price of a laptop computer to $1,100. Assume the price of laptop computers before the tax is $1,000 which results in the sell of 500 units. The increase in price impacts demand negatively by 150 units.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

____________________________________________________________

__________________________

*Continue the next page to check the answer for Practice Problem 3*
Solution to Practice Problem 3

Answer: As a result of the $200 tax imposed on the sale of laptop computers, both the seller and buyers share the burden of the tax equally.

The seller bears $100 and the buyer bears $100 of the tax burden.

Continue to Practice Problem 4 on the next page
**Practice Problem 4: Elastic Supply and Inelastic Demand**

**Scenario:** Recently, the government imposed a tax of $0.50 on the sale of a gallon of milk. The seller has to determine whether or not to pass the tax increase on to buyers. Before making the decision the seller needs to consider the impact of higher costs on sales revenue. Milk is a product that buyers have difficulty finding inexpensive alternatives. Therefore, demand is relatively inelastic while there is ample supply. Assume the before tax price of a gallon of milk is $4.60 resulting in the sale of 100 units. As a result of the tax, milk prices increase by $0.40 and demand drops by 10 units.

Determine the amount of the tax burden each party will bear because of the new tax.

Show **YOUR** work in the space provided below.
Solution to Practice Problem 4

Answer: In this problem, the government imposed a $0.50 tax on the seller of milk. As a result, demand is more inelastic than supply. As a result, each $0.50 of tax revenue paid to the government creates a burden of $0.40 imposed on the buyer in the form of higher milk prices and a $0.10 burden is maintained by the seller in the form of lower net revenue received from the sale of a gallon of milk.
Practice Problem 5: Elastic Supply and Inelastic Demand and the Burden of a Tax

Scenario: The government has placed a $.50 tax per gallon of gas sold. Unfortunately, buyers have few options to switch to when gas prices increase. Before the tax was imposed a gallon of gas was $3.60 which resulted in the sale of 200 gallons of gas. After the tax, gas rose to $4.00 per gallon causing demand to drop to 190 gallons.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

Continue the next page to check the answer for Practice Problem 5
Solution to Practice Problem 5

Answer: As a result of the $.50 per gallon gasoline tax imposed the buyer will bear more of the tax burden than the seller. This is because demand is relatively inelastic.

Specifically, the buyer bears $.40 and the seller bears $.10 of the tax burden.

Continue to Practice Problem 6 on the next page
Practice Problem 6: Elastic Demand and Inelastic Supply

Scenario: You own a business selling custom made t-shirts. Recently, a tax of $3.00 has been imposed on the sale of clothing. Buyers of t-shirts have numerous alternatives to choose from. Therefore, as the seller you have to determine how much of the increased cost you will pass on to the buyer. For this problem, assume the before tax price of a t-shirt is $20.00. At this price you can sell 150 units. As a result of the tax, t-shirt prices increase by $1.00 per shirt. Concurrently, your t-shirt demand drops by 50 units.

Determine the amount of the tax burden each party will bear because of the new tax.

Show YOUR work in the space provided below.

Continue the next page to check the answer for Practice Problem 5
Solution to Practice Problem 6

Answer: In this scenario, the government imposed a $3.00 tax on the seller of t-shirts. In this scenario, supply is more inelastic than demand. As a result, each $3.00 of tax revenue paid to the government creates a burden of $1.00 is imposed on the buyer in the form of t-shirt prices and a $2.00 burden is on the seller in the form of lower net revenue received from the sale of a custom t-shirt.

Continue to Practice Problem 7 on the next page
Practice Problem 7: Inelastic Supply and Elastic Demand and the Burden of a Tax

Scenario: You the owner of a bicycle shop that specializes in selling custom youth bicycles. Recently, a luxury tax of $100 has been imposed on the sell of bicycles. Because you sell custom bicycles buyers have numerous low-end alternatives to choose from. Therefore, as the seller you have to determine how much of the increased cost from the tax you will pass on to the buyer. For this problem, assume the before tax price of a bicycle is $500. At this price you can sell 100 bicycles. As a result of the tax, your prices increase by $25.00 per bicycle. The price increase causes demand to drop by 50 units.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

____________________________________________________________

Continue the next page to check the answer for Practice Problem 7
Solution to Practice Problem 7

Answer: As a result of the $100 luxury tax the seller will bear more of the tax burden than the seller. This is because demand is relatively elastic.

Specifically, the buyer bears $25 and the seller bears $75 of the tax burden.

Record Stop Time: __________
APPENDIX E

PROCESS-ORIENTED INSTRUCTIONAL ACTIVITY MATERIAL

Note: This appendix contains only the instructional portion of the activity. The Mental Effort Rating and Learner Attitude Survey are displayed in separate appendices.

SUPPLY AND DEMAND APPLICATION AND EXTENSIONS:

THE IMPACT OF A TAX

Student Name (Print): _____________________________
(Last name, first initial)

Blackboard Username: ________________________________
Dear Student,

I am a doctoral student under the direction of Professor A. Aubteen Darabi of the College of Education, Department of Educational Psychology and Learning Systems at Florida State University. I am conducting a study to investigate the effectiveness of the use of learning strategies aimed at improving problem solving skills in some topic areas of instructions in this course.

In this research, you may be asked to study a series of worked out examples and/or complete a few practice activities as part of a regularly scheduled 50-minute classroom lesson. In addition, you will also be asked to evaluate the amount of mental effort you invested during these activities: studying the worked out examples and/or completing the practice activities. At the end of the session, you will be asked to complete a 21-question survey designed to evaluate the instructional materials influences of the use of these strategies.

Your participation in this study is voluntary; you must be at least 18 years of age to participate. If you choose not to participate or to withdraw from the study at any time, there will be no penalty, and it will not affect your grade. This study is not a test or an evaluation of your course performance. The results of this activity will only be used to assess the efficiency and effectiveness of the instructional strategies used in the study. The data from this research may be published in aggregate form and by no means would you be individually identified in a publication.

There are no risks to you if you agree to participate in this study.

Microeconomics is a new area for conducting this type of research. By your participation you are contributing to the development of instructional strategies designed to improve student learning and understanding of microeconomics.

If you have any questions concerning this research study, please call me at (850) 878-3085 or email me at dbrooks615@comcast.net or the faculty member supervising the research A. Aubteen Darabi at 850-644-5652.

Sincerely,

C. Darren Brooks

By signing below, I acknowledge that I am at least 18 years of age and I give my consent to participate in the study described above.

_______________________________ (student signature) ______________________ (date)

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at (850) 644-8633.
Introduction
Taxes affect how the market exchanges goods and services. When
governments tax goods and services who bears the burden or incidence?
Economists use the term **tax incidence** to indicate how the burden of a
tax is actually shared between the buyer and seller. While the government
can impose a tax statutorily on either the buyer or seller, the individual
paying the tax is not always the one who ultimately bears the burden of
the tax. Recall from the lecture that the burden of the tax is shared
between the buyer and the seller according to the elasticity of supply and
demand.

