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USING WORKED EXAMPLES FOR TRAINING NUTRITION PROFESSIONALS TO DIAGNOSE NUTRITION PROBLEMS AND USE INTERNATIONAL DIETETICS AND NUTRITION TERMINOLOGY

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USING WORKED EXAMPLES FOR TRAINING NUTRITION PROFESSIONALS TO DIAGNOSE NUTRITION PROBLEMS AND USE INTERNATIONAL DIETETICS AND NUTRITION TERMINOLOGY

BY

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DISSERTATION

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DEDICATION

I dedicate this work to my family: past, present and future. My grandparents and parents instilled a love of life-long learning and emphasized the importance of being an educated person, something I want to say I have done for my own children. My husband Phil and my children Trevor, Tristan, and Laurel not only participated in this work by supporting my personal growth, but also by infusing their own personalities into the interpretation of the concepts I was exploring.

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ABSTRACT.

This study investigated two types of modular worked examples; process-oriented (PSWE) and product-oriented (PDWE), for performance, cognitive load, and efficiency for nutrition diagnosis.

One hundred and four students (104) from a 200-level course in human nutrition participated in the main study. Participants studied the worked examples and completed the practice phase during one regularly scheduled class period. Two weeks later the participants completed the maintenance phase during half a regularly scheduled class period. Both the practice and maintenance phases involved making nutrition diagnoses, using the correct International Dietetics and Nutrition Terminology (IDNT) and writing a diagnostic statement for two cases.

Participants in both conditions were able to make nutrition diagnoses after studying the two worked examples in the learning phase for an average of 22 minutes. More than forty percent of participants in the practice and maintenance phases who attempted to make a diagnosis scored greater than or equal to 67.5% correct on the

diagnostic tasks with the mean higher at 87.5% correct. There were no statistically significant differences in time on task or scores on the diagnostic tasks between worked example conditions. Statistically significant differences in the subscales of perceived cognitive load were observed by worked example type in the learning phase. There is a statistically significant difference in calculated efficiency scores for the maintenance phase cases. The PDWE condition was more efficient $F(1,4)=8.7$, $p=.042$, $\omega^2=.344$, indicating that worked example condition accounts for 34.4% of the variance in calculated efficiency for the maintenance phase, an advantage for PDWE.

Results suggest an application of worked examples for training nutrition professionals.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 1

INTRODUCTION

Training Nutrition Professionals to Diagnose Nutrition Problems

Healthcare practice presents unique and contextually rich clinical situations that require healthcare providers to make connections between somewhat disparate knowledge domains and training experiences to determine the causes, mediators, and potential solutions to managing diseases in humans. The complex nature of healthcare requires that educators offer learning environments and learning processes that enable individuals to develop sustainable, transferable knowledge and skills (Fraser & Greenhalgh, 2001). Learning to diagnose health problems in humans, apply standardized diagnostic terminology, and simultaneously use standardized documentation, exemplifies this educational challenge.

Complexity lies in the process of training new healthcare providers to sift through the elements of a clinical case, recognize and correctly diagnosis a problem, and effectively communicate findings. Diagnosing and formulating a plan for nutritional therapy is a primary role of registered dietitians in the multi- and inter-disciplinary environment of healthcare and is one part of the four-part Nutrition Care Process (International Dietetics and Nutrition Terminology, 2011). International Dietetics and Nutrition Terminology (IDNT) is unique to registered dietitians and the standardized language of IDNT is meant to capture nutrition issues that can be treated independently by the nutrition provider (Hakel-Smith, Lewis, & Eskridge, 2005; Simon, Faut, & Wooley, 2009). Nutrition diagnosis is a complex cognitive skill to perform, and equally complex to learn, requiring simultaneous attention to numerous interacting elements presented in each individual case. Nutrition diagnosis requires general and overall knowledge of concurrent elements related to human nutrition; food science, human growth and development, anatomy and physiology, life course considerations, and pathophysiology. The task exerts a high cognitive load during training, especially for novices. Registered dietitians need to be able to determine how to trouble shoot (diagnose) when observed biochemical or clinical features are associated with a nutrition problem, comparing observations or measurements made in the nutrition assessment phase to measures of optimal functioning or health. Nutrition diagnoses are captured in the medical record by using a Problem, Etiology, and Signs and Symptoms (PES) diagnostic statement. Writing a correct and meaningful diagnostic statement using IDNT, follows a fairly structured format and affords an opportunity for educators to streamline approaches to teaching nutrition providers to document nutrition diagnoses using this method. Designing educational strategies that acknowledge the complex nature of nutrition diagnosis and the potential for cognitive overload in the novice is required. Currently, no literature in the domain of nutrition and nutrition education outlines evidence for specific strategies for effectively teaching this complex skill (Simon et al., 2009). With these challenges in mind, there is a need to refine the way registered dietitians and nutrition professionals are trained to diagnose nutrition problems and use IDNT (Lacey, 2006; Pressely et al., 1990; Zelig, Byham-Gray, Touger-Decker, Parrot, & Rigassio-Radler, 2011).

Worked Examples as an Approach to Training Nutrition Professionals

Programs that train nutrition professionals for clinical practice use case examples to illustrate medical and nutritional problems. Most are presented as conventional problems, cases that tell the story or medical history of an individual and ask the learner to make a determination as to what nutrition issues need to be treated. These conventional cases consist of a question to answer (goal) and some specific information (the givens in a problem) to manipulate to obtain the answer. Novices especially are quickly overwhelmed by possible paths to a solution with conventional problems (Rourke & Sweller, 2009).

Worked examples are an educational tool used to teach problem solving skills. Worked examples model problem solving by labeling the steps and operators experts take to arrive at a solution and, by example, teach the moves required (Atkinson, Derry, Renkl, & Worthham, 2000; Sweller, 1994). Learners are freed from having to discover the moves or operators, a cognitively taxing activity. Expert modeling provided by worked examples helps organize domain knowledge around core concepts, recognize meaningful patterns, efficiently search through the givens in a problem, and outline the procedural knowledge necessary to make a diagnostic determination (Gobet, 2005; Meier, Reinhard, Carter, & Brooks, 2008; Paas & Van Gog, 2006). Improvement in initial learning in the training phase is accomplished by designing education environments that focus on helping students to see relationships and interactions between elements of problems and to discern underlying structure (Chi and VanLehn, 2012; Gobet, 2005). Chi and VanLehn (2012) concluded from their observations that students need to be told to notice these relationships and conclude that transfer (of problem solving skills) is based on the ability to interpret these relationships. Having novices study an expert's approach to problem solving indicates to learners what successful learning and successful problem solving looks like and that it can be replicated.

Using worked examples does not guarantee that students will perform well on all learning outcomes (Grosse & Renkl, 2007). Learning outcomes depend on how worked examples are constructed for specific types of learners and with differing levels of prior knowledge. Specifically for novice nutrition professionals, this early stage of skill development is where worked examples are most likely to prove superior (Kalyuga, Ayres, Chandler, & Sweller, 2003).

Framing the worked examples for level of prior knowledge and engagement includes describing the role of the student as part of a team of individuals where their input and ideas are critical (Engle, Lam, Meyer, & Nix, 2012). In the context of training nutrition professionals, this can be used to situate the student as the member of the healthcare team with expert specific nutrition diagnostic and treatment information to be incorporated into overall care for an individual. Labeling structure and drawing attention in a learning phase, as in a worked example, may make recognition, and therefore the solution, more achievable (Catrambone & Holyoak, 1989; Gobet, 2005). Perkins and Salomon (2012) suggest that this skill of detection can be developed by a variety of educational experiences. The discrepancies noted might be the most powerful in motivating a student to take the next step or elect to explore the relationship of the discrepancies (Wigfield & Eccles, 2000). An example is a clinical case study where the relationships between the discrepancies in assessment parameters and interaction of elements from the individual's history are features of complex tasks. The worked example formats proposed in this research offer example problems that explicitly label features to detect discrepancies and connect information in the example to prior knowledge leading to a nutrition diagnosis.

Purpose of the Study

The present study addressed the need for strategies that effectively teach nutrition diagnosis and the use of IDNT and diagnostic statements, contribute to competent use of IDNT, and facilitate transfer of entry level nutrition diagnosis skills and documentation knowledge for novice nutrition providers. Research methodology compared performance outcomes on isomorphic (similar) and novel clinical cases, training efficiency, and perceived cognitive load between two groups of novice nutrition students randomized to two different types of modular worked examples. International Dietetics and Nutrition Terminology and the use of diagnostic statements have inherent well-defined structures that lend themselves to experimentation on the application of worked example (Chen, Hsu, Liu, & Yang, 2012). Modular worked examples offer an approach to teach students to focus on interaction in the case and to derive schema that that support use of IDNT and writing diagnostic statements not only in the formal learning environment of healthcare education, but also when providing nutrition care to individuals and populations. Process-oriented worked examples provide an avenue for supplying the principles behind each step of the diagnostic process, a typical strategy in healthcare provider education. Worked examples have the potential to decrease cognitive load since more direct instruction reduces searching for meaning, especially for novice nutrition providers. This may in turn improve transfer in subsequent clinical situations, the goal of teaching in this domain.

Significance of the Study

Using worked examples for nutrition provider education extends the worked example literature about the effectiveness of this strategy in different domains and with different types of students (van Gog, Paas, & van Merriënboer, 2004). This study explored the extent to which the worked example conditions tested affected cognitive load during three phases of an educational process for nutrition diagnosis; learning, practice, and maintenance. A particular strength in this research design was the maintenance phase two weeks later that demonstrated students retained an ability to make nutrition diagnoses.

One aspect of this study that has immediate implications to nutrition provider education is that the research was conducted in an authentic classroom environment without the need for a digital or online environment. A set of learning materials to teach nutrition diagnosis based on worked examples could be developed as a supplement to a course as a text or adapted to an online continuing education program for currently practicing registered dietitians.

Research Questions and Hypotheses

Performance on Diagnostic Tasks

Question 1: Do both product-oriented worked example and process-oriented worked example conditions result in an ability to use International Dietetics and Nutrition Terminology and Problem, Etiology, and Signs and Symptoms diagnostic statements by novices as evidenced by performance on diagnostic tasks?

Hypothesis 1: Participants in either worked example condition, product-oriented or process-oriented, will demonstrate an ability to use International Dietetics and Nutrition Terminology and construct a Problem, Etiology, and Signs and Symptoms diagnostic statement.

Question 2: Does the process-oriented worked example condition result in better performance when compared to the product-oriented worked example condition for novices learning to use IDNT and write diagnostic statements?

Hypothesis 2: The process-oriented worked example condition will result in higher performance scores compared to the product-oriented worked example condition.

Efficiency

Question 3: What is the difference between the process-oriented worked example condition and the product-oriented worked example condition on efficiency when calculated from self-report of perceived mental effort and performance on diagnostic tasks?

Hypothesis 3: Calculated efficiency scores will be better for the process-oriented worked example condition compared to the product-oriented worked example condition.

Cognitive Load

Question 4: What is the difference in perceived cognitive load between the product-oriented worked example condition and the process-oriented worked example conditions?

Hypothesis 4-1: The process-oriented worked example condition will result in higher perceived cognitive load scores during the training phase.

Hypothesis 4-2: Perceived success should be higher for the process-oriented worked example condition when compared to the product-oriented worked example condition during the practice and maintenance phases.

Hypothesis 4-3: Perceived stress should be lower for the process-oriented worked example condition when compared to the product-oriented worked example condition during the practice and maintenance phases.

Definition of Terms

Registered Dietitian (RD) is an expert in human nutrition and a member of the healthcare team trained to diagnosis and treat nutrition problems in humans. RDs must complete a nationally approved course of study at a credentialed university. RD designation is only granted after completing the prescribed course of study and passing a national board exam.

International Dietetics and Nutrition Terminology (IDNT) is unique to Registered Dietitians (RD) and the standardized language of IDNT is meant to capture nutrition issues that can be treated independently by the nutrition provider.

Problem, Etiology, and Signs and Symptoms (PES) statement is a diagnostic statement and the way in which nutrition diagnoses are captured in the medical record following a structured format.

Worked examples are an educational tool used to teach problem solving skills. Worked examples model problem solving by labeling the steps and operators experts take to arrive at a solution and by example, teach the moves required.

Worked example effect defines the benefit to learners of presentation of new material related to problem solving in varying domains as completely worked out problems, rather than as conventional problems (Sweller, 1994).

Cognitive load describes the impact on cognitive resources associated with completing a task or learning something new. Cognitive load is reflected in this study as self-reported perceived cognitive load which involves rating perceived task demand, time demand, success, effort, and stress. Cognitive load has three components; intrinsic cognitive load, extraneous cognitive load, and germane cognitive load.

Intrinsic cognitive load is one category of cognitive load. Material to be learned or tasks that are intellectually complex contribute specifically to intrinsic cognitive load**.** Sweller (1994) states, "the primary determinant of intrinsic cognitive load is element interactivity" (pg. 307).

Extraneous cognitive load includes instructional materials and environments that require students to spend working memory searching for procedures or pieces of information that are not relevant to schema construction; however, must be addressed to complete a task (Van Gog, Paas, & van Merriënboer, 2008).

Germane cognitive load enhances learning and, like extraneous cognitive load, may be more readily manipulated in the learning environment. Design elements of instruction to increase germane cognitive load may support the use of working memory resources towards construction of schema.

Molar worked examples are designed to help learners identify structures and main components that help classify a problem. After learners classify a problem, they then use the learned steps to solve the problem as a whole. Simultaneous examples are similar to molar worked examples, where all the solution components are displayed at one time, so that each step is related to the others and not considered on its own (Atkinson & Derry, 2000).

Modular worked examples define sub goals and limit the solution search space to the sub goal and not the overall goal. Modular worked examples provide clues to relevance, order of operations, and associated labels. Within the format of modular examples, structural features that are highlighted also have associated an explicit purpose for performing that step and can stand alone.

Process-oriented worked example (PSWE) is one type of modular worked example where principles and rationale for the process are provided in addition to each step that demonstrates the sub-goal.

Product-oriented worked example (PDWE) is one type of modular worked example that includes only the steps that demonstrate each sub-goal.

Chapter 2

LITERATURE REVIEW

Worked Examples and the Worked Example Effect

Worked examples are an educational tool used to teach problem solving skills. Worked examples model problem solving by labeling the steps and operators experts take to arrive at a solution and by example, teach the moves required (Atkinson, Derry, Renkl, & Worthham, 2000; Sweller, 1994). Learners are freed from having to discover the moves or operators, a cognitively taxing activity. The *worked example effect* defines the benefit of presentation of new material related to problem solving in varying domains as completely worked out problems, rather than as conventional problems (Sweller, 1994). Conventional problems consist of a question to answer (goal) and some specific information (the givens in a problem) to manipulate to obtain the answer. Conventional problem solving can be an effective learning strategy for students who have some domain-specific knowledge; however, for those with limited prior knowledge, this may become a frustrating experience that does not produce the desired learning outcomes. Novices especially, are quickly overwhelmed by possible paths to a solution with conventional problems (Rourke & Sweller, 2009). Worked example approaches to instruction impact distribution of cognitive resources to greatest effect by minimizing the amount of cognitive capacity necessary for a given task and directing the attention of the learner toward the meaningful aspects of the problem solution (Paas, 1992; Sweller, 1988). Worked examples offer a means of increasing performance on subsequent problems while decreasing cognitive load during training (Grosse & Renkl, 2007; Meier, Reinhard, Carter, & Brooks, 2008; Moreno, 2006; ; Paas & van Gog, 2006; van Gog, Paas, & van Merriënboer, 2008; van Gog, Paas, & van Merriënboer, 2006; van Gog, Paas, & van Merriënboer, 2004).

Using expert modeling in worked examples helps organize domain knowledge around core concepts, recognize meaningful patterns, efficiently search through the givens in a problem, and outline the procedural knowledge necessary in a domain (Gobet, 2005; Meier, et al., 2008; Paas & Van Gog, 2006). Chi and VanLehn (2012) make a point that supports the worked example approach for training arguing that the issue is not the failure to transfer what was learned when attempting to solve a different problem, but the failure to learn initially. Improvement in initial learning in the training phase is accomplished by designing education environments that focus on helping students to see relationships and interactions between elements of problems and to discern underlying structure (Chi & VanLehn, 2012; Gobet, 2005). Chi and VanLehn concluded from their observations that students need to be told to notice these relationships and conclude that transfer (of problem solving skills) is based on the ability to interpret these relationships. Having novices study an expert's approach to problem solving indicates to learners what successful learning and successful problem solving looks like and that it can be replicated.

A successful application of this approach outside of the more frequently studied domains of math and engineering was applied to novice students (first year) studying furniture design (Rourke & Sweller, 2009). Comparisons were made between those studying worked examples and those solving equivalent problems on a post test of furniture designer styles. In the first experiment, designer recognition and matching of designers to the examples, a statistically significant main effect was found for worked examples compared to conventional problems (Rourke & Sweller, 2009). The authors noted that test scores for both conditions were low indicating that the material was challenging for novices and speculated that all were at the early stages of skill acquisition. This early stage of skill development is where worked examples are most likely to prove superior (Kalyuga, et al., 2003).

Worked example designs are divided into two main categories. *Intra-example* (design), one category, is concerned with the features of each individual example (Grosse & Renkl, 2007; Paas & van Gog, 2006). Within the category of *intra-example* design is the concept of *structure-emphasizing* examples. These examples help learners determine or detect common underlying structures in problems when presented with different cover stories, *surface features,* and emphasize the recurrent aspects of operations in a domain (Grosse & Renkl, 2007). The skill of discerning structural aspects so that procedural skills and conceptual understanding are appropriately applied is critical for success with future problems. Schwonke et al. (2009) compared a computer-based cognitive tutor for geometry with the same material presented as worked examples in a group of eighth and ninth grade German students to see if students could acquire and apply geometry principles. Though there were no significant differences in post-test (transfer) scores between the groups; the worked-example group was much more efficient (less time was required to learn the same material when compared to the problem-solving condition) d=-1.17 (large effect) (Schwonke et al., 2009). This indicates an advantage, especially to novices, when learning new material. If the same material can be learned in a more efficient way, there is potential that worked examples could prove less frustrating and have a positive effect on student’s motivation to continue with a learning task. The investment of additional mental effort with improved motivation may positively impact learning outcomes over time for those receiving worked example based instruction (Paas, Tuovinen, van Merriënboer, & Darabi, 2005).

For students to derive the most benefit from worked examples, carefully designed learning materials are required (Gerjets, Scheiter, & Catrambone, 2004). The instructional design framework provided by cognitive load theory differentiates between environments and activities that support learning and those that detract from learning. In addition, cognitive load theory includes perceived cognitive load, sometimes measured as only mental effort, in the metrics used to compare different instructional interventions. To fully appreciate differences in learning outcomes when comparing worked example to other types of instructional design, an overview of the tenets of cognitive load theory is necessary.