This activity provides you with the opportunity to study four worked out
examples that demonstrate how to perform an impact analysis of a tax on
a buyer and a seller. After studying each worked out example you will
have the opportunity to apply your new knowledge by completing three
practice problems.

Learning Goals
Following the completion of this instructional activity, you will be able
to:
- Determine the effects of a tax in a market
- Calculate the tax incidence of buyers and sellers
- Analyze the effects of supply and demand elasticity on the tax
  incidence between buyers and sellers

Activity Material
This self-guide instructional activity includes the following material:
- Four Worked Out Examples
- Three Practice Problems
- Mental Effort Rating Scale
- Instructional Materials Survey
Activity Instructions
This activity is comprised of two sections.

Section One:
In Section One, you will study four different worked examples designed to teach you how to solve an impact analysis problem requiring the application of the following concepts and principles:

- Principles of supply and demand
- Tax incidence
- Supply and demand elasticity

After studying a worked out example you will have the opportunity to apply your knowledge on a practice problem similar to the example you studied. If needed, you may use a calculator to complete the calculations. **You must show all your work.**

Section Two:
In Section Two, you will complete two surveys designed to evaluate the effectiveness of the activity.

- On the first survey, Mental Effort Scale, you will rate the amount of mental effort you exerted while studying the worked out examples and completing the practice problems.
- The second survey, Instructional Materials Survey, will require you answer questions about the effectiveness of the activity materials on a 5-point scale. **Record your answers on the scantron form.**

You must complete both sections of this activity. If you have questions about any of the tasks you are performing, raise your hand for a Teaching Assistant to assist you. After completing both sections of the activity, turn in your booklet to the Instructor.

Getting Started
In the next section, you are presented four worked out examples and three practice problems. The first two worked out examples and practice problem expose you to the impact of a tax on both the seller and the buyer. The next two worked out examples and practice problems help you learn about the effect of supply and demand elasticity on the tax incidence. As you work the practice problems, show all your work.

*Continue to Section 1 on the next page*
SECTION ONE

Record Start Time: ____________
List of Key Concepts

The following is a list of the relevant key concepts and principles underlying tax incidence and supply and demand elasticity.

- **Law of Demand** – The principle that states there is an inverse relationship between the price of a good or service and the quantity of it that the buyers are willing to purchase. In other words, as the price of a good increase, buyers will wish to purchase less of it.

- **Law of Supply** – The principle that states there is a direct relationship between the price of a good or service and the quantity of it that sellers are willing to supply.

- **Equilibrium** – The state in which the conflicting forces of supply and demand are in balance. At this point, the decisions of consumers and producers are brought into harmony with one another, and the quantity supplied will equal the quantity demanded.

- **Tax burden (incidence)** – The incidence describes the actual burden of who bears the burden of a tax, buyers or sellers.

- **Demand Elasticity** – The degree of responsiveness to a change in price is demonstrated by the steepness of the demand curve. The more responsive buyers are to a change in price, the flatter or more elastic the demand curve will be. Conversely, the less responsive to price changes, the steeper or inelastic the demand curve will be.

- **Supply Elasticity** – The responsiveness to a change in price is shown by the steepness of the supply curve. The more willing sellers are to alter the quantity supplied in response to a change in price, the flatter or more elastic the supply curve. Conversely, the less willing sellers are to alter the quantity supplied in response to a price change, the steeper or inelastic the supply curve will be.

Review of the Impact of a Tax

Economic analysis indicates that the actual burden of a tax does not depend on whether the tax is statutorily placed on either the buyer or the seller. The true burden of the tax is shared between the buyer and the seller according to the elasticity of supply and demand.

**What determines the incidence or burden of the tax?** The incidence of a tax depends on the responsiveness of buyers and sellers to a change in price. When buyers respond to changes in price by leaving the market and buying other things, they will not be willing to accept a price that is higher than it was prior to the tax. Similarly, if sellers respond to a reduction in what they receive by shifting their goods and resources to other markets, or by going out of business, they will not be willing to accept a smaller payment net of taxes. Therefore, the burden of a tax tends to fall more heavily on the side of the market that is less sensitive to price changes.

*Continue to Example 1 on the next page*
Example 1: The Impact of a Tax Imposed on the Seller

Scenario: The seller of used cars is interested in selling a used car for any price over $6,000. However, a recent $1,000 tax has been placed on the sale of used cars. The seller would prefer to pass the tax increase on to buyers but recognizes that the higher price may result in fewer car sales. As a result, the seller and the buyer have to share the burden of the new tax. Assume the before-tax price of a used car is $7,000 resulting in the sale of 750 units. Used car prices increase by $400 which reduces demand by 250 units. Determine the amount of the tax burden each party will bear because of the new tax by following the steps below and their provided rationale.

Answer: In this scenario, the government passed a $1,000 tax to the seller of used cars. Despite the imposed tax on the seller, both the seller and buyer share the actual tax burden. Each $1,000 of tax revenue paid to the government imposes a burden of $400 on the buyer in the form of higher used-car prices and a $600 burden on the seller in the form of lower net revenue received from the sale of a used car.

Continue to Example 2 on the next page
Example 2: The Impact of a Tax Imposed on the Buyer

Scenario: Continuing with the automobile scenario, a buyer is interested in purchasing a used car. However, recently the government placed a $1,000 tax on the buyer of used cars. Assume the before-tax price of a used car is $7,000, which results in the sale of 750 units. Used car prices increase by $400 for the buyer causing demand to drop by 250 units. Study the following steps and their rationale to determine the amount of the tax burden each party will bear because of the new tax.

Answer: In this scenario, the government imposed a $1,000 tax on the buyers of used cars. Despite the imposed tax, both the seller and buyer share the actual tax burden. Each $1,000 of tax revenue paid to the government imposes a burden of $400 on the buyer in the form of higher used-car prices and a $600 burden on the seller in the form of lower net revenue received from the sale of a used car. The result is the same whether the government places the tax on the buyer or seller.

Continue to the Practice Problem on the next page
Practice Problem for Examples 1 and 2: The Impact of a Tax Imposed on the Seller

Scenario: The seller of laptop computers sells computers for $1,000 each. A tax of $200 has been imposed on the sale of a computer. This raises the price of a laptop computer to $1,100. Assume the price of a laptop computer before the tax is imposed $1,000 which results in the sell of 500 units. The increase in price impacts demand negatively by 150 units.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

__________________________

Continue to the next page for the answer to the Practice Problem
Solution to Practice Problem for Examples 1 and 2

Answer: As a result of the $200 tax imposed on the sale of laptop computers, both the seller and buyer share the burden of the tax equally. The seller bears $100 and the buyer bears $100 of the tax burden.