Cognitive Load Theory

Cognitive load theory is concerned with how meaningful learning can occur when human cognitive architecture constrains processing in complex tasks (Sweller, 1998). Constraints are related to Miller's (1956) proposed functional limit on what can be attended to and manipulated consciously at one time. Design of instructional approaches within cognitive load theory takes into account prior knowledge and characteristics of learners, characteristics of the learning material and learning environment, along with the interaction between all of these (Renkl, Atkinson, & Grosse, 2004). Critical to implementing cognitive load theory in educational interventions is a clear understanding of the key cognitive structures directly involved in information processing.

Cognitive architecture and learning: working and long term memory

Current models of cognitive processing describe structures that mediate what is noticed in the world and what, if anything, is done with that information. The predominant model is based on depicting information processing in much the same way as a computer functions. Processing input involves binding to other relevant and concurrent information so that it can be manipulated. Central to defining cognitive architecture and its role in designing and testing educational interventions within the framework of cognitive load theory, is the function and organization of one cognitive structure, working memory and its relationship to another cognitive structure, long-term memory (Paas, Renkl, & Sweller, 2004). Working memory is the multi-component cognitive structure responsible for processing, via elaboration and encoding, information presented for learning. Information is filtered to some extent based on self-regulatory mechanisms, allowing entry into working memory (Yuan, Steedle, Shavelson, Alonzo, & Oppezzo, 2006). Further, executive function refines the filters through which input must navigate before entering working memory, and may involve emerging or highly developed metacognitive processes on the part of the learner (Baddeley, 2010; Baddeley, 2000; Baddeley & Hitch, 1994). Once information has entered working memory, preservation of that information in long-term memory occurs via encoding. Manipulation of material in working memory may involve very conscious attention (mental effort) or occur automatically. Efficient management of new information in working memory involves, in part, more automation in retrieval and elaboration of existing material from long-term memory. This allows a greater portion of what is left of the limited capacity of working memory, at a particular moment, free to consciously attend to novel information

(Baddeley, 2012). Once information has been stored in long-term memory, learning has taken place.

Long-term memory, contrary to working memory, is believed to have no known capacity limit. Richer encoding in working memory allows retrieval to be triggered by multiple cues. This increases the likelihood that information stored in long-term memory can be accessed for subsequent use and elaboration (Nadolski, Kirschner, & van Merriënboer, 2006). The balance is to provide information to be learned in sufficiently rich formats without having these same formats distract the learner (Moreno, 2004). The learner may have to decide (consciously) what to do with sound, graphics, words, and experiential learning all at the same time, taxing the capacity of working memory and thereby limiting what information is captured and what form makes it to long-term memory (split-attention effect). This exchange and manipulation of to-be-learned material between the limited capacity of working memory and the unlimited capacity of long-term memory illustrates the role of educators in facilitating construction of knowledge in configurations to maximize storage and enhance retrieval. These configurations, or groupings, become the basis of successful learning.

Schema construction and schema automation. Chunking or grouping of related information specific to a particular problem solution, schema, define learning (Sweller, 1994). As learning progresses in a particular domain, schema become more complex as new information from repeated practice and problem solving is incorporated into an existing framework. Most powerful though, is the ability to fully complete a set of schema and use them on such a regular basis that conscious attention to recall is not needed. Conscious attention and awareness of that attention is one of the hallmarks of cognitive load. This developed ability to use sets of schema without conscious attention is critical in the continued development of expert skills. The automaton of schema occurs over time with repeated practice and use of the schema stored in long-term memory. Automation can be enhanced when lower level schemas are incorporated into more complex schemas as learning deepens and experience develops (schema elaboration).

Cognitive load. Cognitive load describes the impact on cognitive resources associated with completing a task or learning something new. Awareness of cognitive load is reflected in perceived mental effort as either a single scale or a set of sub-scales. When a task requires acute attention and is perceived by the learner to be difficult, taxing, or frustrating, it may be that the individual has reached a point in which the immediate resources of working memory required to complete the task are overloaded. Meaningful learning or the ability to complete a task diminishes at this point (Pass, Tuovinen, Tabbers, & van Gerven, 2003; Paas & van Merriënboer, 1994; van Gog, Kester, & Paas, 2011). Awareness of effort may also be a positive signal of engagement or interest in the material. Cognitive load theory differentiates load as either supporting schema construction/automation, germane cognitive load, or detracting from schema construction/automation, extraneous cognitive load. The latter can be related to the material itself, intrinsic cognitive load, or the way in which the material is presented. Intrinsic cognitive load, if it fosters engagement and attention relevant to schema construction, then contributes to germane cognitive load. Extraneous cognitive load, intrinsic cognitive load, and germane cognitive load are additive, so if they are not adapted for different types of learners and materials schema construction and acquisition of new information is quickly impeded as working memory is taxed and cognitive overload occurs (Paas, Renkl, & Sweller, 2003; van Merriënboer & Sweller, 2005). When considered together, each of these types of load offer opportunities for educators to positively impact learning outcomes through careful construction of learning materials and environments. This is essential, since cognitive load is part of the learning process and manipulation changes outcomes (Pass, et al., 2003).

Cognitive Load and Worked Example Design

Intrinsic cognitive load. Materials to be learned or tasks that are intellectually complex contribute specifically to one category of cognitive load, intrinsic cognitive load (Pollack, Chandler, & Sweller, 2002). Sweller (1994) states, "the primary determinant of intrinsic cognitive load is element interactivity" (pg. 307). Element interactivity describes a task that requires the learner to attend to multiple pieces of material (elements) that cannot be easily separated from one another. These elements interact and the task cannot be completed, nor schema constructed, without considering all of the elements together. Complex cognitive skills have high intrinsic cognitive load because they have a high level of element interactivity. In domains where greater numbers of interacting elements are common, learners are frequently overwhelmed (Ayers 2006; Pass, et al., 2003; Paas, Renkl, & Sweller, 2004). Intrinsic cognitive load also involves the expertise (experience) of the learner in the domain, so learners with lower prior knowledge may find a task difficult compared to an expert (Pass, Tuovinen, Tabbers, & van Gerven, 2003; Renkl, Atkinson, & Grosse, 2004). Arguments have been made that intrinsic cognitive load cannot be directly influenced by instructional design; however, intrinsic cognitive load reduction can be accomplished by simplifying tasks to reduce interactivity (Paas, Renkl, & Sweller, 2003; Pass, Tuovinen, Tabbers, & van Gerven, 2003; van Merriënboer, Kirschner, & Kester, 2003; van Merriënboer & Sweller, 2005). Though this may alter learning at a particular stage, it may be necessary with complex, high-element interactivity tasks.

Pollack, Chandler, & Sweller (2002) conducted a series of four experiments to test whether isolating elements of a problem while potentially sacrificing some understanding would prove more effective in actually accomplishing a task when compared to an interacting elements condition. First year industrial trade students were randomly assigned to a condition that eliminated the "what" and the "why" of conducting an insulation resistance test used by electrical engineers (isolated element condition) or a condition that included this information for the steps in the resistance test (interacting elements condition). Instructions were provided in each condition via a diagram with numbered steps in much the same way as a worked example in other domains. The interacting elements condition provided the "why" information associated with each step. Results indicated an advantage for those receiving the isolated elements version of the instructions in the test phase. In addition, mental load ratings were lower in the isolated elements condition and the relative efficiency of instruction, defined as a relationship between mental load and performance, was higher (Pollack, et al., 2002). These observations support modification of learning materials (decreasing intrinsic cognitive load) in initial stages of learning (for novices). This approach recognizes the paradox of not having sufficient prior knowledge (schemas) for learning complex material and the need to provide a learning environment where these schemas can be constructed in the first place. Elements can be added back in later as the experience of the learner increases (Paas, et al., 2003; van Merriënboer & Sweller, 2005; van Merriënboer, et al., 2003).

Extraneous cognitive load. Extraneous cognitive load includes instructional materials and environments that require students to spend working memory searching for procedures or pieces of information that are not relevant to schema construction however must be addressed to complete a task (Van Gog, Paas, & van Merriënboer, 2008). Extraneous cognitive load can also be a result of a task environment, for example one that is perceived as being high stakes. Extraneous cognitive load has frequently been where cognitive load theory is applied, changing the way material is presented to learners and where it is presented. Worked examples are particularly effective in reducing extraneous cognitive load by focusing attention of the learner on the relevant features of a problem (Gerjets, et al., 2004). Focusing attention is facilitated by worked examples when educational approaches limit extraneous cognitive load through structuring the impact of intrinsic cognitive load and encouraging students to invest the remaining cognitive resources toward schema construction, elaboration, and automation, all parts of germane cognitive load.

Germane cognitive load. Germane cognitive load enhances learning and, like extraneous cognitive load, may be more readily manipulated in the learning environment. Design elements of instruction to increase germane cognitive load support the use of working memory resources towards construction of schema. Current research in worked examples is now more focused on how to enhance germane cognitive load (Renkl, et al., 2004). One way of increasing germane cognitive load is by providing training conditions where learners are required to practice different versions of a task (context) where slightly different information is required to complete the task. This contextual inference effect is a result of increased cognitive load, measured as increased perceived mental effort. It is germane cognitive load and directly contributes to relevant schema construction (van Merriënboer, Schuurman, Crook, & Paas, 2002). van Merriënboer, et al. (2002) demonstrated improved training efficiency when comparing high contextual inference to low contextual inference in a group of engineering students. As predicted, the high contextual inference group took more time and reported higher mental effort. More important is that in this experiment students were diagnosing new problems in the testing environment of dynamic chemical systems, not ones they had seen or practiced before. This holds promise for performance on novel tasks (van Merriënboer, et al., 2002).

Example Format and Addition of Principle or Process Information to Worked Examples

Within the worked example literature, most are molar examples; worked examples designed to help learners identify structures and main components that help classify a problem. After learners classify a problem, they then use the learned steps to solve the problem as a whole. Because of the need to classify problems with this approach, these examples might encourage students toward a more recipe-like approach to problem solving which may be a detriment to learning. Molar worked examples direct the student from one step to the next, requiring that what was encountered in the previous step be held in working memory to understand the next step. Approaches using this type of worked example may also give students the illusion of understanding, that they have in fact also learned the rationale or principles behind the solution steps. This may inhibit novel problem solving. Simultaneous examples are similar to molar worked examples, where all the solution components are displayed at one time, so that each step is related to the others and not considered on its own (Atkinson & Derry, 2000). Having to consider the problem and its solution all at once may defeat one goal of worked examples, reducing cognitive load, especially intrinsic cognitive load. Molar examples may not decrease cognitive load in an appreciable way compared to alternative worked example designs (Gerjets, et al., 2004).

An alternative is a modular worked example. Modular worked examples may decrease intrinsic cognitive load more effectively by defining sub goals and limiting the solution search space to the sub goal and not the overall goal. Modular worked examples provide clues to relevance, order of operations, and associated labels that allow grouping of steps, potentially improving sub-goal learning. Within the format of modular examples, structural features that are highlighted also have associated an explicit purpose for performing that step and can stand alone. This may improve the possibility of recognizing steps that can be used or adapted in novel problem solving situations. An experiment designed by Atkinson and Derry, 2000 comparing sequential examples (modular) with simultaneous examples (molar), reported improved understanding of examples and improved performance on post-test problems for subjects in the sequential examples condition. The sequential examples of Atkinson and Derry (2000) are similar to modular examples in that the learner is presented an unsolved example or case with each step successively added with the final page representing the entire solution.

Gerjets, Scheiter, & Catrambone (2004) were able to demonstrate improved performance on isomorphic as well as novel problems when the modular example condition was compared to those studying molar examples. In addition, they replicated the experiment and introduced an alternative tool to measure perceived cognitive load, the NASA-Task Load Index (NASA- TLX) questionnaire (Hart, 2008; Hart and Staveland, 1988). In study five by Gerjets, et al., (2004), modular examples were changed to include or exclude instructional elaborations (principled or process information). Elaborations improved performance measures in the modular group compared to the molar group with elaborations. Most promising was that when modular examples included elaborations, performance improved when compared to the molar group. The NASA-TLX revealed decreased perceived task demands, stress, and effort for those in the modular examples, including elaborations compared to modular examples without elaborations (Gerjets, et al., 2004).

In an extension of their previous work with modular examples, Gerjets, Scheiter, & Catrambone (2006) compared modular examples at three levels of instructional elaboration (low, medium, high). Subjects were German undergraduate students of differing majors. Students were considered novices when it came to calculating complex-event probabilities. Subjects were told that they had to acquire knowledge in four different categories explained by a series of worked examples. In addition to performance measures and time on task, the NASA-TLX was used again with an added category of perceived success in understanding the examples. Results indicated more time was spent studying the medium and high elaborated examples. Elaborations did not improve performance on isomorphic problems within the modular examples; however, the medium to high elaborated examples rated perceived success higher while simultaneously reporting less study effort (lower cognitive load). An additional finding indicated that providing more instructional explanations concerning rationale behind the solution steps provided no clear benefit on problem-solving performance, negatively impacting efficiency because the examples took longer to study (Gerjets, Scheiter, & Catrambone, 2006).

One way to examine the use of modular worked examples is to further delineate between modular examples that list each sub goal, product-oriented worked examples (PDWE) and those that list each sub goal in addition to providing instructional elaborations, process-oriented worked examples (PSWE). Ultimately, the schemas for problems within a domain could become more elaborate using the PSWE approach and may deepen learning and promote understanding providing learners with an advantage when solving novel problems. On the other hand, some empirical evidence seems to support sub goal oriented worked example without elaborations. The advantage to adding process information for PSWE is not clear. There is space for research in the area comparing PDWE to PSWE for novices to determine if modular worked examples support learning and transfer and if PSWE are superior to PDWE on isomorphic and novel tasks.

Design Elements of Process-Oriented and Product-Oriented Worked Examples

Process-oriented and product-oriented worked examples meet the definition of modular examples. PDWE depict independent solution steps for a problem after it has been presented. There is no rationale provided for taking certain steps in PDWE (van Gog, Paas, & van Merriënboer, 2006). The steps are numbered with the step labeled and the associated answer for that step in the solution. PSWE adds domain-principled explanations to each solution step, the "how" and "why". Providing students with the purpose of the solution steps in a procedure has the potential to effectively increase germane cognitive load. This occurs not only through identification of recurrent elements highlighted in the process steps; but also for non-recurrent skills, potentially enhancing transfer performance especially for transfer tasks (novel) that may have slightly different features where following a memorized procedure or set of steps will not work (van Gog, et al, 2004; van Gog, et al, 2006).

Criticism of worked example approaches exists, especially when considering the level of prior knowledge or experience of students in a domain (Leslie, Low, Jin, & Sweller, 2012). For learners with lower prior knowledge, the worked examples may increase germane cognitive load to the point where learning is impeded by increasing overall cognitive load (van Gog, Paas, & van Merriënboer, 2008). To discern whether one type of worked example is more effective than another, an evaluation should address: (1) reducing extraneous cognitive load and intrinsic cognitive load as suggested by cognitive load theory, (2) engaging the students such that students will actually devote the attention needed in the learning phase to benefit from the worked example approach providing germane cognitive load, and (3) clearly identifying the population of students worked examples are being designed for, so content is structured for the level of prior knowledge (van Gog, et al., 2004; van Gog, e al., 2006; van Gog, et al., 2008).

Framing the worked example experiment for level of prior knowledge and engagement include describing the role of the student as part of a team of individuals where their input and ideas are critical (Engle, et al., 2012). In the context of training nutrition professionals, this can be used to situate the student as a member of the healthcare team as the expert with specific nutrition diagnostic and treatment information to be incorporated into overall care for an individual. Likewise, there is evidence to suggest that providing cues to direct student attention to relevant features of a problem will aid the student in developing an explicit problem schema that will trigger a particular solution path when a new problem is presented (Gick & Holyoak, 1983; Gobet, 2005). These schemas then may improve transfer to the novel problem by adding some protection from contextual changes, surface features that occur between learning the material and later application (Catrambone & Holyoak, 1989). Therefore, expansive framing for context and the inclusion of cues to notice problem features creates an expectation for transfer (novel problem solving). This may increase student engagement and support the notion of utility value for the new material potentially improving performance when faced with a novel problem (Engle, et al., 2012). This approach aligns with the worked example approach, specifically PSWE.

The intent in complex learning environments is identification of deep structural similarities and relationships between elements of the problem so that prior learning and the new context can be connected, leading to newly constructed schemas and advanced knowledge, all elements of emerging expertise in a particular domain (Gobet, 2005). At issue is the reality that new problems that could be approached using previously learned information or strategies do not always have similar surface structures and it is the deeper structure that may be a clue to a solution (Day & Goldstone, 2012). Labeling structure and drawing attention in a learning phase, such as worked examples, may make recognition, and therefore the solution, more achievable (Catrambone & Holyoak, 1989; Gobet, 2005). Perkins and Salomon (2012) suggest that this skill of detection can be developed by a variety of educational experiences. The discrepancies noted might be the most powerful in motivating a student to take the next step, or elect to explore the relationship of the discrepancies (Wigfield & Eccles, 2000). An example is a clinical case study example where the relationships between the discrepancies and interaction of elements are features of complex tasks. The modular worked example formats proposed in this research offer example problems that explicitly label features to detect discrepancies and connect information in the example to prior knowledge.

Measures of Perceived Cognitive Load and Mental Effort

Paas and van Merriënboer (1993) suggest cognitive load assessment should include the elements of mental effort, mental load, and performance; however, in practice there are differing approaches depending on the investigator and what the measures are intended to contribute to evaluation of a particular educational intervention or design (Pass, et al, 2003). If changes or approaches to instructional design are situated within cognitive load theory, by definition one of the goals is to decrease cognitive load while achieving acceptable learning outcomes. Physiologic and subjective measures of mental load have been used by investigators to estimate cognitive load. In most educational settings, the specialized equipment required to document physiologic changes related to cognitive load are usually impractical. Subjective measures assume that learners can reflect on the learning task and rank the amount of mental effort spent on a particular task (Paas, van Merriënboer, & Adam, 1994). Frequently, a nine- point scale from very, very low mental effort (1) to very, very high mental effort (9), suggested by Paas and van Merriënboer, is used, sometimes adapting the language of difficulty to the age of subjects (Paas & van Merriënboer, 1993; Paas, van Merriënboer, & Adam, 1994). This subjective measure, a task based indicator, can be used in the learning phase and in the performance phase of an investigation of educational approaches. Evidence suggests that student report of intensity of effort is the essence of cognitive load and the measurement of effort, using this scale, can be used reliably as an index of cognitive load (Ayres, 2006; Paas, et al., 1994).

Performance, correct answers or proficiency, is used frequently as an outcome for many educational approaches. If tied to mental effort or mental load, it is possible to ascertain at what cost performance occurred. For example, students in two different learning conditions may have the same score on a performance measure; however, students in one condition perceived their mental effort or cognitive load, the amount of resources allocated, to be much higher than those in the other condition. In this example, the condition that resulted in better or equal performance with a lower score of mental effort might in fact leave room for additional material and richer schema construction, with a presumed increase in germane cognitive load, than the condition where load was perceived higher (Ayers, 2006; Pass, et al., 1994; Pass, Tuovinen, Tabbers, & van Gerven, 2003). Additionally, this efficiency rating, acceptable performance with lower mental effort/perceived cognitive load, could be used to evaluate differences between learning conditions.

The computational approach for efficiency involves calculating *z* scores for mental effort and performance measures to compute an instructional condition efficiency score (*E*) via the following formula (Pass, et al., 2003):

$$E = \frac{Zperformance - Zmental\ effort}{\sqrt{2}}$$

Results are graphed on a Cartesian axis with performance on the vertical and mental effort on the horizontal with group or individual efficiency scores plotted as a distance from the *E*=0 line, passing from the lower left to the upper right of the grid. The upper left of the grid represents the highest efficiency and the lower right the lowest efficiency

(Pass, et al., 2003). Results can be computed and reported for students or groups by instructional condition. Two interpretations of efficiency exist in the literature, one using mental effort (perceived cognitive load) in the learning phase paired with performance scores in the transfer phase (adapted version) and the other considers mental effort and performance scores in the transfer phase (van Gog, et al., 2006; van Gog, et al., 2008).

Criticisms of a single scale of mental effort, as proposed by Paas & van Merriënboer (1993), for perceived cognitive load, a multi-dimensional construct, stem from the lack of individual measures of intrinsic cognitive load, extraneous cognitive load, and germane cognitive load (Ayers, 2006; Moreno, 2006). Ayers (2006); however, reported results of two experiments that demonstrate a relationship between changes in element interactivity that are reflected in subjective rankings of task difficulty and provide evidence of intrinsic cognitive load. In both experiments, eighth and ninth grade students were given a series of bracket expansion tasks (multiplication). Students had all been exposed to this material in the course of their school curriculum. Ayers used a modified seven-point scale for mental effort after each problem. Interestingly, in both experiments, which grouped students by levels of math skill for analysis, mental effort was highly correlated with error rates, indicating that those with higher reported mental effort made more errors (r=0.85; r=0.74 respectively) (Ayers, 2006).

The NASA-TLX offers an alternative to the criticism of the one item Paas scale (Hart & Staveland, 1988). It has been used in two experimental designs relevant to this proposed research (Gerjets, et al., 2004; Gerjets, et al., 2006). The NASA-TLX has six subscales that can be considered as a total score or separate subscale scores. Gerjets, et al., (2004 &2006) combined the six subscales into five: task demands, time demand, success, effort, and stress. There is evidence for the validity of use in a number of environments (Hart, 2008; Rubio, Diaz, Martin, & Puente, 2004). In this application, the NASA-TLX with five subscales has the potential to be more sensitive than the one item Paas scale to the subjective assessment of subjects and contribute more information for interpretation of results.

Summary and Implications for the Current Study

Based on the literature review, teaching nutrition diagnosis skills using worked examples offers a structured format that could be incorporated into all levels of nutrition education. According to cognitive load theory, worked example types need to be chosen based on the prior knowledge of the targeted learners and the content of the worked examples tailored to the stage of skill acquisition. The instructional design approach in this study specifically focuses on two variations of modular worked examples for the primary reason that learning stand-alone steps offers students a chance at incremental knowledge and skill acquisition since each part of the diagnostic process could be considered a separate skill. The difference between the two conditions of worked examples addresses the tendency of healthcare educators to provide background information related to problem solving that may or may not make it easier for the student to learn the relevant concepts. The advantage to adding process information (background) is not clear. There is a gap in the research comparing PDWE to PSWE for novices. The design of this worked example research, with a specific focus on PSWE, identifies how cognitive load theory and the measurement of perceived cognitive load aid in determining the benefit of worked examples in teaching nutrition diagnosis and how perceived cognitive load might be used to elucidate differences and potential advantages to certain categories of worked example instructional formats.

Chapter 3

METHODS

Introduction

The following sections describe the detailed methods that were used to compare two types of modular worked examples; process-oriented (PSWE) and product-oriented (PDWE), for performance, cognitive load, and efficiency for nutrition diagnosis.
The sections describe the participants, all study material and procedures for data collection and analyses. The pilot study, conducted to test and modify the procedures and instruments, is followed by the description of the main study.

The Pilot Study

Participants

Participants in the pilot study were nineteen undergraduate students attending a large southwestern university in the United States. Participants in the pilot study responded to recruitment flyers and to a short presentation requesting participation given by the investigator. At the time of the pilot, students were enrolled in an undergraduate nutrition course. To be eligible, students had to have taken NUTR 244, a broad introductory course in human nutrition typically taken by those pursuing a career in healthcare or the biological sciences. Participants were novices in nutrition, having just begun the study of human nutrition and the associated biology and chemistry courses that accompany course work in an undergraduate program (Ayers, Greer-Carney, Fatzinger McShane, Miller, & Turner, 2012). Students completed the pilot study in March 2014.

Participation was independent of any course requirement. All participants completed all portions of the study.

Measures

Demographic questionnaire. Demographics for the undergraduate students included age, gender, ethnicity, intention to pursue a career as a nutrition provider (motivation), nutrition course taken when participating in the study, and expected grade in the course, and the number of college nutrition courses taken (Appendix A) (Gross & Renkl, 2007; van Gog, et al., 2006).

Prior knowledge. Scores on a 12-item test of general human nutrition concepts that are typically covered in NUTR 244, the course taken by the target population, were used to assess prior knowledge (Appendix B). This set of questions was constructed specifically for this research. Prior knowledge is an integral part of determining potential benefits of worked example research and structuring worked examples to meet the needs of the intended group of students.

Measure of perceived cognitive load. Perceived cognitive load was assessed by having participants complete the NASA Task Load Index (NASA-TLX) at each phase; learning, practice, and maintenance (Hart & Staveland, 1988). It contains subscales of mental effort, success, stress, time demand, and task demand (Appendices C, D, & E). Perceived cognitive load is integral to the interpretation of results of research situated in cognitive load theory. The NASA-TLX in this study is used as an alternative to the single scale of mental effort, as proposed by Paas & van Merriënboer (1993), for perceived cognitive load, a multi-dimensional construct. The subscales of time demand and stress can be linked to extraneous cognitive load, the subscale of success to germane cognitive load, the subscales of task demand and time demand to intrinsic cognitive load and the effort rating to overall cognitive load.

Problem, Etiology, and Signs and Symptoms statement (PES) score. Scores for performance on diagnostic tasks in the practice and maintenance phases were obtained by scoring the diagnostic task recorded by the participants in the PES statement grid (same grid presented in the learning phase) for use of the correct diagnosis term (IDNT), correct placement of required elements, and etiology and signs and symptoms that corresponded with the diagnostic term. (Appendices F, G, H, & I) The PES format is the required structure for communicating nutrition diagnoses based on International Dietetics and Nutrition Terminology in the medical record. The PES scoring rubric is divided into three sections for the diagnosis; (Problem-P) eight points, etiology (Etiology-E) two points, and signs and symptoms (Signs and Symptoms-S) two points for a total of 12 possible points. A score of eight or better (≥67.5%) was considered good performance.

Materials

International Dietetics and Nutrition Terminology (IDNT) guide. A one page, abridged guide with only IDNT for the intake domain was provided to students to use in the learning, practice and maintenance phases. IDNT used for this study was limited to the intake domain in an abridged version to narrow the focus for these novice students to a smaller subset of possible diagnostic terms. The intake domain of IDNT is the primary area of expertise for nutrition providers. The intake domain is a focus of all educational approaches to teaching emerging nutrition professionals in the use of IDNT and in this context simplifies the number of interaction elements in a whole task representation and should decrease intrinsic cognitive load for these novice students (Simon, Faut, & Wooley, 2009) (Appendix J).

Learning phase cases. Two cases with the same clinical content were presented to students either in a PDWE or PSWE format. Each line of text in the cases and clinical information was numbered. Both conditions of worked example cited the numbered lines in the cases when items were identified as part of the diagnosis and transcribed into the PES diagnostic format. The cases were presented in a written narrative in much the same way one would hear or review a case in a healthcare setting. This case format is familiar to students as it is the most common way to present this type of problem in nutrition courses. The worked example format followed, outlining the solution steps in either a PDWE (Appendix K) or PSWE (Appendix L) condition. One case had one possible diagnosis and the other, two possible diagnoses. The last part of the worked example showed a completed PES diagnostic statement (in a grid format similar to fields on a standardized chart note (paper) or electronic medical record field. Cases presented assessment results such that no calculations were required to interpret the cases. Participants reported perceived cognitive load using the NASA-TLX after studying the learning phase examples.

Practice and maintenance phase cases. Participants were asked to diagnose two cases, one that was similar to the learning phase (isomorphic), case number one and one that was dissimilar (novel), case number two. Cases in each phase were identical for both conditions. The cases were presented in a written narrative in much the same way one would hear or review a case in a healthcare setting. This case format is familiar to students as it is the most common way to present this type of problem in nutrition courses. Cases presented assessment results such that no calculations were required to interpret the cases. Participants reported perceived cognitive load (mental effort) after completing the practice and maintenance phase cases. Students completed the PES diagnostic statement (in a grid format similar to fields on a standardized chart note (paper) or electronic medical record field. Students wrote the IDNT chosen from the provided guide and either rewrote or included the numbered lines from the case corresponding to the elements they wished to include in the correct portions of the PES diagnostic grid. (Appendix M & N)

Design

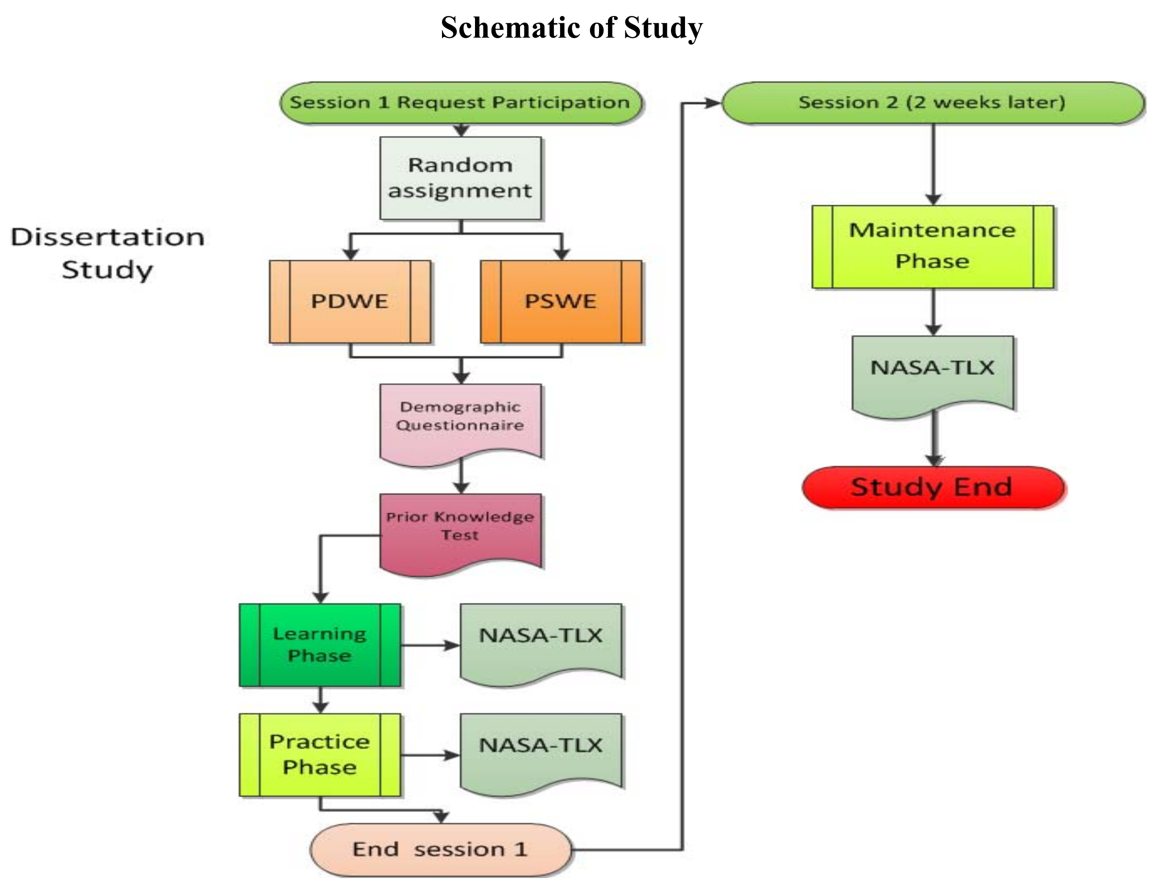
The study was conducted as a comparison by worked example condition, process-oriented (PSWE) or product-oriented (PDWE), with *a priori* covariates of intention to pursue a career as a nutrition provider (motivation) and scores on a 12-item test of general human nutrition concepts that are typically covered in NUTR 244 to determine prior knowledge. Session one consisted of a learning phase and practice phase. Participants were randomized to either PDWE or PSWE. The learning phase consisted of two worked examples, one with a single diagnosis and the other with two diagnoses, within the intake domain of IDNT. Limiting diagnoses to the intake domain will decrease intrinsic cognitive load as well as reinforce the intake domain as the primary area where registered dietitians intervene to provide nutrition care. Cases were the same for both conditions and varied only in whether the worked examples were PSWE or PDWE. In the practice phase, participants were asked to diagnose two cases, one that was similar to the learning phase (isomorphic), case number one, and one that is dissimilar (novel), case number two, after studying the worked examples in the learning phase. Cases in the practice phase were identical for both conditions. Participants reported perceived cognitive load for the learning phase examples and the practice phase cases using the NASA-TLX. Participants were allotted up to one hour and fifteen minutes, a typical class period, combined, for both the learning and practice phases in session one.

Two weeks later, a follow-up maintenance phase, session two, was conducted to assess maintenance of learning. Cases in the maintenance phase were identical for both conditions. Participants had up to 45 minutes, one-half a typical class period, to complete the maintenance phase tasks. Participants reported perceived cognitive load for the maintenance phase cases using the NASA-TLX.

The goal of the pilot study was to ascertain the clarity of instruction, structure of the case studies, timing, refinement of the scoring rubric for the diagnostic tasks in the practice and maintenance phases, and use of the cognitive load measure.

The schematic represented in Figure 1 outlines the study processes.

Figure 1. Schematic of Study



Human Subjects Protections

Participants were asked to give informed, signed consent to allow the investigator to use the results of their participation in the worked example experiment. Informed, signed consent consistent with the University Of New Mexico main campus Internal Review Board (Parkes/Bennett 13-874), for the pilot study was obtained after students arrived at the location for pilot study participation. (Appendix O)

Procedures

Participants in the pilot study responded to recruitment flyers and a short presentation requesting participation given by the investigator in an undergraduate nutrition course. This convenience sample was chosen to meet the requirement of novice nutrition provider. Participants must have taken the prerequisite NUTR 244 course that contains the same course objectives as the courses that comprise the targeted sample at the community college for the dissertation study.

Participants had one hour and fifteen minutes, to complete the learning and practice phase. The maintenance phase was conducted the same way two weeks later with one-half of a class period, about 45 minutes, allowed for completion. The study took place in a classroom setting on the campus of a large southwestern university outside of regularly scheduled class time. All participants in the pilot study completed the portions of the study at two separate times that accommodated the schedule of interested participants. Students in the pilot study were compensated with a gift card to a local restaurant for completing both portions of the pilot study, the initial session (learning and practice phases) and the follow-up maintenance phase.

Participants were randomly assigned to one of two worked example conditions when they arrived at the first session; product oriented worked examples (PDWE) or process-oriented worked examples (PSWE). Experimental materials were distributed to students in large envelopes of the same color, with a small sticker on the back that identified the condition as PSWE or PDWE. After the session, all materials were returned to the investigator inside the large envelope. Students completed all tasks using a pencil or pen and the provided materials. Study materials were designed to be used without a calculator.

The large envelope for session one contained two additional different colored envelopes. Colors corresponded to learning or practice tasks. Before beginning the learning phase, participants signed the consent form, completed the demographic information page, and completed the prior knowledge test. Participants completed the learning tasks first and returned all the learning materials to that envelope before proceeding with the practice tasks. Participants had the entire period to complete both learning and transfer tasks. Students wrote the time on each envelope (read from a large digital clock supplied by the investigator) after completion of each phase. A graduate student intern assisting with data collection kept time so that an average could be determined for that section of the study if the recorded time was missing from the participant envelopes.

The learning phase envelope contained all the materials needed for this phase: an introduction to participants describing (framing) their role as nutrition providers in this setting and a brief overview of the role of IDNT and the PES diagnostic format for communicating nutrition diagnosis in the medical record, worked example cases with completed PES diagnostic statement answer grid, perceived cognitive load questions (NASA-TLX); and the IDNT guide for the intake domain. The investigator was present to answer process questions and clarify study requirements and informed consent during each session.

For session two, two weeks later, the maintenance phase envelope contained all materials needed for this phase: an explanation of the task in the maintenance phase;

cases; PES diagnostic answer grid; perceived cognitive load questions (NASA-TLX); and IDNT guide for the intake domain.

Data Analyses

A series of one way ANOVAs were conducted, for between-subjects, with the dependent variables scores on the diagnostic tasks (PES statements), perceived cognitive load scores in learning, practice and maintenance phases, and calculated efficiency; with the independent variable worked example condition of either PDWE or PSWE. The alpha for statistical significance testing was set at α=0.05. Prior nutrition knowledge and intention to pursue a career as a nutrition provider (motivation) were identified *a priori* as covariates with the plan of using one way ANCOVA. Initial inspection of the pilot study data revealed that since this convenience sample was so homogeneous, 89.5% intended to pursue a career as nutrition professional, using this as a covariate was not helpful in interpreting results. Similarly, the scores on the prior knowledge test were uniformly high (PSWE *M*=9.8/12, *SD*=1.5; PDWE *M*=10.2/12, *SD*= 1.3), did not differ between groups, (F (1, 17) = .408, p=.531), and did not correlate highly with the dependent variables. ANCOVA with these covariates was not used with the pilot study sample.

The computational approach for efficiency involved calculating *z* scores for mental effort and performance measures and computing an instructional condition efficiency score (*E*) via the following formula (Pass, et al., 2003):

$$E= \frac{Zperformance - Zmental\ effort}{\sqrt{2}}$$

Efficiency scores (*E*) were calculated for each diagnostic task for each worked example condition. A one way ANOVA was conducted on the practice phase cases and the maintenance phase cases by worked example condition.