Continue to Example 3 on the next page
Example 3: Elasticity and the Burden of a Tax: Elastic Supply and Inelastic Demand

Scenario: Recently, the government imposed a tax of $0.50 on the sale of a gallon of milk. The seller has to determine whether or not to pass the tax increase on to buyers. Before making the decision, the seller needs to consider the impact of higher costs on sales revenue. Milk is a product that buyers have difficulty finding inexpensive alternatives. Therefore, demand is relatively inelastic while there is ample supply. Assume the before-tax price of a gallon of milk is $4.60 resulting in the sale of 100 units. As a result of the tax, milk prices increase by $0.40 and demand drops by 10 units. Study the steps below to determine the amount of the tax burden each party will bear because of the new tax.

Answer: In this scenario, the government imposed a $0.50 tax on the seller of milk. In this scenario, demand is more inelastic than supply. As a result, each $0.50 of tax revenue paid to the government creates a burden of $0.40 imposed on the buyer in the form of higher milk prices and a $0.10 burden is maintained by the seller in the form of lower net revenue received from the sale of a gallon of milk.

Continue to the Practice Problem on the next page

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**Step 1:** Draw the Supply and Demand Curves and plot the price and quantity equilibrium before the tax is imposed. The demand curve represents consumer demand for a good or service. The concept of elasticity determines how much the quantity of a good or service responds to a change in price. In this scenario, the good is inelastic because consumers view milk as a necessity.

**Step 2:** Shift the supply curve upward. A tax imposed on the seller causes the supply curve to shift upward.

**Step 3:** Plot price consumers ($P_c$) are willing to pay after tax is applied. The new equilibrium price represents the seller’s and buyer’s acceptance of a portion of the tax burden. When demand is inelastic, the consumer accepts a larger portion of the tax burden.

**Step 4:** Calculate and plot the price the seller will receive ($P_p$) net of taxes. $5.00 (P_c) - $0.50 (tax) = $0.50 (P_p)$ This point represents the price the seller receives after adjusting the price due to the tax. Prior to the tax, the original price for a gallon of milk was $4.60.

**Step 5:** Determine the tax burden of the seller and buyer. Remember, the actual burden of a tax (or share of the burden) does not depend on whether the tax is statutorily placed on the seller or the buyer. The supply and demand elasticity determines how the tax is distributed between the buyer and seller. Because the effect of price on the quantity demanded is minimal, the seller is able to pass on a larger portion of the tax burden to the consumer.

**Buyer’s Burden**

\[ P_c - P_{\text{No Tax}} \]

\[ $0.40 \]

**Seller’s Burden**

\[ P_{\text{No Tax}} - P_p \]

\[ $0.10 \]
Practice Problem for Example 3: Elastic Supply and Inelastic Demand

Scenario: The government has placed a $.50 tax per gallon of gas sold. Unfortunately, buyers have few options to switch to when gas prices increase. Before the tax was imposed, a gallon of gas was $3.60 which resulted in the sale of 200 gallons of gas. After the tax, gas rose to $4.00 per gallon causing demand to drop to 190 gallons.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

____________________________________________________________

Continue to the next page for the answer to the Practice Problem
Solution to the Practice Problem for Example 3

Answer: As a result of the $.50 per gallon gasoline tax imposed the buyer will bear more of the tax burden than the seller. This is because demand is relatively inelastic.

Specifically, the buyer bears $.40 cents and the seller bears $.10 cents of the tax burden.

Continue to Example 4 on the next page
Example 4: Elasticity and the Burden of a Tax: Elastic Demand and Inelastic Supply

Scenario: You own a business selling custom made t-shirts. Recently, a tax of $3.00 has been imposed on the sale of clothing. Buyers of t-shirts have numerous alternatives to choose from. Therefore, as the seller you have to determine how much of the increased cost you will pass on to the buyer. For this problem, assume the before tax price of a t-shirt is $20. At this price you can sell 150 units. As a result of the tax, t-shirt prices increase by $1.00 per shirt. Concurrently, your t-shirt demand drops by 50 units. Study the following steps and their rationale to determine the amount of the tax burden each party will bear because of the new tax.

Answer: In this scenario, the government imposed a $3.00 tax on the seller of t-shirts. In this scenario, supply is more inelastic than demand. As a result, each $3.00 of tax revenue paid to the government creates a burden of $1.00 is imposed on the buyer in the form of t-shirt prices and a $2.00 burden is on the seller in the form of lower net revenue received from the sale of a custom t-shirt.
Practice Problem for Example 4: Inelastic Supply and Elastic Demand

Scenario: You are the owner of a bicycle shop that specializes in selling custom youth bicycles. Recently, a luxury tax of $100 has been imposed on the sell of bicycles. Because you sell custom bicycles buyers have numerous low-end alternatives to choose from. Therefore, as the seller you have to determine how much of the increased cost from the tax you will pass on to the buyer. For this problem, assume the before tax price of a bicycle is $500. At this price you can sell 100 bicycles. As a result of the tax, your prices increase by $25 per bicycle. The price increase causes demand to drop by 50 units.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

__________________________________________________________________________________

Continue to the next page for the answer to the Practice Problem
Solution to Practice Problem for Example 4

Answer: As a result of the $100 luxury tax, the seller will bear more of the tax burden than the seller. This is because demand is relatively elastic.

Specifically, the buyer bears $25 and the seller bears $75 of the tax burden.

Record Stop Time: __________
APPENDIX F

PRODUCT-ORIENTED INSTRUCTIONAL ACTIVITY MATERIAL

Note: This appendix contains only the instructional portion of the activity. The Mental Effort Rating and Learner Attitude Survey are displayed in separate appendices.

SUPPLY AND DEMAND APPLICATION AND EXTENSIONS:

THE IMPACT OF A TAX

Student Name (Print): _____________________________

(Last name, first initial)

Blackboard Username: ________________________________
**Introduction**

Taxes affect how the market exchanges goods and services. When governments tax goods and services who bears the burden or incidence? Economists use the term **tax incidence** to indicate how the burden of a tax is actually shared between the buyer and seller. While the government can impose a tax statutorily on either the buyer or seller, the individual paying the tax is not always the one who ultimately bears the burden of the tax. Recall from the lecture that the burden of the tax is shared between the buyer and the seller according to the elasticity of supply and demand.

This activity provides you with the opportunity to study four worked out examples that demonstrate how to perform an impact analysis of a tax on a buyer and a seller. After studying each worked out example you will have the opportunity to apply your new knowledge by completing three practice problems.

**Learning Goals**

Following the completion of this instructional activity, you will be able to:

- Determine the effects of a tax in a market
- Calculate the tax incidence of buyers and sellers
- Analyze the effects of supply and demand elasticity on the tax incidence between buyers and sellers

**Activity Material**

This self-guide instructional activity includes the following material:

- Four Worked Out Examples
- Three Practice Problems
- Mental Effort Rating Scale
- Instructional Materials Survey
This activity is comprised of two sections.

**Section One:**

In Section One, you will study four different worked out examples designed to teach you how to solve an impact analysis problem requiring the application of the following concepts and principles:

- Principles of supply and demand
- Tax incidence
- Supply and demand elasticity

After studying a worked out example you will have the opportunity to apply your knowledge on a practice problem similar to the example you studied. If needed, you may use a calculator to complete the calculations. **You must show all your work.**

**Section Two:**

In Section Two, you will complete two surveys designed to evaluate the effectiveness of the activity.