Time stamps from the pilot study were reviewed to determine if sufficient time was allotted to the learning and transfer tasks. This data was used in securing Institutional Review Board approval at the community college as there were concerns that students would not be able to complete the study within a regularly scheduled class period. Additionally, any comments students wrote on their study materials were reviewed to determine the need for modifications in the materials provided to participants prior to the main dissertation study.

All of the diagnostic tasks (PES diagnostic statements) were scored by the investigator using a rubric designed by the investigator for the cases in the experiment. To check the scoring rubric, a random sample of the PES diagnostic statements was scored by a University of New Mexico nutrition faculty volunteer using the investigator's rubric. Scores and score agreement were examined to determine if any modifications in the scoring rubric needed to occur.

The PES scoring rubric was divided into three sections for the diagnosis; (Problem-P) eight points, etiology (Etiology-E) two points, and signs and symptoms (Signs and Symptoms-S) two points for a total of 12 possible points. A score of eight or better ($\geq$67.5%) was considered good performance as it is close to the requirement of 70% on most licensing or proficiency exams in healthcare. Each PES section was scored separately since each represents a slightly different aspect of diagnostic skill. Each diagnostic task, three in the practice phase and three in the maintenance phase, had specific diagnostic codes and assessment elements that resulted in a score (Appendices F, G, H, & I).

For the diagnosis code (Problem-P), a score of eight was given if the diagnosis name and number matched the rubric. Four was scored if not as precise a diagnosis, two if it was related but broader and less specific than the diagnosis that would have scored four, and zero if it did not match anything on the rubric or was not present. For the etiology (Etiology-E), two points were given for a match on the scoring rubric, one point for a related etiology outlined on the rubric, but not the root cause, and zero if it was not an etiology, related, or blank. For the signs and symptoms section (Signs and Symptoms-S) two points were given for a match on the scoring rubric, one point for related, but missing objective measurable signs (quantitative data from the case study such as anthropometrics or laboratory studies) and zero if not a symptom or sign, or blank (Appendices F, G, H, & I).

The Main Study

Participants

Participants were 104 undergraduate students in eight separate class sessions at a community college with ties to a large southwestern university and the undergraduate nutrition bachelors program. To be eligible, participants had to be currently enrolled in one of two introductory nutrition courses, NUTR 2110 or NUTR 1015, both broad introductory courses in human nutrition typically taken by those pursuing a career in healthcare or the biological sciences. These participants were novices in nutrition, having just begun the study of human nutrition and the associated biology and chemistry courses that accompany course work in the first two years of an undergraduate nutrition program (Ayers, et al., 2012).

Measures

Demographic questionnaire. Demographics for the undergraduate students included age, gender, ethnicity, intention to pursue a career as a nutrition provider (motivation), nutrition course taken when participating in the study, and expected grade in the course (motivation), and the number of college nutrition courses taken (Appendix A) (Gross & Renkl, 2007; van Gog, et al., 2006).

Prior knowledge. Scores on a 12-item test of general human nutrition concepts that are typically covered in NUTR 244, the course taken by the target population, was used to assess prior knowledge (Appendix B). This set of questions was constructed specifically for this research. Prior knowledge is an integral part of determining potential benefits of worked example research and structuring worked examples to meet the needs of the intended group of students.

Measure of perceived cognitive load. Perceived cognitive load was assessed by having participants complete the NASA Task Load Index (NASA-TLX) at each phase; learning, practice, and maintenance (Hart & Staveland, 1988). It contains subscales of mental effort, success, stress, time demand, and task demand (Appendices C, D, & E). Perceived cognitive load is integral to the interpretation of results of research situated in cognitive load theory. The NASA-TLX in this study is used as an alternative to the single scale of mental effort, as proposed by Paas & van Merriënboer (1993), for perceived cognitive load, a multi-dimensional construct. The subscales of time demand and stress can be linked to extraneous cognitive load, the subscale of success to germane cognitive load, the subscales of task demand and time demand to intrinsic cognitive load, and the effort rating to overall cognitive load.

Problem, Etiology, and Signs and Symptoms statement (PES) score. Scores for performance on diagnostic tasks in the practice and maintenance phases were obtained by scoring the diagnostic task recorded by the participants in the PES statement grid (the same grid presented in the learning phase) for use of the correct diagnosis term (IDNT), correct placement of required elements, and etiology and signs and symptoms that corresponded with the diagnostic term (Appendices F, G, H, & I). The PES format is the required structure for communicating nutrition diagnoses based on International Dietetics and Nutrition Terminology in the medical record. The PES scores were obtained using the rubric tested in the pilot study.

Materials

International Dietetics and Nutrition Terminology (IDNT) guide. A one page, abridged guide with IDNT only for the intake domain, was provided to students to use in the learning, practice and maintenance phases. IDNT used for this study was limited to the intake domain in an abridged version to narrow the focus for these novice students to a smaller subset of possible diagnostic terms. The intake domain of IDNT is the primary area of expertise for nutrition providers. The intake domain is a focus of all educational approaches to teaching emerging nutrition professionals in the use of IDNT and, in this context, simplifies the number of interaction elements in a whole task representation and decreases intrinsic cognitive load for these novice students (Simon, et al., 2009) (Appendix J).

Learning phase cases. Two cases with the same clinical content were presented to students either in a PDWE or PSWE format. Each line of text in the cases and clinical information was numbered. Both conditions of worked example cited the numbered lines in the cases when items were identified as part of the diagnosis and transcribed into the PES diagnostic format. The cases were presented in a written narrative in much the same way one would hear or review a case in a healthcare setting. This case format is familiar to students as it is the most common way to present this type of problem in nutrition courses. The worked example format followed, outlining the solution steps in either a PDWE (Appendix K) or PSWE (Appendix L) condition. One case had one possible diagnosis and the other, two possible diagnoses. The last part of the worked example showed a completed PES diagnostic statement (in a grid format similar to fields on a standardized chart note (paper) or electronic medical record field. Cases presented assessment results such that no calculations were required to interpret the cases. Participants reported perceived cognitive load using the NASA-TLX after studying the learning phase examples.

Practice and maintenance phase cases. Participants were asked to diagnose two cases, one that was similar to the learning phase (isomorphic), case number one, and one that was dissimilar (novel), case number two. Cases in each phase were identical for both conditions. The cases were presented in a written narrative in much the same way one would hear or review a case in a healthcare setting. This case format is familiar to students as it is the most common way to present this type of problem in nutrition courses. Cases presented assessment results such that no calculations were required to interpret the cases. Participants reported perceived cognitive load (NASA-TLX) after completing the practice and maintenance phase cases. Students completed the PES diagnostic statement in a grid format similar to fields on a standardized chart note (paper) or electronic medical record field. Students wrote the IDNT chosen from the provided guide and either rewrote or included the numbered lines from the case corresponding to the elements they wished to include in the correct portions of the PES diagnostic grid. (Appendices M & N)

Design

The study was conducted as a comparison by worked example condition, process-oriented (PSWE) or product-oriented (PDWE), with *a priori* covariates of intention to pursue a career as a nutrition provider (motivation) and scores on a 12-item test of general human nutrition concepts that are typically covered in introductory nutrition courses such as NUTR 2110 or NUTR 1015 to determine prior knowledge.

Session one consisted of a learning phase and practice phase. Participants were randomized to either PDWE or PSWE. The learning phase consisted of two worked examples, one with a single diagnosis and the other with two diagnoses within the intake domain of IDNT. Limiting diagnoses to the intake domain decreases intrinsic cognitive load as well as reinforces the intake domain as the primary area where registered dietitians intervene to provide nutrition care. Cases were the same for both conditions and varied only in whether the worked examples were PSWE or PDWE.

In the first transfer phase (practice phase), participants were asked to diagnose two cases, one that was similar to the learning phase (isomorphic), case number one, and one that was dissimilar (novel), case number two, after studying the worked examples in the learning phase. Cases in the practice phase were identical for both conditions.

Participants reported perceived cognitive load for the learning phase examples and the practice phase cases. Participants were allotted up to one hour and fifteen minutes, one whole class period, combined, for both the learning and practice phases in session one.

Two weeks later, a follow-up maintenance phase, session two, was conducted to assess maintenance of learning. Cases in the maintenance phase were identical for both conditions. Participants had up to 45 minutes, approximately one-half a class period, to complete the maintenance phase tasks. Participants reported perceived cognitive load (NASA-TLX) for the maintenance phase cases.

Human Subjects Protections

Participants were asked to give informed, signed consent to allow the investigator to use the results of their participation in the worked example experiment in their nutrition class sessions consistent with the Central New Mexico Community College Institutional Review Board (Bennett 011314) (Appendix P). Consent allowed the investigator to use the results of their participation in the worked example experiment to evaluate worked examples for teaching nutrition diagnosis. Faculty consent, consistent with the Central New Mexico Community College Institutional Review Board (Bennett 011314) (Appendix Q) was required before the investigator was allowed to engage the students in the worked example experiment. Participation fulfilled a course requirement within the structure of the class for students in classes that faculty consent was obtained. Students who did not consent to have the results of their work used by the investigator worked with the study materials in both sessions; however, data from their work was not included and study materials were shredded at the completion of the experiment.

Procedures

In class sessions where faculty consent was obtained, participants were asked o give informed, signed consent to allow the investigator to use the results of their participation in the worked example experiment.

Participants had one hour and fifteen minutes to complete the learning and first transfer (practice) phase. The maintenance transfer phase was conducted the same way two weeks later with one-half of a class period, about 45 minutes, allowed for completion. Both sessions of the study took place during a regularly scheduled class session on the campus of a community college with ties to a large southwestern university.

Participants were randomly assigned to one of two worked example conditions, product oriented worked examples (PDWE) or process-oriented worked examples (PSWE), when they arrived at the first session. Experimental materials were distributed to students in large envelopes of the same color, with a small sticker on the back that identified the condition as PSWE or PDWE. After the session, all materials were returned to the investigator inside the large envelope. Students completed all tasks using a pencil or pen and the provided materials. Study materials were designed to be used without a calculator.

The large envelope for session one contained two additional different colored envelopes. Colors corresponded to learning or practice tasks. Before beginning the learning phase, participants signed the consent form, completed the demographic information page, and completed the prior knowledge test. Participants completed the learning tasks first and returned all the learning materials to that envelope before proceeding with the practice tasks. Participants had the entire period to complete both learning and transfer tasks. Students wrote the time on each envelope (read from a large digital clock supplied by the investigator) after completion of each phase. A graduate student intern assisting with data collection kept time so that an average could be determined for that section of the study if the recorded time was missing from the participant envelopes.

The learning phase envelope contained all the materials needed for this phase: an introduction to participants describing (framing) their role as nutrition providers in this setting, a brief overview of the role of IDNT, the PES diagnostic format for communicating nutrition diagnosis in the medical record, worked example cases with completed PES diagnostic statement answer grid, perceived cognitive load questions (NASA-TLX); and IDNT guide for the intake domain. The investigator was present to answer process questions and clarify study requirements and informed consent during each session.

For session two, two weeks later, the maintenance phase envelope contained all materials needed for this phase: an explanation of the task in the practice phase; cases; PES answer grid; perceived cognitive load questions (NASA-TLX); and IDNT guide for the intake domain.

Data Analyses

A series of one way ANCOVAs were conducted for between-subjects, with the dependent variables scores on the diagnostic tasks (PES statements), perceived cognitive load scores in learning, practice and maintenance phases, and calculated efficiency with the independent variable worked example condition of either PDWE or PSWE. The alpha for statistical significance testing was set at $\alpha=0.05$. Prior nutrition knowledge and intention to pursue a career as a nutrition provider (motivation) were identified *a priori* as covariates. Initial inspection of the study data revealed this sample was homogeneous with regard to pursuing a career as a nutrition professional, 85.6% did not intend to pursue a nutrition career, so using this as a covariate was not helpful in interpreting results. The scores on the prior knowledge test did correlate highly with the dependent variable, so ANCOVA with the covariate of prior knowledge was used with the main dissertation study sample.

The computational approach for efficiency involved calculating *z* scores for mental effort and performance measures to compute an instructional condition efficiency score (*E*) via the following formula (Pass, et al., 2003):

$$E = \frac{Zperformance - Zmental\ effort}{\sqrt{2}}$$

Efficiency scores (*E*) were calculated for each diagnostic task for each worked example condition. A one way ANOVA was conducted on the practice phase cases and the maintenance phase cases by worked example condition.

All of the diagnostic tasks (PES statements) were scored by the investigator using a rubric designed for the cases in the experiment in the same manner as for the pilot study. Comments written by participants on their study materials were reviewed to identify themes associated with any difficulty with the study materials and if any of the study materials were familiar to participants.

Secondary analysis. High scores on the PES diagnostic statements ($\geq$ 8 of 12) were explored to determine if any relationships existed between student demographics and prior knowledge.

Chapter 4

RESULTS

Introduction

This study investigated two types of modular worked examples; process-oriented (PSWE) and product-oriented (PDWE), for performance, cognitive load, and efficiency for nutrition diagnosis. This chapter reports the results of statistical analyses to answer the research questions proposed in Chapter One. Results of the pilot study are followed by results of the main study and an overall summary.

Pilot Study

Data for the pilot study was analyzed using a one-way ANOVA. An $\alpha = 0.05$ was chosen for determining statistical significance. This was deemed a reasonable compromise between Type I and Type II error. Effect sizes for relationships that reached a level of statistical significance are the most important for interpretation of group differences. Correlations were interpreted at an $\alpha = 0.05$ to identify any variables that were identified as *a priori* covariates that should in fact be further investigated before including them in the model. Statistically significant correlations were not identified as dependent variables in the study and no hypotheses were structured around interpretation of the correlations. For those variables analyzed using one-way ANOVA, tests for assumptions (normality, homogeneity of group variances) were evaluated prior to the analysis.

The *a priori* covariates of motivation (intent to pursue a career in human nutrition) and level of prior knowledge (scores on a general test of nutrition knowledge) were not included; therefore, analysis using a one-way ANCOVA was not conducted. The *a priori* covariate of motivation (intent to pursue a career in human nutrition) was not included because 89.5% of all participants intend to pursue a career in human nutrition. The level of motivation in this sample as assessed by this question was high. There was no statistically significant difference between groups on the test of nutrition prior knowledge (PSWE M=9.8/12, SD=1.5; PDWE M=10.2/12, SD= 1.3), F (1, 17) = .408, p=.531) and the scores were relatively high (81.6-85% correct answers). Internal consistency using Cronbach's alpha was calculated on the 12 items of the prior knowledge test (α =-.041). This low value indicates the almost non-existent correlations between items and the nature of the prior knowledge exam measuring a wide array of concepts. In addition there was very little variability in the scores. There was no statistically significant correlation of prior knowledge with any of the dependent variable scores on the diagnostic tasks (performance). There was a statistically significant correlation between prior knowledge and minutes working the practice cases $r(19)$ = .553, $p < .05$, indicating that the higher the score on the test of prior knowledge more time was spent working with the maintenance cases.

The pilot study sample is biased in that the participants were highly motivated to participate in the pilot study based on their career choice and very different from students in the target population of the main study who were taking an introductory nutrition course. All but two participants indicated that they were pursuing a career in human nutrition and, as a result, most had taken two or more college nutrition courses (M=6.05, SD=2.4), with at least one of them NUTR 244. Participant characteristics are outlined in (Table 1).

Table 1. Pilot Study Participants Characteristics

Worked Example Condition	PSWE	PDWE
Number of participants (total = 19)	10	9
Gender	3 male; 7 female	1 male; 8 female
Age	M=28.1	M=28.67
Number of college nutrition courses taken	$\geq$ 2 (range 2-10)	$\geq$ 4 (range 4-10)
Score on general nutrition prior knowledge test	M=9.8/12 (SD= 1.5)	M=10.2/12 (SD=1.3)
Intent to pursue career in human nutrition	8 yes, 80%	9 yes, 100%
Ethnic Group		
Native American/Alaska Native	0	1
Hispanic	5	1
Non-Hispanic White	4	5
Other	1	2

The stated purpose of the pilot study was to evaluate the study materials and the design of the experiment. This involved assessing the time it took for all the phases of the experiment so that this could be included in the IRB submission at Central New Mexico Community College for the main study; assessing inter-rater reliability for the scoring rubric, and noting any errors or confusing directions identified by the pilot study participants. All these were accomplished with this pilot study sample. Results follow for time on task at each phase of the study and the Interclass Correlation Coefficient for the scoring rubric. A minor typographical error was found on the one-page IDNT guide and two within the text of the case studies. These were corrected before the main study. Participants uniformly used the line scale on the NASA-TLX as a 20 point rather than a 21 point scale; therefore subscale scores were interpreted on a 20 point scale for both the pilot and main study.

Performance on Diagnostic Tasks

To address the first two research questions and the associated hypothesis of (1) whether both product-oriented worked example and process-oriented worked example conditions result in an ability to use International Dietetics and Nutrition Terminology (IDNT) and Problem, Etiology, and Signs and Symptoms (PES) diagnostic statements by novices as evidenced by performance on diagnostic tasks and (2) whether the process-oriented worked example condition results in better performance on diagnostic tasks when compared to product-oriented worked example condition for novices learning to use IDNT and PES diagnostic charting, scores on the diagnostic tasks were examined by worked example type. Results for the practice phase and maintenance phase are presented sequentially.

Practice Phase-Pilot

Practice phase data was analyzed using a one-way ANOVA for (1) the time spent studying the worked examples, and (2) total scores on the diagnosis tasks for each case (PES score). Levene's test of homogeneity of variance revealed no violations of the assumption of homogeneity of variance with p values >.10. Shapiro-Wilk tests of normality indicate p values less than 0.10 which leads to the rejection of the null hypothesis that the dependent variables are normally distributed thereby violating the assumption of normality for all variables except for minutes working with the practice cases. Histograms for the PES scores are negatively skewed and leptokurtic consistent with the high scores on the tasks. ANOVA is robust to the violation of the assumption of normality, so these analyses were conducted despite the non-normality. There were no statistically significant differences between worked example conditions for any of the -

variables for performance during the practice phase (Table 2). Participants did very well on the diagnostic tasks with both groups scoring at or better than 74% correct for each of the three diagnostic tasks (8.9/12).