- On the first survey, Mental Effort Scale, you will rate the amount of mental effort you exerted while studying the worked out examples and completing the practice problems.
- The second survey, Instructional Materials Survey, will require you answer questions about the effectiveness of the activity materials on a 5-point scale. **Record your answers on the scantron form.**

You must complete both sections of this activity. If you have questions about any of the tasks you are performing, raise your hand for a Teaching Assistant to assist you. After completing both sections of the activity, turn in your booklet to the Instructor.

In the next section, you are presented with four worked out examples and three practice problems. The first two worked examples and practice problem expose you to the impact of a tax on both the seller and the buyer. The next two worked out example and practice problems help you learn about the effect of supply and demand elasticity on the tax incidence. As you work the practice problems, show all your work.

**Turn to the next page to begin Section 1**
SECTION ONE

Record Start Time: ____________
List of Key Concepts

The following is a list of the relevant key concepts and principles underlying tax incidence and supply and demand elasticity.

- **Law of Demand** – The principle that states there is an inverse relationship between the price of a good or service and the quantity of it that the buyers are willing to purchase. In other words, as the price of a good increase, buyers will wish to purchase less of it.
- **Law of Supply** – The principle that states there is a direct relationship between the price of a good or service and the quantity of it that sellers are willing to supply.
- **Equilibrium** – The state in which the conflicting forces of supply and demand are in balance. At this point, the decisions of consumers and producers are brought into harmony with one another, and the quantity supplied will equal the quantity demanded.
- **Tax burden (incidence)** – The incidence describes the actual burden of who bears the burden of a tax, buyers or sellers.
- **Demand Elasticity** – The degree of responsiveness to a change in price is demonstrated by the steepness of the demand curve. The more responsive buyers are to a change in price, the flatter or more elastic the demand curve will be. Conversely, the less responsive to price changes, the steeper or inelastic the demand curve will be.
- **Supply Elasticity** – The responsiveness to a change in price is shown by the steepness of the supply curve. The more willing sellers are to alter the quantity supplied in response to a change in price, the flatter or more elastic the supply curve. Conversely, the less willing sellers are to alter the quantity supplied in response to a price change, the steeper or inelastic the supply curve will be.

Review of the Impact of a Tax

Economic analysis indicates that the actual burden of a tax does not depend on whether the tax is statutorily placed on either the buyer or the seller. The true burden of the tax is shared between the buyer and the seller according to the elasticity of supply and demand.

**What determines the incidence or burden of the tax?** The incidence of a tax depends on the responsiveness of buyers and sellers to a change in price. When buyers respond to changes in price by leaving the market and buying other things, they will not be willing to accept a price that is higher than it was prior to the tax. Similarly, if sellers respond to a reduction in what they receive by shifting their goods and resources to other markets, or by going out of business, they will not be willing to accept a smaller payment net of taxes. Therefore, the burden of a tax tends to fall more heavily on the side of the market that is less sensitive to price changes.

*Continue to Example 1 on the next page*
Example 1: The Impact of a Tax Imposed on the Seller

Scenario: The seller of used cars is interested in selling a used car for any price over $6,000. However, a recent $1,000 tax has been placed on the sale of used cars. The seller would prefer to pass the tax increase on to buyers but recognizes that the higher price may result in fewer car sales. As a result, the seller and the buyer have to share the burden of the new tax. Assume the before-tax price of a used car is $7,000 resulting in the sale of 750 units. Used car prices increase by $400 which reduces demand by 250 units. Determine the amount of the tax burden each party will bear because of the new tax by following the steps below and their provided rationale.

Answer: In this scenario, the government passed a $1,000 tax to the seller of used cars. Despite the imposed tax on the seller, both the seller and buyer share the actual tax burden. Each $1,000 of tax revenue paid to the government imposes a burden of $400 on the buyer in the form of higher used-car prices and a $600 burden on the seller in the form of lower net revenue received from the sale of a used car.

Continue to Example 2 on the next page
Example 2: The Impact of a Tax Imposed on the Buyer

Scenario: Continuing with the automobile scenario, a buyer is interested in purchasing a used car. However, recently the government placed a $1,000 tax on the buyer of used cars. Assume the before-tax price of a used car is $7,000, which results in the sale of 750 units. Used car prices increase by $400 for the buyer causing demand to drop by 250 units. Study the following steps and their rationale to determine the amount of the tax burden each party will bear because of the new tax.

Answer: In this scenario, the government imposed a $1,000 tax on the buyers of used cars. Despite the imposed tax, both the seller and buyer share the actual tax burden. Each $1,000 of tax revenue paid to the government imposes a burden of $400 on the buyer in the form of higher used-car prices and a $600 burden on the seller in the form of lower net revenue received from the sale of a used car. The result is the same whether the government places the tax on the buyer or seller.

Continue to the Practice Problem on the next page
Practice Problem for Examples 1 and 2: The Impact of a Tax Imposed on the Seller

Scenario: The seller of laptop computers sells computers for $1,000 each. A tax of $200 has been imposed on the sale of a computer. This raises the price of a laptop computer to $1,100. Assume the price of a laptop computer before the tax is imposed $1,000 which results in the sell of 500 units. The increase in price impacts demand negatively by 150 units.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

________________________________________________________________________

Continue to the next page for the answer to the Practice Problem
Solution to the Practice Problem for Examples 1 and 2

Answer: As a result of the $200 tax imposed on the sale of laptop computers, both the seller and buyers share the burden of the tax equally.

The seller bears $100 and the buyer bears $100 of the tax burden.

Continue to Example 3 on the next page
Example 3: Elasticity and the Burden of a Tax: Elastic Supply and Inelastic Demand

Scenario: Recently, the government imposed a tax of $0.50 on the sale of a gallon of milk. The seller has to determine whether or not to pass the tax increase on to buyers. Before making the decision, the seller needs to consider the impact of higher costs on sales revenue. Milk is a product that buyers have difficulty finding inexpensive alternatives. Therefore, demand is relatively inelastic while there is ample supply. Assume the before-tax price of a gallon of milk is $4.60 resulting in the sale of 100 units. As a result of the tax, milk prices increase by $0.40 and demand drops by 10 units. Study the steps below to determine the amount of the tax burden each party will bear because of the new tax.

Answer: In this scenario, the government imposed a $0.50 tax on the seller of milk. In this scenario, demand is more inelastic than supply. As a result, each $0.50 of tax revenue paid to the government creates a burden of $0.40 is imposed on the buyer in the form of higher milk prices and a $0.10 burden is maintained by the seller in the form of lower net revenue received from the sale of a gallon of milk.

Continue to the Practice Problem on the next page
Practice Problem for Example 3: Elastic Supply and Inelastic Demand

Scenario: The government has placed a $.50 tax per gallon of gas sold. Unfortunately, buyers have few options to switch to when gas prices increase. Before the tax was imposed, a gallon of gas was $3.60 which resulted in the sale of 200 gallons of gas. After the tax, gas rose to $4.00 per gallon causing demand to drop to 190 gallons.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

Continue to the next page for the answer to the Practice Problem
Solution to the Practice Problem for Example 3

Answer:  As a result of the $.50 per gallon gasoline tax imposed the buyer will bear more of the tax burden than the seller. This is because demand is relatively inelastic.

Specifically, the buyer bears $.40 cents and the seller bears $.10 cents of the tax burden.

Continue to Example 4 on the next page
Example 4: Elasticity and the Burden of a Tax: Elastic Demand and Inelastic Supply

Scenario: You own a business selling custom made t-shirts. Recently, a tax of $3.00 has been imposed on the sale of clothing. Buyers of t-shirts have numerous alternatives to choose from. Therefore, as the seller you have to determine how much of the increased cost you will pass on to the buyer. For this problem, assume the before tax price of a t-shirt is $20. At this price you can sell 150 units. As a result of the tax, t-shirt prices increase by $1.00 per shirt. Concurrently, your t-shirt demand drops by 50 units. Study the following steps and their rationale to determine the amount of the tax burden each party will bear because of the new tax.

Answer: In this scenario, the government imposed a $3.00 tax on the seller of t-shirts. In this scenario, supply is more inelastic than demand. As a result, each $3.00 of tax revenue paid to the government creates a burden of $1.00 is imposed on the buyer in the form of t-shirt prices and a $2.00 burden is on the seller in the form of lower net revenue received from the sale of a custom t-shirt.

Continue to the Practice Problem on the next page
Practice Problem for Example 4: Inelastic Supply and Elastic Demand

Scenario: You are the owner of a bicycle shop that specializes in selling custom youth bicycles. Recently, a luxury tax of $100 has been imposed on the sell of bicycles. Because you sell custom bicycles buyers have numerous low-end alternatives to choose from. Therefore, as the seller you have to determine how much of the increased cost from the tax you will pass on to the buyer. For this problem, assume the before tax price of a bicycle is $500. At this price you can sell 100 bicycles. As a result of the tax, your prices increase by $25 per bicycle. The price increase causes demand to drop by 50 units.

Determine the amount of the tax burden each party will bear as a result of the tax.

Show YOUR work in the space provided below.

____________________________________________________________

Continue to the next page for the answer to the Practice Problem
Solution to the Practice Problem for Example 4

Answer: As a result of the $100 luxury tax the seller will bear more of the tax burden than the seller. This is because demand is relatively elastic.

Specifically, the buyer bears $25 and the seller bears $75 of the tax burden.

Record Stop Time: __________
APPENDIX G

MENTAL EFFORT SURVEY

<table>
<thead>
<tr>
<th>Mental Effort Scale</th>
<th>Using the 9-point scale below, rate the amount of mental effort you exerted during the activity you have just finished.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circle One</td>
<td>1 = Very, very low mental effort</td>
</tr>
<tr>
<td></td>
<td>2 = Very low mental effort</td>
</tr>
<tr>
<td></td>
<td>3 = Low mental effort</td>
</tr>
<tr>
<td></td>
<td>4 = Rather low mental effort</td>
</tr>
<tr>
<td></td>
<td>5 = Neither low nor high mental effort</td>
</tr>
<tr>
<td></td>
<td>6 = Rather high mental effort</td>
</tr>
<tr>
<td></td>
<td>7 = High mental effort</td>
</tr>
<tr>
<td></td>
<td>8 = Very high mental effort</td>
</tr>
<tr>
<td></td>
<td>9 = Very, very high mental effort</td>
</tr>
</tbody>
</table>
APPENDIX H

SUBJECT-SPECIFIC PRIOR KNOWLEDGE ASSESSMENT ITEMS

1. The economic way of thinking is
   a. a set of historical generalizations that indicates what goods should be produced.
   b. a body of statistical data that indicates how an economy should be organized.
   c. a set of basic concepts that helps one understand human choices.
   d. a set of complex, highly abstract theories that provides persons skilled in statistics with the information necessary to tell others what choices they should make.

2. With voluntary exchange,
   a. both the buyer and seller will be made better off.
   b. the buyer will be made better off, while the seller will be made worse off.
   c. the seller will be made better off, while the buyer will be made worse off.
   d. both the buyer and the seller will be made worse off.

3. Steve values his Honda Accord at $10,000, and Jennifer values it at $14,000. If Jennifer buys it from Steve for $11,000, which of the following is true?
   a. Steve gains $1,000 of value, and Jennifer gains $3,000 of value.
   b. Steve gains $11,000 of value, and Jennifer loses $11,000 of value.
   c. Steve gains $10,000 of value, and Jennifer loses $14,000 of value.
   d. Steve and Jennifer both gain $11,000 of value.

4. Three basic decisions must be made by all economies. What are they?
   a. How much will be produced; when will it be produced; who will produce it?
   b. What goods will be produced; how will goods be produced; for whom will goods be produced?
   c. What will be consumed; how will goods be consumed; for whom will goods be consumed?
   d. How will the opportunity cost principle be applied; if the law of comparative advantage will be utilized, how will it be utilized; will the production possibilities constraint apply?

5. The law of demand refers to the
   a. inverse relationship between the price of a good and the willingness of consumers to buy it.
   b. price increase that results from an increase in demand for a good of limited supply.
   c. inverse relationship between the price of a good and the quantity offered for sale.
6. In which statement(s) are "demand" and "quantity demanded" used correctly?  
(I) "An increase in the price of coffee will reduce the quantity demanded of coffee."  
(II) "An increase in the price of coffee will reduce the demand for creamer used in coffee."  
   a. in both statements I and II  
   b. in statement I only  
   c. in statement II only  
   d. in neither statements I nor II  

7. Two goods are considered substitutes if  
   a. a decrease in the demand for one leads to a decrease in the supply of the other.  
   b. an increase in the demand for one leads to a decrease in the supply of the other.  
   c. an increase in the price of one leads to an increase in the demand for the other.  
   d. a decrease in the price of one leads to an increase in the demand for the other,  
   e. a decrease in the supply of one leads producers to switch to production of the other.  

8. According to the law of supply,  
   a. more of a good is desired by consumers as the price falls.  
   b. less of a good is desired by consumers as the price rises.  
   c. more of a good will be offered by suppliers as the price rises.  
   d. less of a good will be offered by suppliers as the price rises.  

9. Which of the following events would increase producer surplus?  
   a. Sellers' costs stay the same and the price of the good increases.  
   b. Sellers' costs increase and the price of the good stays the same.  
   c. Sellers' costs increase and the price of the good decreases.  
   d. All of the above are correct.  