Table 2. Pilot study practice phase performance dependent variables (M; SD)-ANOVA

Worked Example Condition	**PSWE**	**PDWE**	*p* value	*F* (1, 17)
Time spent working with the clinical cases (minutes)	34. (6.7)	35.6 (6.2)	0.715	0.138
PES score Case 1 Diagnosis 1*	10. (3.1)	11.4 (0.7)	0.339	0.969
PES score Case 1 Diagnosis 2*	9.9 (2.9)	9.6 (3.7)	0.824	0.051
PES score Case 2 Diagnosis 1*	9.7 (3.5)	8.9 (4.5)	0.666	0.193

* of possible 12 points

Maintenance Phase-Pilot

For the maintenance phase, data was analyzed using a one-way ANOVA for (1) the time spent studying the worked examples, and (2) total scores on the diagnosis tasks for each case (PES score). Levene's test of homogeneity of variance revealed a violation of the assumption of homogeneity of variance for the first case, diagnosis one, with *p* values >.10. Brown-Forsythe test was used to interpret results for this case. Shapiro-Wilk tests of normality indicate *p* values less than 0.10 which leads to the rejection of the null hypothesis that the dependent variables are normally distributed thereby violating the assumption of normality for all variables except for minutes working with the practice cases. Histograms for the PES scores are negatively skewed and leptokurtic consistent with the high scores on the tasks. ANOVA is robust to the violation of the assumption of normality, so these analyses were conducted despite the non-normality. There were no statistically significant differences between worked example conditions for any of the variables for performance during the maintenance phase (Table 3). Participants did very well on the diagnostic tasks with both groups scoring at or better than 67.5% for each of the three diagnostic tasks (8.1 of 12) correct.

Table 3 Pilot study maintenance phase performance dependent variables (M; SD)-ANOVA

Worked Example Condition	PSWE	PDWE	p value	F (1,17)
Time spent working with the clinical cases (minutes)	24.6 (4.9)	23.7 (6.9)	0.738	0.686
PES score Case 1 Diagnosis 1*	8.1 (4.2)	10.7 (.087)	0.089	3.6^
PES score Case 2 Diagnosis 1*	9.0 (3.3)	10.1 (1.7)	0.381	0.809
PES score Case 2 Diagnosis 2*	9.5 (2.4)	9.1 (3.4)	0.776	0.116

^ Brown-Forsythe
* of possible 12 points

Interrater Reliability for PES Diagnostic Statement Scores

Interrater reliability was assessed for scores on diagnostic tasks by taking a random sample of five participants from the pilot study and calculating an intraclass correlation coefficient between the investigator using the scoring rubric designed for the study and a nutrition faculty volunteer using the same rubric on each of the six diagnostic tasks. Intraclass correlation coefficient was calculated on 30 scores for each of two raters. Results of a two-way mixed consistency intraclass correlation coefficient calculation for average measures was $ICC_{(3, 2)} = .942$, $F(29, 29) = 17.38$, $p = .000$. Excellent inter-rater reliability was observed using the rubric for scoring diagnostic tasks.

Cognitive Load

To address research question four and the associated hypotheses, four, whether there is a difference in perceived cognitive load between the PDWE and the PSWE conditions, scores on the five subscales of the NASA-TLX were compared by worked example condition. In addition, a cognitive load score was computed as the sum of NASA-TLX subscales of task demand, effort and stress (Gerjets, et al., 2004). Perceived cognitive load was assessed by having participants complete the NASA Task Load Index (NASA-TLX) at each phase; learning, practice, and maintenance (Hart & Staveland, 1988). It contains subscales of mental effort, success, stress, time demand, and task demand (Appendices C, D, & E). Perceived cognitive load is integral to the interpretation of results of research situated in cognitive load theory. The NASA-TLX in this study is used as an alternative to the single scale of mental effort, as proposed by Paas & van Merriënboer (1993), for perceived cognitive load, a multi-dimensional construct. The subscales of time demand and stress can be linked to extraneous cognitive load, the subscale of success to germane cognitive load, the subscales of task demand and time demand to intrinsic cognitive load and the effort rating to overall cognitive load. Each of the five subscales was rated by participants from 0-20. Participants rated each subscale from 0-20. In addition to perceived cognitive load measured by the NASA-TLX, time spent on each phase (minutes working) is also compared by worked example condition.

Internal consistency using Cronbach's alpha for the four subscales on the NASA-TLX of task demand, time demand, effort, and stress measuring a similar construct of perceived cognitive load corresponding to intrinsic or extraneous cognitive was α =.858 for the learning phase, α =.843 for the practice phase, and α =.853 for the maintenance phase. The success subscale is related to germane cognitive load and was removed from the analysis. The four subscales of the NASA-TLX in this application were found to be highly reliable.

Learning Phase-Pilot

Data for the learning phase was analyzed using a one-way ANOVA. Levene's test of homogeneity of variance revealed some of the variables (minutes studying the examples, success, and stress) violate the assumption of homogeneity of variance with *p* values that are lower than $\alpha = 0.10$. The Brown-Forsythe method, for those variables that violate the assumption of homogeneity of variance, was used to interpret results. Shapiro-Wilk tests of normality indicate *p* values less than 0.10 which leads to the rejection of the null hypothesis that the dependent variables are normally distributed thereby violating the assumption of normality. Histograms for the prior knowledge test and success on the NASA-TLX are negatively skewed and those for the variables of effort, stress, task demand, time demand and minutes studying worked examples are positively skewed indicating non normal distribution. ANOVA is robust to the violation of the assumption of normality, so these analyses were conducted despite the non-normality.

There were no statistically significant differences between worked example conditions for any of the variables in the learning phase (Table 4). For both groups, perceived success was high (PSWE *M*=17.4, *SD*=2.9; PDWE *M*=15.3, *SD*=5.7 on a 0-20 scale) and cognitive load as measured by the NASA-TLX subscales as a computed variable combining task demand, effort and stress, was relatively low when the possible score for the cognitive load variable is a 60 point scale (PSWE *M*=18.2, *SD*=13.7; PDWE *M*=13.3, *SD*=9.4).

Table 4. Pilot study learning phase cognitive load dependent variables (M; SD) ANOVA

Worked Example Condition	**PSWE**	**PDWE**	*p* value	*F* (1, 17)
Time spent studying the worked examples (minutes)	18.1 (4.5)	16.4 (1.5)	0.287	1.2
Perceived Cognitive Load-NASA TLX (0-20 scale for each item)				
	PSWE	**PDWE**	*p* value	*F* (1, 17)
Task demand	6.1 (4.7)	4.9 (3.3)	0.527	0.416
Time demand	5.2 (4.6)	3.0 (2.0)	0.2	1.8
Success	17.4 (2.9)	15.3 (5.7)	0.33	1
Effort	6.3 (4.9)	5.1 (5.2)	0.615	0.263
Stress	5.8 (5.4)	3.0 (1.7)	0.16	2.1
Cognitive load -learning	18.2 (13.7)	13 (9.4)	0.355	0.904

Practice Phase-Pilot

Data for the practice phase was analyzed using a one-way ANOVA. Levene's test of homogeneity of variance revealed some of the variables (time demand and stress) violate the assumption of homogeneity of variance with *p* values that are lower than α=0.10. The Brown-Forsythe method, for those variables that violate the assumption of homogeneity of variance, was used to interpret results. Shapiro-Wilk tests of normality indicate *p* values less than 0.10 for the time demand variable only which leads to the rejection of the null hypothesis that the dependent variable are normally distributed thereby violating the assumption of normality. ANOVA is robust to the violation of the assumption of normality, so these analyses were conducted despite the non-normality.

There was no statistically significant difference between worked example types on any of the cognitive load variables during the practice phase for the pilot study (Table 5).

Table 5 Pilot study practice phase cognitive load dependent variables (M; SD)-ANOVA

Worked example Condition	**PSWE**	**PDWE**	p value	F (1, 17)
Perceived Cognitive load-NASA TLX (0-20 scale for each item)				
Task demand	8.1 (5.1)	7.9 (4.7)	0.936	0.007
Time demand	5.8 (5.9)	3.4 (3.1)	0.291	1.2^
Success	12.5 (5.6)	14.4 (5.0)	0.385	0.797
Effort	8.1 (5.3)	9.9 (5.5)	0.508	0.459
Stress	7.2 (5.9)	5.1 (3.1)	0.348	.944^
Cognitive load- practice	23.4 (15.2)	22.9 (12.1)	0.937	0.006

^ Brown-Forsythe

Maintenance Phase-Pilot

Data for the maintenance phase was analyzed using a one-way ANOVA. Levene's test of homogeneity of variance revealed one variable (task demand) violated the assumption of homogeneity of variance with p value that was lower than $\alpha = 0.10$. The Brown-Forsythe method was used to interpret results for task demand. Shapiro-Wilk tests of normality indicate p values less than 0.10 for the time demand, minutes working with the cases, stress, and effort variables leading to the rejection of the null hypothesis that the dependent variables are normally distributed thereby violating the assumption of normality. ANOVA is robust to the violation of the assumption of normality, so these analyses were conducted despite the non-normality (Table 6).

Table 6. Pilot study maintenance phase cognitive load dependent variables (M; SD)-ANOVA

Worked example Condition	PSWE	PDWE	*p* value	*F* (1,17)
Perceived Cognitive load-NASA TLX (0-20 scale for each item)				
Task demand	7.5 (4.7)	5.1 (2.8)	0.19	1.9^
Time demand	4.9 (4.2)	3.3 (4.2)	0.427	0.661
Success	15.2 (3.3)	11.4 (5.1)	0.069	3.8
Effort	10.5 (3.1)	6.9 (4.5)	0.055	4.2
Stress	6.0 (3.9)	5.9 (4.9)	0.957	0.003
Cognitive load -maintenance	24 (9.2)	17.9 (11.5)	0.218	1.6

^ Brown-Forsythe

There were no statistically significant differences between worked example types for any of the cognitive load measures; however, for success (PSWE *M*=15.2, *SD*=3.3; PDWE *M*=11.4, *SD*= 5.1), $F(1,17) = 3.8$, $p = .069$ and effort (PSWE *M*=10.5, *SD*=5.1; PDWE *M*=6.9, *SD*= 4.5), $F(1,17) = 4.2$, $p = .055$, the difference was noticeable even in this small sample. $\omega^2 = .127$ for success indicates that worked example condition accounted for 12.7% of the variance in the success rating and $\omega^2 = .146$ for effort indicates that worked example condition accounted for 14.6% of the variance in effort rating in the maintenance phase.

Themes from Comments from Write in Questions on NASA-TLX

Participants had an opportunity to write answers to two questions on the NASA-TLX for each phase; learning, practice and maintenance. Question one was: “What was the hardest part about working with or studying the clinical case worked examples”? Question two was “Were the situations depicted in the clinical cases and worked examples familiar to you and why”?

Learning Phase

Question one. Themes that emerged were related to reading about new terminology and comparing the worked examples; to how this information was presented differently than in their course work; reading through a lot of material; and trying to decide what was important as they were studying the examples in a new format.

Question two. Most participants found the cases and themes of the cases similar to course work from their own or family experiences.

Practice Phase

Question one. The most common themes that emerged were remembering where things go in the PES format, deciding what was the most important nutrition problem in the case, and trying to decide which IDNT codes to use.

Question two. Most participants reported they were familiar with using case examples from their course work. Most commented on case two (novel case) being difficult and not being sure how to make a diagnosis when they thought they did not have enough information.

Maintenance Phase

Question one. The most common themes that emerged were remembering where things go in the PES format, deciding what was the most important nutrition problem in the case, and trying to decide which IDNT codes to use. Participants commented most frequently on having trouble with what was an etiology and what was a sign and symptom as part of the PES diagnostic statement. Participants also commented on trying to remember what they had learned from session one of the experiment and not being confident they were doing the work correctly.

Question two. Most participants reported they were familiar with similar types of case examples from their course work.

Calculated Efficiency

To address research question three whether there is a difference between the PSWE condition and the PDWE condition on training efficiency when calculated from self-report of mental effort from the NASA-TLX subscale of effort and performance on diagnostic tasks, a one way ANOVA was conducted on the practice phase cases and the maintenance phase cases by worked example condition.

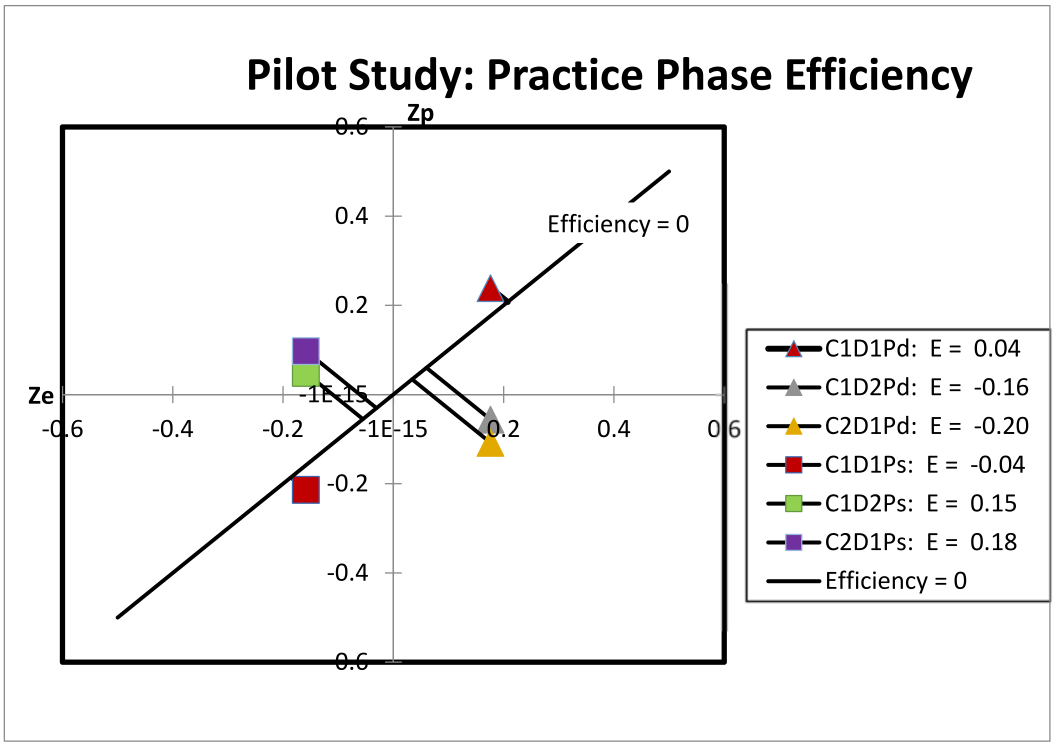
The computational approach for efficiency involved calculating *z* scores for mental effort and performance measures, by worked example condition, to compute an instructional condition efficiency score (*E*) via the following formula (Pass, et al., 2003):

$$E=\frac{Zperformance-Zmental\ effort}{\sqrt{2}}.$$

Efficiency scores (E) were calculated for each diagnostic task for each worked example condition on each of the three diagnostic tasks in the practice and maintenance phase (Table 6). Efficiency in this study was calculated and interpreted as mental effort and performance scores in each transfer phase (practice or maintenance) (van Gog, et al., 2008; van Gog, et al., 2006). Results were graphed on a Cartesian axis with performance on the vertical and mental effort on the horizontal with worked example condition efficiency scores plotted as a distance from the *E*=0 line, passing from the lower left to the upper right of the grid. The upper left of the grid (positive E) represents the highest efficiency and the lower right the lowest efficiency (negative E) (Pass, et al., 2003).

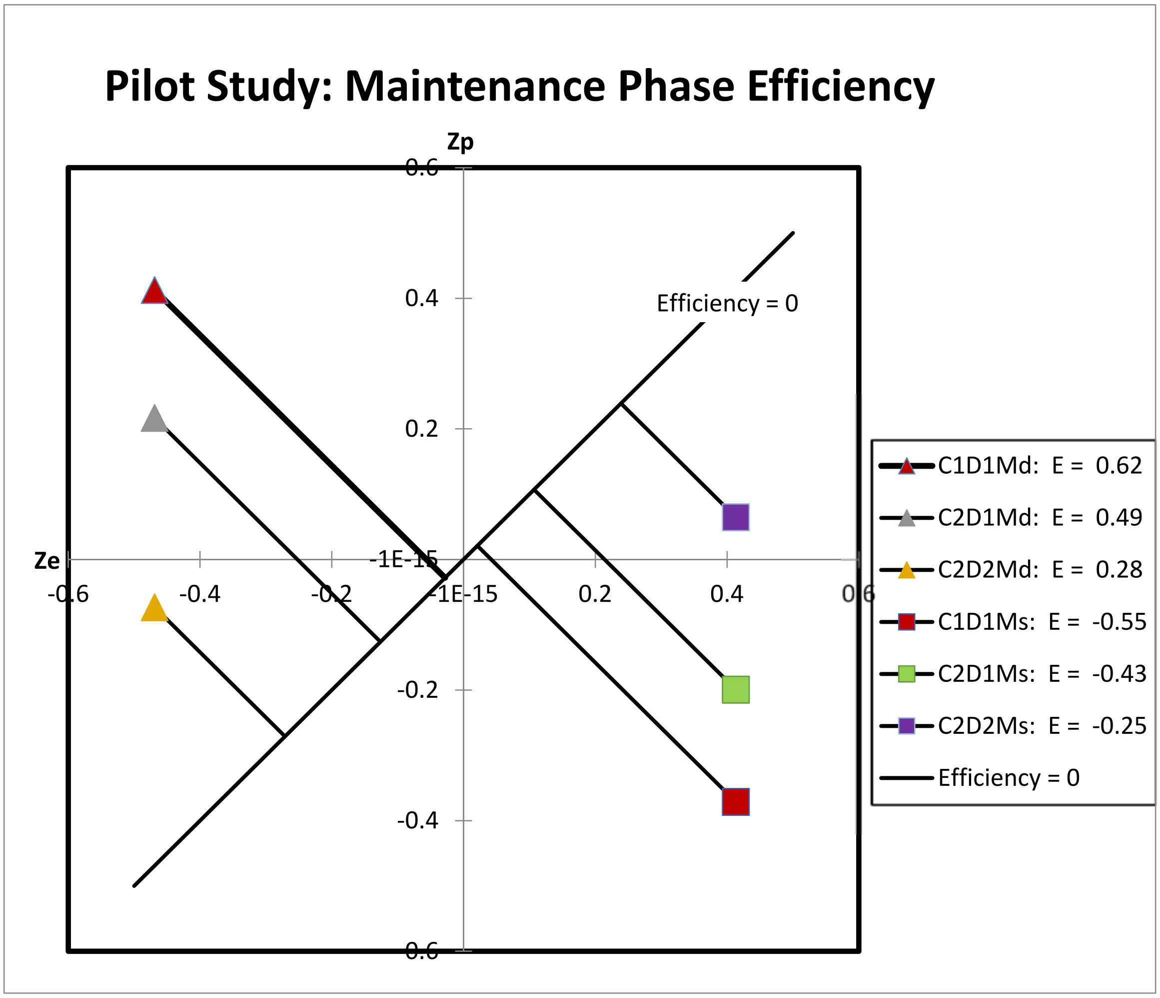
There is no statistically significant difference between worked example conditions for calculated efficiency in the practice phase of the pilot study $F(1, 4) = 4.0$, $p = .115$. (Figure 2.)