10. In which statement(s) are "supply" and "quantity supplied" used correctly?  
   (I) "An increase in the price of computers will increase the quantity supplied of computers."  
   (II) "A technological advance that lowers the cost of producing computers will increase the supply of computers."  
   a. in both statements I and II  
   b. in statement I only  
   c. in statement II only  
   d. in neither statements I nor II  

11. When there is excess demand for a product in a market,  
   a. price will tend to fall.  
   b. price must be below the equilibrium price.  
   c. price must be above the equilibrium price.  
   d. producers will reduce output and sales will fall.
12. If we observe an increase in the price of a good and a decrease in the amount of the good bought and sold, this could be explained by
   a. an increase in the supply of the good.
   b. an increase in the demand for the good.
   c. a decrease in the demand for the good.
   d. a decrease in the supply of the good.

13. How will an increase in the price of coffee affect the market for cocoa, a substitute good?
   a. The supply of cocoa will increase, leading to a reduction in the price of cocoa.
   b. The supply of cocoa will decrease, leading to an increase in the price of cocoa.
   c. The demand for cocoa will increase, leading to an increase in the price of cocoa.
   d. The demand for cocoa will decrease, leading to a reduction in the price of cocoa.

14. Suppose demand decreases and supply increases. Which of the following will happen?
   a. Equilibrium price will rise, fall, or stay the same while equilibrium quantity will decrease.
   b. Equilibrium price will rise, fall, or stay the same while equilibrium quantity will increase.
   c. Equilibrium quantity will rise, fall, or stay the same and equilibrium price will increase.
   d. Equilibrium quantity will rise, fall, or stay the same while equilibrium quantity will decrease.
   e. The change in equilibrium price and quantity cannot be determined.

15. Adam Smith's invisible hand principle stresses
   a. that benevolence is a powerful motivator that encourages individuals to engage in productive economic activity.
   b. the tendency of the competitive market process to direct self-interested individuals into activities that enhance the economic welfare of society.
   c. the potential of government regulation as a means of bringing the self interest of individuals into harmony with the economic welfare of society.
   d. the tendency of self-interested individuals to pursue activities that benefit themselves but harm the overall economic welfare of society.
## INSTRUCTIONAL MATERIALS MOTIVATION SURVEY

<table>
<thead>
<tr>
<th>Instructional Materials Motivation Survey Instructions</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. There are 21 statements in this questionnaire. Please think about each statement in relation to the instructional materials you have just studied, and indicate how true it is. Give the answer that truly applies to you, and not what you would like to be true, or what you think others want to hear.</td>
<td></td>
</tr>
<tr>
<td>2. Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to other statements.</td>
<td></td>
</tr>
<tr>
<td>3. Record your responses by circling the appropriate response. Thank you.</td>
<td></td>
</tr>
</tbody>
</table>

### Questions

<table>
<thead>
<tr>
<th>Questions</th>
<th>Circle the Appropriate Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I first looked at this lesson, I had the impression that it would be easy for me.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. There was something interesting at the beginning of this lesson that got my attention.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>3. This material was more difficult to understand than I would like for it to be.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>4. After reading the introductory information, I felt confident that I knew what I was supposed to learn from this lesson.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>5. Many of the pages had so much information that it was hard to pick out and remember the important points.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>6. These materials grabbed my attention.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>7. The quality of the writing helped to hold my attention.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>8. This lesson is so abstract that it was hard to keep my attention on it.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>9. As I worked on this lesson, I was confident that I could learn the content.</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>10. The pages of this lesson look dry and unappealing.</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

*Continue to the next page*
### Instructional Materials Motivation Survey
(Continued)

#### Questions

<table>
<thead>
<tr>
<th>Number</th>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>The way the information is arranged on the pages helped keep my attention.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>The exercises in this lesson were too difficult.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>13.</td>
<td>This lesson has things that stimulated my curiosity.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I learned some things that were surprising or unexpected.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>15.</td>
<td>After working on this lesson for a while, I was confident that I would be able to pass a test on it.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>As I worked on this lesson, I was confident that I could learn the content.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>17.</td>
<td>The variety of reading passages, exercises, illustrations, etc., helped keep my attention on the lesson.</td>
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</tr>
<tr>
<td>18.</td>
<td>The style of writing is boring.</td>
<td></td>
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</tr>
<tr>
<td>19.</td>
<td>There are so many words on each page that it is irritating.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>20.</td>
<td>I could not really understand quite a bit of the material in this lesson.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>The good organization of the content helped me be confident that I would learn this material.</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
APPENDIX J

PERFORMANCE ASSESSMENT FOR ACHIEVEMENT AND TRANSFER

1. Along the inelastic portion of a demand curve,
   a. the change in price will always be less than the change in quantity demanded.
   b. the percentage change in price will be less than the percentage change in quantity demanded.
   c. the change in price will always be more than the change in quantity demanded.
   d. the percentage change in price will be more than the percentage change in quantity demanded.

2. A good that takes up a very large percentage of the consumer's budget will tend to have
   a. an elastic demand.
   b. a perfectly elastic demand.
   c. an inelastic demand.
   d. an upward-sloping demand curve.
   e. very many substitutes.

3. If the price elasticity of demand is computed for two products, and product A measures .79, and product B measures 1.6, then:
   a. product A is more price elastic than product B.
   b. product B is more price elastic than product A.
   c. consumers are more sensitive to price changes in product A than in product B.
   d. product B is more price inelastic than product A.
   e. products A and B must be substitutes.

4. If the price of apples increases, total expenditures on apples will decline if
   a. the demand for apples is inelastic.
   b. the demand for apples is elastic.
   c. the quantity of apples purchased is unresponsive to changes in price.
   d. there are few good substitutes for apples.

5. A 20 percent increase in the price of sugar reduces sugar consumption by about 10 percent. Such a price increase causes households to
   a. spend less on sugar.
   b. spend more on sugar.
   c. spend the same amount on sugar as before.
   d. consume more goods like coffee and tea, which are sugar complements.
6. *(Transfer Item 1)* Suppose a city that operates local electric and natural gas companies wants to raise revenues by increasing its rates for electricity and natural gas. The price rise will increase city revenues if the elasticity of demand for electricity and natural gas is
   a. less than 1 in absolute value.
   b. elastic.
   c. negative.
   d. equal to −1.

7. *(Transfer Item 2)* A recent study on enrollment at a liberal arts college concluded that demand elasticity is 0.91. The administration is considering a tuition increase to help balance the budget. The revenue-maximizing decision is to
   a. decrease tuition, which should boost enrollment enough to balance the budget.
   b. decrease tuition, which would bring in more revenue.
   c. leave tuition as is—an increase would not help balance the budget.
   d. increase tuition, which would generate more revenue.

8. The number of CDs purchased increased by 5 percent when consumer income increased by 10 percent. Assuming other factors are held constant, CDs would be classified as
   a. inferior goods.
   b. normal goods.
   c. elastic goods.
   d. inelastic goods.

9. The costs of a firm indicate the desire of consumers for
   a. the product produced by the firm.
   b. other goods that might have been produced with the same resources.
   c. goods that can be easily substituted for the good produced by the firm.
   d. goods that are complementary with the good produced by the firm.

10. *(Transfer Item 3)* Which of the following is correct?
    a. An increase in the number of students choosing to major in marketing would likely lead to an increase in the wage earned by marketing graduates.
    b. A new law allowing nurses to offer patients some of the medical services that are currently only available through doctors would increase the wage rate earned by doctors.
    c. An increase in the demand for newly constructed homes would lead to a reduction in the price of lumber.
    d. New licensing requirements that substantially lowered the number of plumbers would likely lead to an increase in the wage rate of plumbers.
11. A tax on the buyers of coffee will
   a. increase the price of coffee paid by buyers, increase the net price of coffee
      received by sellers, and increase the equilibrium quantity of coffee.
   b. decrease the price of coffee paid by buyers, increase the net price of coffee
      received by sellers, and decrease the equilibrium quantity of coffee.
   c. increase the price of coffee paid by buyers, decrease the net price of coffee
      received by sellers, and decrease the equilibrium quantity of coffee.
   d. increase the price of coffee paid by buyers, decrease the net price of coffee
      received by sellers, and increase the equilibrium quantity of coffee.

12. Suppose that a tax is placed on DVDs. If the sellers end up bearing most of the tax
    burden, this indicates that the
    a. demand is more inelastic than supply.
    b. supply is more inelastic than demand.
    c. government has required that buyers remit the tax payments.
    d. government has required that sellers remit the tax payments.

13. If the government wants to raise tax revenue and shift most of the tax burden to the
    consumers, it would impose a tax on a good with a:
    a. flat (elastic) demand curve and a steep (inelastic) supply curve.
    b. steep (inelastic) demand curve and a flat (elastic) supply curve.
    c. steep (inelastic) demand curve and steep (inelastic) demand curve.
    d. flat (elastic) demand curve and a flat (elastic) supply curve.

14. If the federal government placed a 50 cent per pack excise tax on cigarette manufacturers,
    and if as a result, the price to consumers of a pack of cigarettes went up by 40 cents, the
    a. actual burden of this tax falls mostly on consumers.
    b. actual burden of this tax falls mostly on manufacturers.
    c. actual burden of the tax would be shared equally by producers and consumers.
    d. tax would clearly be a progressive tax.

15. (Transfer Item 4) The federal government currently levies a 15.3 percent payroll tax
    (7.65 percent statutorily on both the employer and employee) on the wages of all
    workers. If the tax were redefined such that the entire 15.3 percent was statutorily levied
    on employers, economic analysis suggests that the actual burden of the tax would
    a. remain unchanged.
    b. shift more heavily toward employers.
    c. shift more heavily toward employees.
    d. be different than if the entire 15.3 percent was statutorily imposed on employees.
APPENDIX K

ACTIVITY LEADER GUIDE

**Activity Material**

This instructional activity requires the following material:

- Instructional Packet (Three different versions)
- Scantron form (approximately 500)
- Pencil (for scantron)

**Activity Instructions**

Good morning! As you can see, I am not Dr. Calhoun. Unfortunately, he was unable to be here today but asked me to facilitate your activity today. My name is Darren Brooks. I am a doctoral student in the Instructional Systems Department in the College of Education. I have been working with Dr. Calhoun for over a year in order to improve the effectiveness of his economics courses.

Regarding today’s activity, you will continue your study of the impact taxes have on market exchanges between buyers and sellers. By now, each of you should have received an activity packet and scantron form. We have randomly distributed one of three different versions of the activity to each of you.

Please note this is **NOT** a test but rather an opportunity to apply what you have learned about tax incidence and elasticity. Do the best you can!

At the end of today’s session, you will have a chance to evaluate the effectiveness of today’s activity.

Please open up your packets to page 2.

*(Show Consent Form on Document Imager)* Since we are collecting evaluation data from you on the effectiveness of the materials used in this activity, you will need to **sign and date the consent form**, which will allow us to use your feedback in our analysis.

This activity material is divided into two sections.

**Section 1** starts on page 5. In this section, you will study several different scenarios, similar to your PRS questions on Wednesday. This will require you to apply your recently acquired knowledge of tax incidence and elasticity.

There are simple calculations throughout the activity. You may use a calculator to complete the calculations, if needed. **You must show all your work**

Be sure to **record both your start and stop time** for section 1.
Activity Leaders Guide (continued)

In Section 2, you will complete two surveys designed to evaluate the effectiveness of the activity.

- **(Show ME Rating Scale)** On the first survey, you will rate the amount of mental effort you exerted during the activity. You will rate mental effort by circling a choice on the form.
- **(Show IMMS Survey)** On the second survey, you will answer 21-questions about the activity materials. **Record your answers on the scantron form.**
- I will alert you when there is about 10 minutes to go before the end of class so you can complete the survey information.

You must complete both sections of this activity in order to receive the participation points for today. If you have questions during the activity procedure, raise your hand for a Teaching Assistant to assist you. Although we cannot answer questions about the subject matter content. Remember, do the best you can.

Once you have completed the activity, place your **activity packet and scantron form** in the boxes found on each side of the auditorium.

You may begin.
APPENDIX L

ACTIVITY INSTRUCTIONS

Tax Incidence and Elasticity Activity
Course: ECO 2023 Microeconomics Section: 01
Instructor: Calhoun

(Note: This slide was presented as students entered the classroom)

➢ Make sure you have the following materials:
  o Activity Packet
  o Scantron form
  o Pencil

➢ Print name and blackboard username on cover page of the activity packet

➢ Complete course, section, instructor name, date, and your name on the scantron form

➢ Do not start the activity early

➢ Instructions will be given before you start the activity

➢ You will receive double participation points for completing both sections of the activity

➢ At the conclusion of the activity, review the material to ensure you have completed all parts of the activity and signed the consent page

➢ Encouraging word:

  “I am a great believer in luck and I find the harder I work the more of it I have.”

  - Thomas Jefferson
Review and sign the consent form (this allows us to use your survey responses in our analysis)

Start Section One on page 5

Make sure you record your START and STOP time for Section One

Section Two:

- Rate your Mental Effort by circling your response in the Activity Packet

- Instructional Materials Survey – Respond to the 21-questions on the Scantron form

Pace yourself so you can complete the entire activity to receive full participation points

This is NOT a test – Do the best you can!

At the conclusion of the activity, review the material to ensure you have completed all parts of the activity and signed the consent page

Remember you will receive double participation points for completing the activity

Encouraging word:

“Perseverance and spirit have done wonders in all ages.”

- General George Washington
APPENDIX M

EVALUATION OF PREVIOUS ECONOMIC EXPERIENCE

Previous Economics Experience: Your responses to the following questions will provide an understanding of your prior experience in academic economics courses that may have exposed you to certain topics covered in this section of the course.