Figure 2 Pilot Study: Practice Phase Efficiency



There is a statistically significant difference in calculated efficiency scores for the maintenance phase cases. The PDWE condition was more efficient $F(1, 4) = 43.8$, $p = .003$ $\omega^2 = .867$. This indicates that worked example conditions accounts for 86.7 % of the variance in calculated efficiency for the maintenance phase. (Figure 3.)

Figure 3 Pilot Study: Maintenance Phase Efficiency



Since there were no significant differences in performance between worked example conditions, the difference can be interpreted as those in the PDWE condition performed as well as those in the PSWE condition with less mental effort, therefore the PDWE condition was more efficient.

Main Study

Data for the main study were analyzed using one-way ANCOVA with prior knowledge (scores on a general test of nutrition knowledge) included as a covariate in most instances. An $\alpha = 0.05$ was chosen for interpretation of statistical significance. This was deemed a reasonable compromise between Type I and Type II error. Effect sizes for relationships that reached a level of statistical significance are the most important for interpretation of group differences. Correlations were interpreted at an $\alpha = 0.05$ to identify any variables that were identified as *a priori* covariates that should in fact be further investigated before including them in the model. Statistically significant correlations were not identified as dependent variables in the study and no hypotheses were structured around interpretation of the correlations. The *a priori* covariate of motivation (intent to pursue a career in human nutrition) was not used since 85.6 % of the participants indicated they were not pursuing a career as a nutrition professional and including it does not aid in interpretation of results. Expected course grade was explored as an indicator of motivation to engage in the experiment. Though it was highly correlated with prior knowledge, there were instances when it was correlated with other dependent variables in a way that with prior knowledge was not. There was no statistically significant difference between worked example conditions on the test of nutrition prior knowledge (PSWE, M=6.8/12, SD=2.2; PDWE M=6.35/12, SD= 2.1) F (1, 102) = 1.2, p=.281) (52.9 - 56.7% correct answers). Participants were predominantly female (78 of 104) and had a mean age of 25.7 years (SD=8.4). Table 7 outlines the characteristics of the participants in the main study.

Table 7. Dissertation study participant characteristics

Worked example Condition	PSWE	PDWE
Number of participants (total= 104)	52	52
Gender	12 male; 40 female	14 male; 38 female
Age	*M*=27.2 (SD=10.2)	*M*=24.2 (SD=5.8)
Number of college nutrition courses taken	84.6% with 1 course (range 1-3)	78.8% with 1 course (range 1-4)
Score on general nutrition prior knowledge test	*M*=6.8/12 (SD= 2.2)	*M*=6.35/12 (SD=2.1)
Intent to pursue career in human nutrition	7 yes, 13.5%	8 yes, 15.4%
Ethic group		
Native American/Alaska Native	6 (11.5%)	7 (13.5%)
Hispanic	21 (40.4%)	24 (46.2%)
Non-Hispanic White	16 (30.8%)	16 (30.8%)
African American/Black	4 (7.7%)	1 (1.9%)
Asian	1 (1.9%)	1 (1.9%)
Other	4 (7.7%)	3 (5.8%)

Only data for participants who attempted making a diagnosis were included in the analysis of performance scores on the diagnostic tasks in the practice and maintenance phases and the cognitive load scores in the practice and maintenance phases. The number of included cases is identified in the results tables for each of the measures in each phase of the study. Average time for the section of the class the student was engaged in the experiment was used when time data was not recorded by participants on the envelopes. Average time was used for 44 participants during the learning phase (42.3%), 31 participants in the first practice (32.3%) case and 28 participants for the second practice case (34.1%). Missing data for perceived cognitive load as recorded on the NASA-TLX was treated as missing and those cases were excluded from the analysis. There was a 9.6 % attrition rate between session one of the study and session two (*n*=10).

Tests of the assumptions for one-way ANCOVA (correlation with the dependent variable, normality, homogeneity of regression slopes, linearity, and homogeneity of group variances) were evaluated prior to using any variable as a covariate. For those variables analyzed using one-way ANOVA tests for assumptions (normality, homogeneity of group variances) were evaluated prior to the analysis.

Performance on Diagnostic Tasks

Based on the above correlations, a statistically significant correlation exists between prior knowledge and the scores on case one, diagnosis one $r(96) = .420$, $p < .01$, and case one, diagnosis two $r(96) = .464$, $p < .01$, indicating that the higher the score on the prior knowledge test, the higher the score on the diagnostic tasks for case one in the practice phase (Table 8).

Table 8. Main Study Practice Phase Performance- Correlations Case One

	Expected course grade	Total score prior knowledge	Total score PES case 1 1st ND practice phase	Total score PES case 1 2nd ND practice phase	Minutes working practice cases
Expected course grade	1	.323**	.090	.214*	.080
Total score prior knowledge test		1	.420**	.464**	.078
Total score PES case 1 1st ND practice phase			1	.666**	.156
Total score PES case 1 2nd ND practice phase				1	.048
Minutes working practice cases					1

**. P< 0.01

*. P< 0.05

Data for the main study were analyzed using one-way ANCOVA with prior knowledge (scores on a general test of nutrition knowledge) included as a covariate for those participants who attempted to make a diagnosis (Table 9). All the variables for the practice phase, except minutes working, violated the normality assumption. There were a number of participants who did not receive any points for the diagnosis even though they attempted a diagnosis. There were no significant differences by worked example condition for the practice phase performance measures (Table 10).

Table 9. Diagnosis Attempted-Main Study-Practice Phase

Worked Example Condition	PSWE	PDWE
Total Number of Participants For Practice Phase	52	52
Case 1	47 (90.4%)	49 (94.2%)
Case 2	42 (80.8%)	40 (76.9%)

Table 10. Main study practice phase performance dependent variables (M; SD)

Worked Example Condition	PSWE	PDWE
Time spent working with the clinical cases (minutes)	32.5(6.9)	32.3 (6.5)
PES score Case 1 Diagnosis 1*	6.3 (4.9)	6.6 (4.6)
PES score Case 1 Diagnosis 2*	5.1 (5.2)	5.0(4.9)
PES score Case 2 Diagnosis 1*	5.7 (4.7)	5.6(5.1)

* of possible 12 points

Practice Phase-Case Two

Based on the correlations below, a statistically significant correlation exists between prior knowledge and case two $r(82) = .485$, $p < .01$, indicating that the higher the score on the prior knowledge test, the higher the score on the diagnostic tasks for case two in the practice phase (Table 11).

Table 11. Main Study Practice Phase Performance- Correlations Case Two

	Total score prior knowledge test	Total score PES case 2 practice	Minutes working practice cases
Total score prior knowledge test	1	.485**	.136
Total score PES case 2 practice		1	.096
Minutes working practice cases			1

**. , $p < .01$

Secondary Analysis of Practice Phase Cases

Data for those scoring ≥8 was explored for both practice cases. Correlations and assumption tests were conducted and reported where relevant to the analysis performed.

Case One Diagnosis One

There is no statistically significant correlation with a score on the first case and first diagnosis and either course grade and score on the test of prior knowledge for participants whom scored ≥8/12 on the diagnostic task (Table 12). The distribution is not normal and negatively skewed consistent with the high scores on the task.

Table 12. Scores ≥ 8 Main study practice phase performance dependent variables (M; SD)

Worked Example Condition	PSWE	PDWE
Number scoring ≥8 of those that attempted	21/47 (44.7%)	26 /49 (53.1%)
PES score Case 1 Diagnosis 1*	11.4 (0.81)	10.6 (1.5)
Number scoring ≥8 of those that attempted	19/42 (45.2%)	14/40 (35%)
PES score Case 1 Diagnosis 2*	10.9 (1.2)	10.9 (1.2)
Number scoring ≥8 of those that attempted	20/42 (47.6%)	19/40 (47.5%)
PES score Case 2 Diagnosis 1*	10.4 (1.2)	10.7 (1.1)

* of possible 12 points

Data for case one diagnosis one in the practice phase was analyzed using a one-way ANOVA. Levene's test of homogeneity of variance revealed scores violated the assumption of homogeneity of variance with *p* value that was lower than α= 0.10. The Brown-Forsythe method was used to interpret results for task demand. Shapiro-Wilk tests of normality indicate *p* values less than 0.10 for scores leading to the rejection of the null hypothesis that the dependent variables are normally distributed thereby violating the assumption of normality. ANOVA is robust to the violation of the assumption of normality, so these analyses were conducted despite the non-normality.

There was a statistically significant difference by worked example condition for participants scoring $\geq$8 on the first diagnostic task (PSWE *M* = 11.4, *SD* =0.81 and PDWE *M* = 10.6, *SD* = 1.5) in the practice phase, $F(1, 39.1) = 5.8$, $p = .02$, $\omega^2 = .081$, thus 8.1% of the variance in scores is due to worked example condition. Those in the PSWE scored higher with an average of 95% correct and those in the PDWE an average of 88.8% correct.

Case One Diagnosis Two

There is no statistically significant correlation with a score on the first case and second diagnosis and either course grade and score on the test of prior knowledge for participants who scored $\geq$8 of 12 on the diagnostic task. The distribution is not normal and negatively skewed consistent with the high scores on the task. Analysis using one-way ANOVA showed no significant difference in scores on the first case, second diagnosis by worked example condition.

Case Two Practice Phase

There is no statistically significant correlation with a score on the second case and first diagnosis and either course grade and score on the test of prior knowledge for participants who scored $\geq$8 of 12 on the diagnostic task. The distribution is not normal and negatively skewed consistent with the high scores on the task. Analysis using one-way ANOVA showed no significant difference in scores on second case and first diagnosis by worked example type.

Maintenance Phase- Main Study

Data was analyzed using one-way ANCOVA with prior knowledge (scores on a general test of nutrition knowledge) included as a covariate for those participants who attempted to make a diagnosis (Table 13). All the variables for the maintenance phase except minutes working violated the normality assumption. Histograms indicated that there were a number of participants who did not receive any points for the diagnosis even though they attempted a diagnosis. For those who scored, a negative skew existed.

Table 13 Main Study Diagnosis Attempted

Worked Example Condition	PSWE	PDWE
Number of Participants for Maintenance Phase	49 (5.8% attrition)	45 (13.5% attrition)
Case 1	46 (88.5%)	42 (80.8%)
Case 2	46 (88.5%)	45 (100%)

Based on the correlations below, a statistically significant correlation exists between prior knowledge and case one $r(88) = .436$, $p < .01$, indicating that the higher the score on the prior knowledge test, the higher the score on the diagnostic tasks for case one in the maintenance phase. A statistically significant correlation exists between minutes working and expected course grade $r(88) = -.216$, $p < .05$, indicating that the higher expected course grade, less time was spent on diagnostic tasks in the maintenance phase. A statistically significant correlation exists between scores on case one and expected course grade $r(88) = .315$, $p < .01$, indicating that the higher expected course grade, the higher the score for case one in the maintenance phase (Table 14).

Table 14. Main Study Maintenance Phase Performance- Correlations Case One

	Expected Course Grade	Total Score Prior Knowledge Test	Total Score PES Case 1 Maintenance	Minutes Working Maintenance Cases
Expected Course Grade	1	.398**	.315**	-.216*
Total Score Prior Knowledge Test		1	.436**	-.130
Total Score PES Case 1 Maintenance			1	.029
Minutes Working Maintenance Cases				1

**. $p < .01$

*. $p < .0.05$

Based on the above correlations, a statistically significant correlation exists between prior knowledge and case two, diagnosis one $r(91) = .425$, $p < .01$, case two, diagnosis two $r(91) = .411$, $p < .01$, indicating that the higher the score on the prior knowledge test, the higher the score on the diagnostic tasks for case two in the maintenance phase. A statistically significant correlation exists between expected course grade and minutes working $r(91) = -.222$, $p < .05$, indicating that the higher expected course grade, less time was spent on diagnostic tasks in the maintenance phase. A statistically significant correlation exists between expected course grade and case two, diagnosis two $r(91) = .292$, $p < .01$, indicating that the higher expected course grade, the higher the score for case two diagnosis two in the maintenance phase. There were no statistically significant differences between worked example condition and performance measures for case two of the maintenance phase (Table 15).

Table 15. Main Study Maintenance Phase Performance- Correlations Case Two

	Expected Course Grade	Total Score Prior Knowledge Test	Total Score PES Case 2 1st ND Maintenance	Total Score PES Case 2 2nd ND Maintenance	Minutes Working Cases
Expected Course Grade	1	.417**	.197	.292**	-.222*
Total Score Prior Knowledge Test		1	.425**	.411**	-.159
Total Score PES Case 2 1st ND Maintenance			1	.658**	-.009
Total Score PES Case 2 2nd ND Maintenance				1	-.088
Minutes Working Maintenance Cases					1

**. $p < .01$

*. $p < .0.05$

There were no significant differences by worked example condition for case one of the maintenance phase (Table 16).

Table 16. Main Study Maintenance Phase Dependent Variables *(M; SD)*

Worked Example Condition	**PSWE**	**PDWE**
Time spent working with the clinical cases (minutes)	22.9 (6.2)	22.9 (5.1)
PES Score Case 1 Diagnosis 1*	5.3 (4.7)	5.6 (4.9)
PES Score Case 1 Diagnosis 2*	5.7 (4.5)	5.2; (4.3)
PES Score Case 2 Diagnosis 1*	4.6;(4.3)	5.6; (4.8)

* of possible 12 points

Secondary Analysis of Maintenance Phase Cases

Data for those scoring ≥8 was explored for both maintenance cases. Correlations and assumption tests were conducted and reported where relevant to the analysis performed (Table 17).

Table 17. Scores ≥ 8 Main study maintenance phase performance dependent variables *(M; SD)*

Worked example Condition	PSWE	PDWE
Number scoring ≥8 of those that attempted	19/46; (41.3%)	19 /42; (45.2%)
PES Score Case 1 Diagnosis 1*	10.6; (1.1)	10.6; (1.1)
Number scoring ≥8 of those that attempted	20/46; (43.4.2%)	18/45; (40%)
PES Score Case 1 Diagnosis 2*	10.5; (1.4)	9.9; (1.3)
Number scoring ≥8 of those that attempted	14/46; (30.4%)	22/45; (48.9%)
PES Score Case 2 Diagnosis 1*	10.4; (1.2)	10.3; (1.3)

* of possible 12 points

Case One Diagnosis One

There is no statistically significant correlation with a score on the first case and first diagnosis and either course grade and score on the test of prior knowledge for participants who scored ≥8 of 12 on the diagnostic task. The distribution is not normal and negatively skewed consistent with the high scores on the task. Analysis using one-way ANOVA showed no significant difference in scores on first case and first diagnosis by worked example type.

Case Two Diagnosis One

There is no statistically significant correlation with a score on the second case, first diagnosis and either course grade or score on the test of prior knowledge for participants who scored ≥8/12 on the diagnostic task. The distribution is not normal and negatively skewed consistent with the high scores on the task. Analysis using one-way ANOVA showed no significant difference in scores on second case and first diagnosis by worked example type.

Case Two Diagnosis Two

There is no statistically significant correlation with a score on the second case and second diagnosis and either course grade and score on the test of prior knowledge for participants who scored $\geq$8/12 on the diagnostic task. The distribution is not normal and negatively skewed consistent with the high scores on the task. Analysis using one-way ANOVA showed no significant difference in scores on second case and second diagnosis by worked example type.

Cognitive Load

To address research question four and the associated hypotheses, four, whether there is a difference in perceived cognitive load between the PDWE and the PSWE conditions, scores on the five subscales of the NASA-TLX were compared by worked example condition. In addition, a cognitive load score was computed as the sum of NASA-TLX subscales of task demand, effort and stress (Gerjets, et al., 2004). Perceived cognitive load was assessed by having participants complete the NASA Task Load Index (NASA-TLX) at each phase; learning, practice, and maintenance (Hart & Staveland, 1988). It contains subscales of mental effort, success, stress, time demand, and task demand (Appendices C, D, & E). Perceived cognitive load is integral to the interpretation of results of research situated in cognitive load theory. The NASA-TLX in this study is used as an alternative to the single scale of mental effort, as proposed by Paas & van Merriënboer (1993), for perceived cognitive load, a multi-dimensional construct. The subscales of time demand and stress can be linked to extraneous cognitive load, the subscale of success to germane cognitive load, the subscales of task demand and time demand to intrinsic cognitive load and the effort rating to overall cognitive load.

Participants rated the subscales from 0-20. In addition to perceived cognitive load measured by the NASA-TLX, time spent on each phase (minutes working) is also compared by worked example condition.

Learning Phase

Based on the correlations below, a statistically significant correlation exists between expected course grade and success $r(99) = .332$, $p < .01$, effort $r(103) = -.297$, $p < .01$, and cognitive load $r(103) = -.196$, $p < .05$ indicating that if the expected course grade is high, perceived effort and cognitive load are lower and success is higher (Table 18).

Table 18. Main Study Learning Phase Cognitive Load Correlations

	Expected course grade	Total score prior knowledge test	TLX task demand learning phase	TLX time demand learning phase	TLX success rating learning phase	TLX effort rating learning phase	TLX stress rating learning phase	Cognitive Load Learning	Minutes studying worked examples learning phase
Expected course grade	1	.303**	-.104	-.057	.322**	-.297**	-.091	-.196*	.097
Total score prior knowledge test		1	.031	-.187	.139	.085	-.098	.004	-.050
TLX task demand learning phase			1	.268**	-.233*	.555**	.468**	.793**	.134
TLX time demand learning phase				1	-.285**	.283**	.388**	.378**	-.044
TLX success rating learning phase					1	-.337**	-.369**	-.380**	-.037
TLX effort rating learning phase						1	.609**	.865**	.085
TLX stress rating learning phase							1	.843**	.019
Cognitive load- learning								1	.092
Minutes studying worked examples learning phase									1

**. p< 0.01

*. p< 0.05

A statistically significant difference exists between worked example conditions for effort in the learning phase (PSWE *M*=9.6, *SD*=5.0; PDWE *M*=6.8, *SD*=4.1) with those in the PSWE condition reporting more effort. $F(1, 100) = 11.8$, $p = .001$. ω^2=.022 indicates that 2.2% of the variance in effort rating is accounted for by worked example condition when the covariate expected course grade is included in the model (Table 19).

Table 19. Main study learning phase cognitive load dependent variables (*M; SD*)

Worked Example Condition	PSWE	PDWE
Total n=104	52	52
Time spent studying the worked examples (minutes)	22.5 (6.6)	21.7 (6.7)
Cognitive load -learning (task, effort, stress)	27.5 (11.5)	21.2 (11.4)
Missing cases	0	1
Perceived Cognitive Load-NASA TLX (0-20 scale for each item)		
Task demand	9.4 (4.3)	7.7 (4.4)
Missing cases	0	1
Time demand	7.8 (5.6)	5.3 (4.6)
Missing cases	0	1
Success	11.8 (5.0)	13.1 (5.2)
Missing cases	1	4
Effort	9.6 (5.0)	6.8 (4.1)
Missing cases	0	1
Stress	8.6 (4.9)	6.8 (5.0)
Missing cases	0	1

A statistically significant difference exists between worked example conditions for cognitive load in the learning phase (PSWE *M*=27.5, *SD*=11.5; PDWE *M*=21.2, *SD*=11.4) with those in the PSWE condition reporting more overall cognitive load, $F(1, 100) = 8.9$, $p = .003$. ω^2=.013 indicates that 1.3% of the variance in cognitive load is accounted for by worked example condition when the covariate expected course grade is included in the model.

The remaining variables were analyzed using one-way ANOVA. A statistically significant difference exists between worked example conditions for task demand in the learning phase (PSWE *M*=9.4, *SD*=4.3; PDWE *M*=7.7, *SD*=4.4) with those in the PSWE condition reporting more task demand, $F(1, 101) = 4.0$, $p = .047$. ω^2=.029 indicates that 2.9% of the variance in task demand is accounted for by worked example condition.

A statistically significant difference exists between worked example conditions for time demand in the learning phase (PSWE *M*=7.8, *SD*=5.6; PDWE *M*=5.3, *SD*=4.6) with those in the PSWE condition reporting more time demand, $F(1, 101) = 6.8$, $p = .011$. ω^2=.053 indicates that 5.3% of the variance in time demand is accounted for by worked example condition.

Practice Phase

Based on the correlations below, a statistically significant correlation exists between expected course grade, task demand $r(91) = -.290$, $p < .01$, time demand $r(91) = -.243$, $p < .05$ and cognitive load $r(91) = -.264$, $p < .05$, indicating that if the expected course grade is high, perceived task demand and cognitive load are lower and perceived time demand is higher for the first practice phase case (Table 20).

Table 20. Main Study Practice Phase Cognitive Load Case One- Correlations

	Expected course grade	Total score prior know-ledge test	TLX task demand practice phase	TLX time demand practice phase	TLX success rating practice phase	TLX effort rating practice phase	TLX stress rating practice phase	Minutes working practice cases	Cog load practice phase
Expected course grade	1	.323**	-.290**	-.243*	.117	-.185	-.200	.080	-.264*
Total score prior knowledge test		1	-.020	-.143	.123	-.098	-.185	.078	-.123
TLX task demand practice phase			1	.272**	-.321**	.586**	.468**	.000	.801**
TLX time demand practice phase				1	-.227*	.288**	.358**	.109	.364**
TLX success rating practice phase					1	-.264*	-.304**	-.047	-.350**
TLX effort rating practice phase						1	.642**	-.045	.886**
TLX stress rating practice phase							1	-.040	.842**
Minutes working practice cases								1	-.035
Cog load practice phase									1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Based on the correlations below, a statistically significant correlation exists between expected course grade, task demand $r(79) = -.256$, $p < .05$, and cognitive load $r(79) = -.243$, $p < .05$, indicating that if the expected course grade is high, perceived task demand and cognitive load are lower for the second practice phase case (Table 21).

Table 21. Correlations Main Study Practice Phase Cognitive Load Case Two-

	expected course grade	total score prior knowledge test	TLX task demand practice phase	TLX time demand practice phase	TLX success rating practice phase	TLX effort rating practice phase	TLX stress rating practice phase	minutes working practice cases	Cog load practice phase e
Expected course grade	1	.361**	-.256*	-.216	.081	-.188	-.181	.148	-.243*
Total score prior knowledge test		1	-.052	-.157	.144	-.114	-.212	.116	-.152
TLX task demand practice phase			1	.275*	-.347**	.617**	.509**	.001	.821**
TLX time demand practice phase				1	-.221	.374**	.470**	.019	.444**
TLX success rating practice phase					1	-.380**	-.387**	-.021	-.438**
TLX effort rating practice phase						1	.618**	-.018	.881**
TLX stress rating practice phase							1	-.001	.843**
Minutes working practice cases								1	-.007
Cog load practice phase									1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Analysis was conducted using one-way ANOVA. There were no statistically significant differences between worked example conditions in perceived cognitive load in the practice phase (Table 22).

Table 22. Main study practice phase cognitive load - case two (*M; SD*)

Worked example Condition	**PSWE**	**PDWE**
Total n= 83	43	40
time spent working the practice cases (minutes)	32.1 (7.1)	31.1 (6.4)
cognitive load- learning (task, effort, stress)	32.5(12.7)	30.9 (12.6)
missing cases	3	1
Perceived Cognitive load-NASA TLX (0-20 scale for each item)		
Task Demand	11.2 (4.6)	10.1 (4.5)
Missing Cases	3	1
Time Demand	7.6 (5.5)	6.5 (4.7)
Missing Cases	3	1
Success	9.8 (5.0)	9.8 (4.5)
Missing Cases	3	1
Effort	10.9 (5.2)	11.0 (5.1)
Missing Cases	3	1
Stress	10.4 (5.1)	9.8 (5.2)
Missing Cases	3	1

Maintenance Phase Cognitive Load

Based on the correlations below, a statistically significant correlation exists between expected course grade and effort $r(84) = -.334$, $p <.01$, cognitive load $r(84) = -.256$, $p < .05$ and minutes working on the first maintenance phase case $r(88) = -.216$, $p < .05$ indicating that if the expected course grade is high, perceived effort and cognitive load are lower and less time was spent on the case (Table 23).

Table 23. Correlations Maintenance Phase Cognitive Load Case One

	Expected course grade	Total score prior knowledge test	TLX task demand maintenance phase	TLX time demand maintenance phase	TLX success rating maintenance phase	TLX effort rating maintenance phase	TLX stress rating maintenance phase	Minutes working maintenance cases	Cog load maintenance phase
Expected course grade	1	.398**	-.175	-.107	-.019	-.334**	-.143	-.216*	-.256*
Total score prior knowledge test		1	-.015	-.020	.040	-.067	.061	-.130	-.008
TLX task demand maintenance phase			1	.191	-.202	.638**	.557**	.136	.853**
TLX time demand maintenance phase				1	-.290**	.269*	.474**	.118	.369**
TLX success rating maintenance phase					1	-.162	-.343**	.106	-.278*
TLX effort rating maintenance phase						1	.565**	.177	.864**
TLX stress rating maintenance phase							1	.085	.835**
Minutes working maintenance cases								1	.156
Cog load maintenance phase									1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Analysis of cognitive load measures was conducted using one-way ANOVA. Levene's test of homogeneity of variance revealed the variable time demand violated the assumption of homogeneity of variance with p value that was lower than $\alpha= 0.10$. The Brown-Forsythe method was used to interpret results for time demand. A statistically significant difference exists between worked example conditions for time demand in the maintenance phase for case one (PSWE M=6.2, SD=4.7; PDWE M=4.2, SD=3.8), with those in the PSWE condition reporting more time demand, Brown-Forsythe $F(1, 86.02) = 4.5$, $p = .036$. $\omega^2=.039$ indicates that 3.9% of the variance in time demand is accounted for by worked example condition. There was no statistically significant difference between worked example conditions for effort; however, the difference is noticeable, $F(1,82) =3.3$, $p =.073$, $\omega^2=.027$ indicates that 2.7% of the variance in effort is accounted for by worked example condition.

Table 24 outlines the results of the cognitive load measures for case one of the maintenance phase.

Table 24. Main study maintenance phase cognitive load - case one (M; SD)

Worked example condition	**PSWE**	**PDWE**
Total n=88	**46**	**42**
Time spent working the practice cases (minutes)	22.9 (6.1)	22.6 (5.0)
Cognitive load learning (task, effort, stress)	27.8 (13.5)	23.4 (11.1)
Missing cases	3	1
Perceived Cognitive load-NASA TLX (0-20 scale for each item)		
Task demand	9.5(5.1)	8.3 (4.3)
Missing cases	3	1
Time demand	6.2(4.7)	4.2 (3.8)
Missing cases	3	1
Success	11.6 (4.5)	11.9 (4.2)
Missing cases	3	1
Effort	10.6 (5.1)	6.6 (4.7)
Missing cases	3	1
Stress	7.7 (5.4)	6.6 (4.6)
Missing cases	3	1

Based on the correlations below, a statistically significant correlation exists between expected course grade and effort $r(87) = -.337$, $p <. 01$, cognitive load $r(87) = -$

.258, p < .05 and minutes working on the second maintenance phase case r(91) = -.222, p < .05 indicating that if the expected course grade is high, perceived effort and cognitive load are lower and less time was spent on the case (Table 25).

Table 25. Correlations Main Study Maintenance Phase Cognitive Load Case Two-

	TLX task demand maintenance phase	TLX time demand maintenance phase	TLX success rating maintenance phase	TLX effort rating maintenance phase	TLX stress rating maintenance phase	minutes working maintenance cases	Cog load maintenance phase	expected course grade	total score prior knowledge test
TLX task demand maintenance phase	.215*	1	-.207	.639**	.539**	.175	.852**	-.158	-.039
TLX time demand maintenance phase	1		-.285**	.275**	.462**	.134	.376**	-.087	-.023
TLX success rating maintenance phase			1	-.186	-.340**	.067	-.288**	.011	.068
TLX effort rating maintenance phase				1	.561**	.203	.866**	-.337**	-.091
TLX stress rating maintenance phase					1	.090	.828**	-.159	.043
minutes working maintenance cases						1	.183	-.222*	-.159
Cog load maintenance phase							1	-.258*	-.034
expected course grade								1	.417**
total score prior knowledge test									1

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 26 outlines the results of the cognitive load measures for case two of the maintenance phase. Analysis was conducted using one-way ANOVA. Levene's test of homogeneity of variance revealed the variable time demand violated the assumption of homogeneity of variance with *p* value that was lower than $\alpha = 0.10$. The Brown-Forsythe method was used to interpret results for time demand. A statistically significant difference exists between worked example conditions for time demand in the maintenance phase case two (PSWE M=6.2, SD=4.6; PDWE M=4.3, SD=3.8), with those in the PSWE condition reporting more time demand, Brown-Forsythe $F(1, 80.6) = 4.4$, *p*

= .038. ω^2=.038 indicates that 3.8% of the variance in time demand is accounted for by worked example condition.

There was no statistically significant difference between worked example conditions for effort; however, the difference is noticeable, F (1.88) =2.9, p =.091, ω^2=.021.

Table 26. Main study maintenance phase cognitive load - case two (M; SD)

Worked example Condition	PSWE	PDWE
Total n=91	**46**	**45**
Time spent working the practice cases (minutes)	22.9 (6.1)	23.0 (5.1)
Cognitive load learning (task, effort, stress)	27.8 (13.5)	24.0 (11.1)
Missing cases	3	1
Perceived Cognitive load-NASA TLX (0-20 scale for each item)		
Task demand	9.5 (5.1)	8.4 (4.5)
Missing cases	3	1
Time demand	6.2 (4.7)	4.3 (3.8)
Missing cases	3	1
Success	11.6 (4.3)	11.6 (4.3)
Missing cases	3	1
Effort	10.6 (5.1)	8.9 (4.8)
Missing cases	3	1
Stress	7.7 (5.4)	6.7 (4.5)
Missing cases	3	1

Themes from Comments from Write In Questions on NASA-TLX

Participants had an opportunity to answer two questions on the NASA-TLX for each phase; learning, practice and maintenance. Question one was: “What was the hardest part about working with or studying the clinical case worked examples”?

Question two was “Were the situations depicted in the clinical cases and worked examples familiar to you and why”?

Learning Phase

Question one. Themes that emerged were related to reading about new terminology and new information, reading through a lot of material, and trying to decide what was important as they were studying the examples in a new format.

Question two. Most participants found the cases and themes of the cases similar to course work from their own or family experiences.

Practice Phase

Question one. The most common themes that emerged were remembering where things go in the PES format, deciding on the most important nutrition problem in the case, and trying to decide which IDNT codes to use.

Question two. Participants reported they were familiar with similar types of case examples from family or their own experience and that they had covered some of the topics in the clinical cases in the nutrition class. A noticeable number of participants also noted that the cases were not at all familiar. Participants noted the similarity between the worked example cases and the cases they were asked to work with on their own.

Maintenance Phase

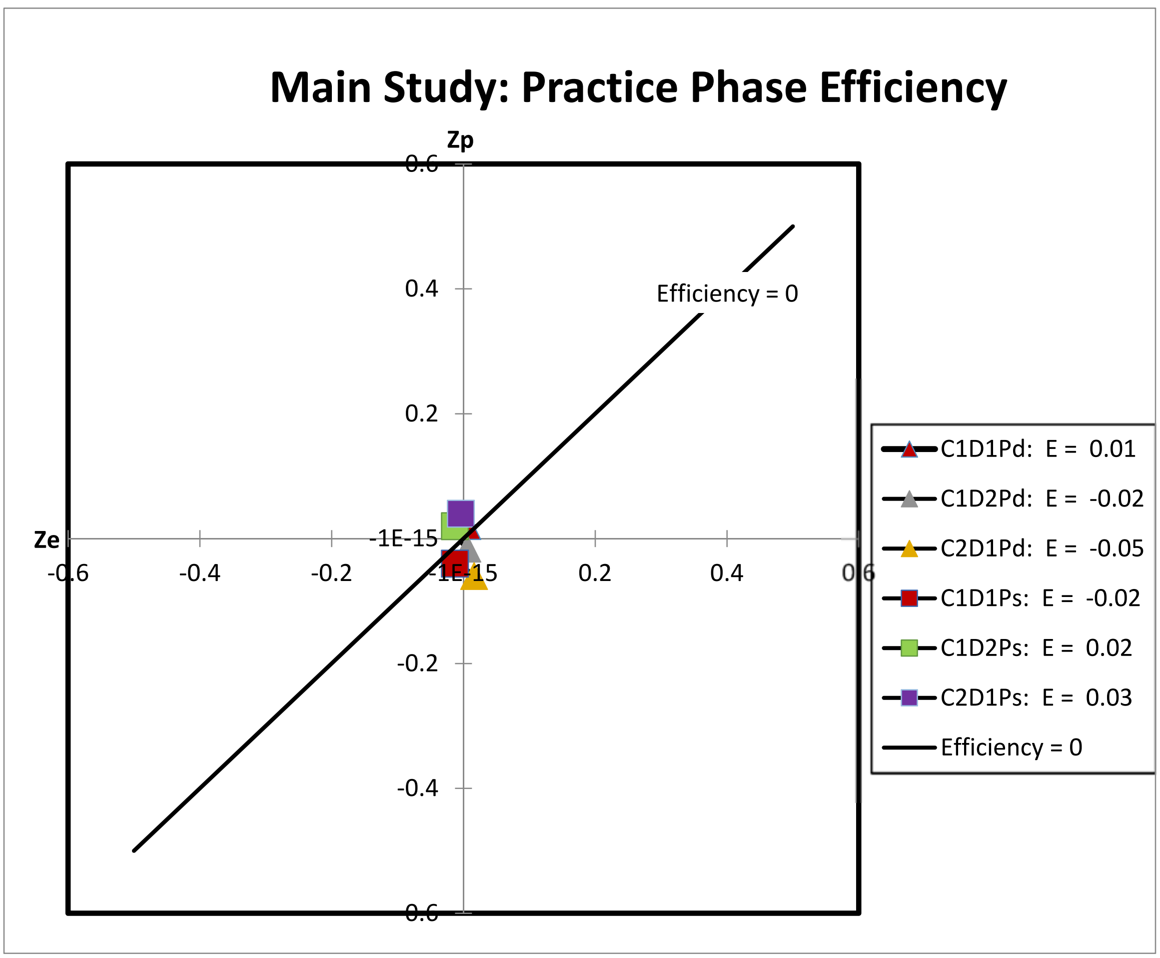
Question one. The most common themes that emerged were remembering where things go in the PES format, deciding on the most important nutrition problem in the case, and trying to decide which IDNT codes to use. Participants commented most frequently on having trouble with what was an etiology and what was a sign and symptom as part of the PES diagnostic statement.

Question two. Most participants reported they were familiar with similar types of case examples from their course work or personal experience.

Calculated Efficiency

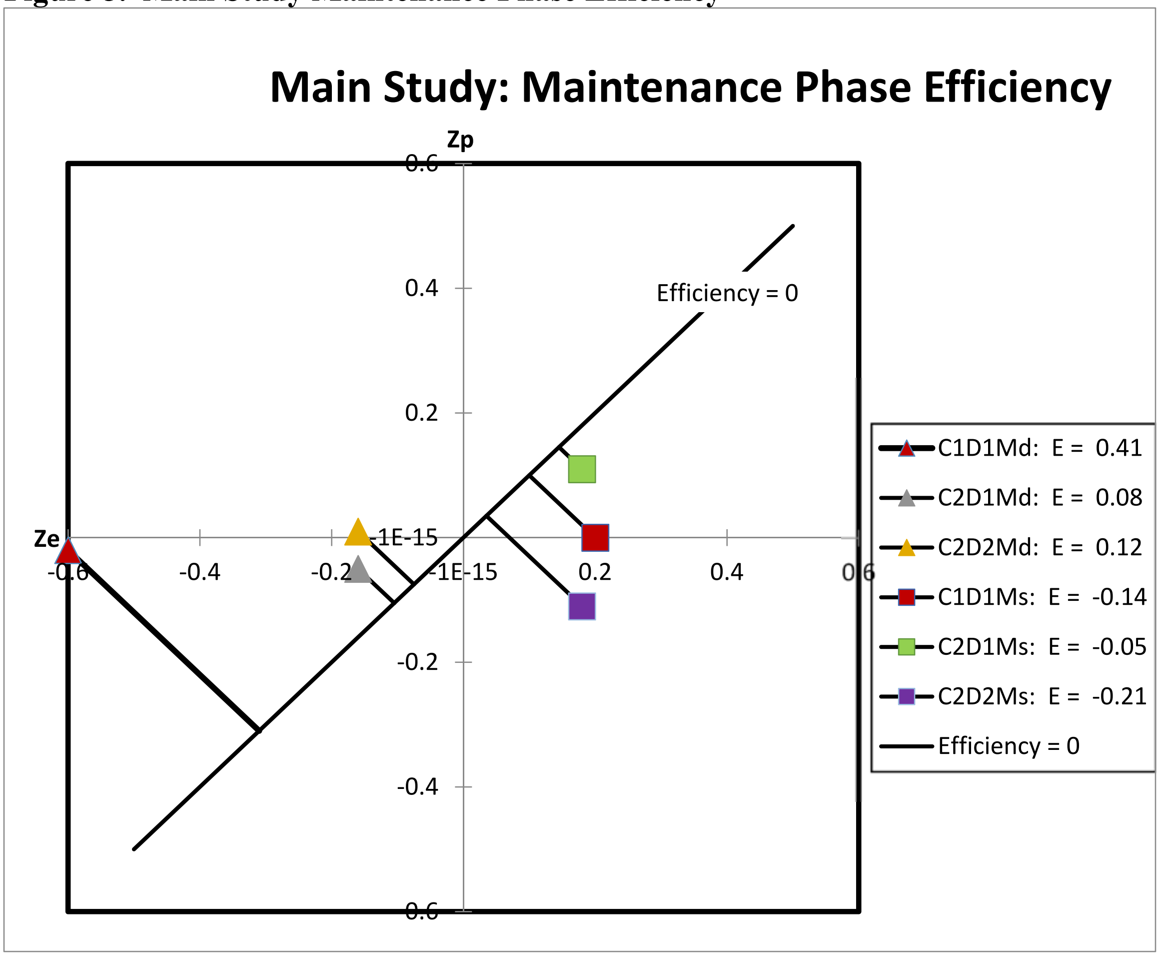
Efficiency was calculated and interpreted in the main study in the same way as for the pilot study. There was no statistically significant difference between worked example conditions for calculated efficiency in the practice phase of the main dissertation study $F(1,4) = 1.7$ p=.264 (Figure 4)

Figure 4. Main Study Practice Phase Efficiency



There is a statistically significant difference in calculated efficiency scores for the maintenance phase cases (Figure 5). The PDWE condition was more efficient $F(1,4)=8.7$, $p=.042$ $\omega^2=.344$. This indicates that worked example condition accounts for 34.4 % of the variance in calculated efficiency for the maintenance phase.