<table>
<thead>
<tr>
<th>Select the appropriate response</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Have you previously taken an introductory economics course in high school?</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2. Have you previously taken a college level introductory economics course?</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3. Have you previously taken college level economics course with this instructor?</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
REFERENCES


BIOGRAPHICAL SKETCH

EDUCATION

Doctor of Philosophy  Instructional Systems  Florida State University
Master of Science  Instructional Systems  Florida State University
Bachelor of Science  Psychology  Florida State University

CERTIFICATIONS

Graduate Certificate in Program Evaluation  Florida State University
Graduate Certificate in Human Performance Technology  Florida State University
Professional in Human Resources  SHRM

PROFESSIONAL EXPERIENCE

State of Florida, Department of Children and Families  2007-Present
Director of Administrative Services, Information Technologies  2009-Present
Direct a staff of 17 professionals in the delivery of budget, human resources, training, communications, revenue management, facilities management, and contracts management. Manage a budget of $67 million in the delivery of IT services to agency staff and external providers of social service and mental health/substance abuse services.

Director of Human Resources  2007-2008
Direct a staff of 25 human resource professionals in the development and implementation of full-service HR programs and services to a 13,500 employee state government agency.

– Directing the re-design and development of a new employee development and job skill training curriculum.
– Centralizing the development and coordination of a firm wide recruitment strategy to bring consistency and responsiveness to the strategic recruitment needs of the Department.
– Selected to serve as a Steering Committee Member for the development of a State of Florida Human Resource Strategic Plan.

Learning Design Manager
Direct a team of 20 project managers, instructional designers and an additional 20 contractors, who create learning solutions for client organizations as part of Hewitt’s HR MBPO offering.

– Direct the design and development of 11,000+ hours of multi-delivery channel instruction per quarter resulting in approximately $2.4 million in annual revenue.
– Develop and implement structural alignment of resources, new design/development processes and procedures, and new design and project management systems to operate in a revenue generation model for start up learning design department.
– Negotiate vendor and consultant contracts to ensure consistent and quality service for clients.
– Consult with clients on learning and non-learning interventions to improve organizational performance.
– Serve as a consulting advisor to the Hewitt Learning Research and Development team.
Wachovia Corporation 1997-2005
Vice President, Senior Learning Manager, Learning Design Team 2003–2005
Manage a team of 14 instructional designer/developers, and up to an additional 17 contractors, who create learning solutions in a variety of delivery mediums from instructor led to highly interactive web based training. Accountability for managing an operating budget of approximately $1 million dollars as well as contractor funding in excess of $1.5 million dollars annually.

- Directed the design and development of job-skill and soft-skill instruction in support of multiple business lines and corporate initiatives.
- Obtained project funding and allocated resources, oversight of multiple project budgets, ensured projects closed on time and exceeded internal clients expectations.
- Consulted with internal clients and partners on most efficient and effective learning intervention to improve line of business performance.

Vice President, Senior Recruiting Manager/Director, Florida Region & Recruiting Solutions Project Manager, General Bank Recruiting (Corporate-wide) 1998-2003
Direct the development and implementation of all General Bank recruiting strategies in the Florida region. Train, develop and manage a staff of 11 Recruiting Consultants and 7 Staffing Coordinators and manage a budget of $1.3 million. Also, responsible for the recruitment of exempt and executive level positions.

- Direct the recruiting activity that has resulted in an annual hire rate of 2600+ positions for each of the past 5 plus years.
- Designed and developed a process to identify entry-skill gaps and employment trends of new employees in an effort to increase the effectiveness and efficiency of Wachovia’s selection system.
- Co-developed a workforce planning model/staffing report currently used in the General Bank.
- Developed a monthly diversity candidate/hiring analysis to analyze diversity recruitment flow activity corporate wide.
- Designed, developed and implemented the Recruiting Solutions Service Level Agreement, which recruiters use in establishing expectations between Recruiter and line management. Also, designed a template for developing tactical recruitment plans.
- Developed and delivered job search, networking and interview training workshops and seminars.

Assistant Vice President, Senior Human Resources Generalist 1997 - 1998
Provided broad generalist services, in a multi-site environment, with specific expertise in recruiting and staffing, training and development, compensation and employee relations.

- Recruiting Services Design project team.
- Consulted with management to develop Portfolio Management incentive plans.
- Authored the performance management section of First Union Corporation's Commercial Bank compensation system manual.
- Developed and delivered technical and soft-skill training for Florida Commercial Credit managers and employees.
Barnett Banks, NA (N.K.A. Bank of America)  1996-1997
Senior Staffing Specialist/Team Leader
Directed the recruitment operations of 15 exempt and non-exempt recruiters in support of Barnett's Corporate
Business Unit and the Consumer Credit Group. Internal consultant to affiliate management on issues relating
to the development of recruitment strategy, compensation and salary negotiation, staffing trends, hiring and
training practices and provide management training on the use of recruitment as a vehicle to increase
employee retention.

Branch Manager/Registered Investment Representative

TEACHING EXPERIENCE

Florida State University, College of Education  2003-2004
Instructor/Teaching Assistant for Dr. Robert Branson’s graduate-level course in Change Management.

COMMITTEES/SERVICE

Search Committee, Student Representative 2007 – Performance Improvement and Human Resource
Development Faculty Position, The Florida State University, College of Education, Educational
Psychology and Learning Systems Department, Dr. Rita Conrad, Committee Chair.

Instructional Systems, Masters Curriculum Redesign Task Force, Student Representative 2006,
Dr. Bonnie Armstrong, Task Force Chair.

Volunteer Instructor and Mentor, Florida State University Career Center

PUBLICATIONS


INVITED PRESENTATIONS

Brooks, C. D. (2007). Socio-Organizational Factors Affecting the Use of Task Analysis by
Instructional Designers in Organizational Settings. Paper presented at the Association for
Education Communication & Technology 2007 Conference, Anaheim, California.

2006 to Wachovia Corporation, Charlotte, North Carolina

Paper presented at the Florida State University Mental Models workshop, Tallahassee, Florida.

interaction patterns and performance in computer-mediated communications. Paper presented at the
Association for Educational Communications & Technology 2005 Conference, Orlando, Florida.
Brooks, C. D. (2005, April). Effective project estimation for complex ID projects: Effort hours versus project duration. Guest expert to Dr. Bonnie Armstrong’s graduate level Managing Instructional Development class, Florida State University, Tallahassee, Florida.


**PROFESSIONAL AND COMMUNITY AFFILIATIONS**

International Society for Performance Improvement  
Academy of Human Resource Development  
Society for Human Resource Management  
American Society of Training and Development  
Association for Educational Communications and Technology  
Volunteer Youth Athletic Coach

**HONORS AND ACTIVITIES**

Finalist 2005-2006 Gagne/Briggs Outstanding Service Award, Instructional Systems, Recipient 2002-2003 Gagne/Briggs Outstanding (Masters) Distance-Learning Student, Phi Kappa Phi, National Academic Honor Society  
Eta Sigma Gamma, National Academic Honor Society  
Psi Chi, National Academic Honor Society in Psychology  
Finalist, Howard D. Baker Undergraduate Research Award, Florida State University  
Captain, Florida State University Varsity Cheerleading Team  
Outstanding College Students of America, 1989-1992  
Eagle Scout, Boy Scouts of America