Figure 5. Main Study Maintenance Phase Efficiency



Summary of Results

Results are summarized by research question

Table 27. Summary of Results

Research Question 1. Do both product-oriented worked example and process-oriented worked example conditions result in an ability to use International Dietetics and Nutrition Terminology (IDNT) and Problem, Etiology, and Signs and Symptoms (PES) statements by novices as evidenced by performance on diagnostic tasks?

Learning Phase

Practice Phase

There were no statistically significant differences between worked example conditions for any of the variables for performance during the practice phase. Participants in the **pilot study** did very well on the diagnostic tasks with both groups scoring at or better than 74% correct for each of the three diagnostic tasks (8.9/12).

Maintenance Phase

There were no statistically significant differences between worked example conditions for any of the variables for performance during the maintenance phase. Participants in the **pilot study** did very well on the diagnostic tasks with both groups scoring at or better than 67.5% for each of the three diagnostic tasks (8.1/12) correct.

Research Question 2. Does the process-oriented worked example condition result in better performance on diagnostic tasks when compared to product-oriented worked example condition for novices learning to use IDNT and PES charting?

Learning Phase

Practice Phase There were no significant differences by worked example condition for the practice phase performance measures.

Maintenance Phase. There were no significant differences by worked example condition for the maintenance phase performance measures.

Research Question 3. What is the difference between the process-oriented worked example condition and the product-oriented worked example condition on training efficiency when calculated from self-report of perceived mental effort and performance on diagnostic tasks?

Learning Phase.

Practice Phase. There were no significant differences in calculated efficiency by worked example condition for each of the three cases in the practice phase for the pilot study or main study.

Maintenance Phase. There was a statistically significant difference in calculated efficiency in the maintenance phase of the pilot and the main study; the PDWE condition was more efficient.

Research Question 4. What is the difference in perceived cognitive load between the product-oriented worked example condition and the process-oriented worked example condition?

Learning Phase. There were no statistically significant differences between worked example conditions for any of the cognitive load variables in the learning phase of the **pilot study**. For both groups perceived success was high and cognitive load as measured by the NASA-TLX subscales as a computed variable combining task demand, effort and stress, was relatively low.

For the **main study**, a statistically significant difference exists between worked example conditions for effort, task demand, time demand, and overall cognitive load (computed variable) in the learning phase with those in the PSWE condition reporting more effort for task demand, time demand, and overall cognitive load.

Practice Phase. There was no statistically significant difference between worked example types on any of the cognitive load variables during the practice phase for the **pilot study** or the **main study**.

Maintenance Phase. There were no statistically significant differences between worked example types for any of the cognitive load measures in the **pilot study**.

In the **main study** a statistically significant difference exists between worked example conditions for time demand in the maintenance phase with those in the PSWE condition reporting more time demand.

Chapter 5

DISCUSSION

This study investigated two types of modular worked examples; process-oriented (PSWE) and product-oriented (PDWE), for performance, cognitive load, and efficiency for nutrition diagnosis.

One hundred and four students from a 200-level course in human nutrition participated in the main study. Student participants completed the learning phase studying the worked examples and the practice phase during one regularly scheduled class period. Two weeks later the students completed the maintenance phase during half a regularly scheduled class period. Both the practice and maintenance phases involved making nutrition diagnoses, using the correct International Nutrition and Diagnostic Terminology, and writing a diagnostic statement for two cases.

Discussion in this chapter will be structured around the research questions and associated hypotheses.

Performance on Diagnostic Tasks

Question 1: Do both product-oriented worked example and process-oriented worked example conditions result in an ability to use International Dietetics and Nutrition Terminology (IDNT) and Problem, Etiology, and Signs and Symptoms (PES) statements by novices as evidenced by performance on diagnostic tasks?

Hypothesis 1: Participants in either worked example condition, product-oriented or process-oriented, will demonstrate an ability to use International Dietetics and Nutrition Terminology (IDNT) and construct a Problem, Etiology, and Signs and Symptoms (PES) statement.

Students in both conditions in the main study were able to make a nutrition diagnoses in the practice phase and the maintenance phase after studying the two worked examples in the learning phase for an average of 22 minutes. These participants were able to construct a meaningful diagnostic statement using IDNT and the PES format scored on a rubric that is consistent with expectations for nutrition professionals finishing a dietetic internship and sitting for a national licensing exam for cases of similar complexity.

What is particularly noteworthy is that 45.2% of participants in the practice phase of the main study who attempted to make a diagnosis scored greater than or equal to eight of twelve possible points (67.5% correct) on the diagnostic task with the mean higher at 87.5% correct. In the maintenance phase, 41.5% of participants in the maintenance phase of the main study who attempted to make a diagnosis scored greater than or equal to eight of twelve possible (67.5% correct) points on the diagnostic task with the mean higher at 87.5% correct.

The main study participants were enrolled in their first college nutrition course when they took part in the experiment and would not have been exposed to nor expected to have been exposed to IDNT and the PES format for constructing a diagnostic statement as part of the introductory course. When scores for all main study participants are taken as a whole, scores in both conditions were low (41.5% correct) indicating the material was challenging and that, as expected, participants in this sample of undergraduate students were truly novices in the early stages of learning about human nutrition and the diagnostic process. Participants in the pilot study had higher levels of prior knowledge and had been exposed to the idea of IDNT and the PES format for constructing diagnostic statements compared to those in the main study. Some students in the main study did as well as students in the pilot study (those scoring $\geq$8). Results provide support for hypothesis one, (1) participants in either worked example condition, product-oriented or process-oriented, will demonstrate an ability to use International Dietetics and Nutrition Terminology (IDNT) and construct a Problem, Etiology, and Signs and Symptoms (PES) statement.

Question 2: Does the process-oriented worked example condition result in better performance on diagnostic tasks when compared to product-oriented worked example condition for novices learning to use IDNT and PES charting?

Hypothesis 2: The process-oriented worked example condition will result in higher performance scores on diagnostic tasks compared to the product-oriented worked example condition.

There were no statistically significant differences in time on task or scores on the diagnostic tasks between worked example conditions in the pilot study or the main study. This is similar to results reported by Richey & Nokes-Malach (2013) when comparing performance on problem solving tasks between students in worked examples that either contained or withheld instructional explanations. In experiment one and two, worked example groups for withholding or containing did not differ on problem solving performance (Richey & Nokes-Malach, 2013). Students in both conditions in the main study were able to make a nutrition diagnoses in the practice phase and the maintenance phase and construct a meaningful diagnostic statements suggesting that there may not have been a great enough difference in the worked example conditions in this study to detect an advantage for one condition over another. The type of process information provided in this study might not have been effective. Since students in the main study had not been exposed to the diagnostic process, the added background information in the PSWE condition may have become extraneous cognitive load that participants had to deal with without impacting overall learning and diagnostic performance when the new cases were encountered, negating any hypothesized advantage of the PSWE condition. There is some support for this observation in this study when effort ratings from the NASA-TLX in the maintenance phase are considered. Differences in perceived effort during the maintenance phase did not reach a level of statistical significance; however; higher perceived effort for the PSWE condition was present in both the pilot and main study. It may be that participants in the PSWE condition, even two weeks after the initial training phase, still experienced this extraneous cognitive load as they tried to recall the more detailed aspects of the PSWE condition when working with the maintenance cases with the results showing no advantage in the more detailed process information when working with the new cases.

Efficiency

Question 3: What is the difference between the process-oriented worked example condition and the product-oriented worked example condition on efficiency when calculated from self-report of perceived mental effort and performance on diagnostic tasks?

Hypothesis 3: Calculated efficiency scores will be better for the process-oriented worked example condition compared to the product-oriented worked example condition.

There is a statistically significant difference in calculated efficiency scores for the maintenance phase cases of the pilot study. The PDWE condition was more efficient

$F(1,4)=43.8$, $p=.003$, $\omega^2=.867$, indicating that worked example condition accounts for 86.7% of the variance in calculated efficiency for the maintenance phase.

There is a statistically significant difference in calculated efficiency scores for the maintenance phase cases of the main study. The PDWE condition was more efficient $F(1,4)=8.7$, $p=.042$, $\omega^2=.344$, indicating that worked example condition accounts for 34.4% of the variance in calculated efficiency for the maintenance phase.

It appears that the additional information provided to the participants in the PSWE condition during training increased, rather than decreased, the effort they expended in completing the diagnostic tasks at a time separated from the initial learning and practice. Comparison of the pilot study to the main study shows the same large effect for both samples, an advantage in efficiency for PDWE. Though differences in effort ratings in the maintenance phase for PSWE reporting more effort than PDWE did not reach a level of statistical significance, they were large enough to impact calculated efficiency. Since performance did not differ, this observation may indicate surplus cognitive capacity available for additional learning for those in the PDWE condition. This is similar to the finding by Gerjets, et al., (2006) that the elaborations or process information added to the modular worked examples did not improve performance and appears to have negatively impacted efficiency. Results suggest students spent more effort searching for and trying to recall more complicated aspects of diagnostic problem solving presented in the PSWE condition. One explanation is since the PDWE condition had only the steps and results for each step, remembering how to accomplish each sub goal was easier when there was a two-week time interval between the initial learning and the maintenance phase.

Results of this study do not support hypothesis three (3), calculated efficiency scores between training and transfer will be higher for the process-oriented worked example condition compared to the product-oriented worked example condition. There was no difference in the practice phase and a significant difference in the maintenance phase with the PDWE being more efficient.

Cognitive Load

Question 4: What is the difference in perceived cognitive load between the product-oriented worked example condition and the process-oriented worked example conditions?

Hypothesis 4-1: The process-oriented worked example condition will result in higher perceived cognitive load scores during the training phase.

Hypothesis 4-2: Perceived success should be higher for the process-oriented worked example condition when compared to the product-oriented worked example condition during the practice and maintenance phases.

As hypothesized, the PSWE condition in the main study resulted in statistically significant higher perceived cognitive load during the learning phase. This finding was reflected in the NASA-TLX subscales of effort, time demand, task demand, and calculated overall cognitive load score. Effect sizes were small from 1.3-5.3 % of variance attributed to worked example condition. This differed from the decreased task demand, stress, and effort observed on the NASA-TLX reported by Gerjets, et al. (2004) for modular worked example with elaborations (like PSWE in this study), to those without. In the context of the present study, the PSWE condition added three more pages to the learning phase examples when compared to the PDWE. Comments from some of the students in the write-in portion of the NASA-TLX are consistent as students reported there was a lot to read. This might impact perceptions of time demand and task demand especially in a classroom setting where participants might be monitoring the progress of others and when others switched from one task to another in the experiment.

These differences did not persist in the practice phase. During the maintenance phase, the only cognitive load sub-scale score in the main study that was significantly different was time demand, with those in the PSWE condition reporting more time demand than those in the PDWE. This time demand could be a result of trying to recall, after two weeks, the more detailed elements of the process information supplied during the learning phase for the PSWE condition when working with the new cases. Of note are the differences in perceived effort during the maintenance phase between worked example types with PSWE reporting higher scores for effort. This difference did not reach a level of statistical significance; however, it was present in both the pilot and main study and did impact calculated efficiency for the maintenance phase.

Hypothesis 4-2: Perceived success should be higher for the process-oriented worked example condition when compared to the product-oriented worked example condition during the practice and maintenance phases.

There was no statistically significant difference for perceived success by worked example condition for any portion of the study. Success in the main study was basically 10 out of 20 for both practice and maintenance phases in both conditions, indicating all participants felt moderately successful in working with the cases. There is no support demonstrated in this study for hypothesis (4-2): perceived success should be higher for the process-oriented worked example condition when compared to the product-oriented worked example condition during the practice and maintenance phases.

Hypothesis 4-3: Perceived stress should be lower for the process-oriented worked example condition when compared to the product-oriented worked example condition during the practice and maintenance phases.

There was no statistically significant difference for perceived stress by worked example condition for any portion of the study; therefore, there is no support for hypothesis (4-3): perceived stress should be lower for the process-oriented worked example condition when compared to the product-oriented worked example condition during the practice and maintenance phases.

Discussion

Effect of modular worked examples on the complex skill of diagnostic problem solving

This study adds to the evidence that supports the use of worked examples to teach complex skills and problem solving to novices. In this study students were able to accomplish the diagnostic tasks with some participants performing extremely well. Modular worked examples used in this study appear well suited to the skill of the diagnostic reasoning specific to nutrition professionals since this complex skill can be broken down into sub-goals of (1) noting discrepancies in clinical and medical history data, (2) naming the primary nutrition diagnosis (describing using IDNT) related to the discrepancy, (3) connecting it to a root cause or etiology and (4) clearly indicating objective measures from a clinical assessment that provide evidence for the diagnosis.

Implications for training nutrition professionals

Pass and Merriënboer (1994) state that worked examples offer an approach to make the tacit knowledge of experts explicit by clearly demonstrating the use of general principles when problems are well constructed. "Therefore, worked out problems can be used as a kind of concrete schemata to map new solutions and at the same time foster schema acquisition (pg. 365)." This observation coincides nicely with the concept of the culture of expert practice and apprenticeship. Current nutrition provider education starts with a bachelor degree in human nutrition and then progresses to graduate work (based on an apprenticeship model) that prepares individuals to sit for national board examination and licensing. The graduate portion of the process in some cases is only 10 months, limiting the time educators have to support the development of expertise. The Nutrition Care Process, including the diagnostic portion investigated in this study, is introduced inconsistently in undergraduate studies and is highly dependent on the program and instructor. Use of a structured approach, such as worked examples, developed for the prior knowledge and experience of the learner, could be introduced early in the undergraduate process with success, as demonstrated here. Students may be more likely to incorporate all portions of the Nutrition Care Process if, at each stage of their education; subsequent parts are added and elaborated so that adequate schema for the assessment, diagnostic, intervention, and monitoring portions of the Nutrition Care Process are ready when students enter the portion of graduate school portion of their training program. Universities that are credentialed to train nutrition professional are required to offer the same undergraduate content; therefore, the materials to be covered in each level of the undergraduate program are well known. In this study, diagnostic tasks were introduced with worked examples to students at the 200 level; this could further be investigated by using worked examples for the intervention and monitoring stages at the 300 and 400 level.

Implications for Intervention Design of Worked Examples

In the application of worked example in this study, students were able to work independently with no coaching by the investigator. Well written materials such as the ones used in this study could be used as homework or as an augment to class work even for instructors less familiar with teaching nutrition diagnosis and use of IDNT. This study also demonstrated it was very feasible to use the worked example strategy within an authentic classroom setting without the need for digital or online materials and within the time frame allotted for weekly instruction.

PSWE did not result in better diagnostic performance than PDWE in this study. PDWE are easier to construct since there is no need within the example to explain the steps. Complexity could be added to the PDWE cases as students add to their knowledge and experience increasing germane cognitive load. In addition, more experienced students can be asked to consider a larger array of diagnostic categories and terms. Process information, typically covered by the instructor in the discussion and lecture portion of a class, might be all that is needed for novices at this stage of their education.

Implications for Assessment of Diagnostic Performance

Using a rubric designed along with the cases, as for this study, makes scoring PES statements more meaningful and the rubric itself can be used as a tool for instruction after the diagnostic tasks are completed and scored. The nutrition faculty member who volunteered to score a random sample from the pilot study commented that it was great to have something to follow when evaluating PES diagnostic statements.

Strengths and Limitations of the Study

The domain of human nutrition is large and this study limited, by design, the complexity of the material presented to the students and the diagnostic terms students were asked to consider. This was appropriate for the population of interest and this sample; however, it limits how broadly results can be interpreted. Interpretation is appropriate for undergraduate nutrition students in credentialed programs meeting requirements for students entering graduate programs in human nutrition. The prior knowledge test constructed for this research covered a large array of nutrition concepts resulting in poor internal consistency; however, the score on this test differed predictably between the pilot study (81.6-85% correct answers) and the main study (52.9 - 56.7% correct answers).

Cognitive load is a complicated construct and that makes measuring it difficult. The goal of this research was not to address the question of cognitive load measurement, instead to use an instrument that has been applied to this area of research to add information for interpretation of experimental results. This study extended the work of others in an alternative to the one item Paas & Merriënboer (1993) scale by using the NASA-TLX for assessing cognitive load in worked example research (Hart & Staveland, 1988; Gerjets et al., 2004; Gerjets et al., 2006). Using calculated efficiency to describe differences in worked example research adds to evidence for this approach and was a strength in the present study. The difference noted in the maintenance phase indicate that worked example research needs not only to look at the immediate performance measures when evaluating worked example approaches, but also the effect of those approaches that occur after the initial training phase as these might be the most important when deciding which worked example approach to use with a specific student population.

In this experiment there was no alternative to learning the material except by worked example condition for the students in the main study. They would not have been exposed to IDNT or expected to use it or the format for constructing diagnostic statements. Since there is strong support for worked example strategies for teaching novices over conventional problem solving, this was not investigated in the present study.

This study has potential for high ecological validity as discrepancies in training and adoption of IDNT have been noted in the nutrition literature. The sample of undergraduate novices was appropriate for this preliminary work and for generalizability; application would be for undergraduate students taking nutrition courses.

Implications and Recommendations for Future Research

Questions that arise regarding this research center primarily on how this approach to teaching nutrition diagnosis compares to other education strategies. Since there are no specific strategies suggested or supported in the nutrition literature for teaching this skill, suggestions for future research include: (1) testing the worked example format for teaching nutrition diagnosis against a classroom approach where students were expected to learn this skill and that the material was covered in lecture and homework. In other words, what is the alternative to worked example for this teaching this skill and can it be replicated? (2) Would a worked example approach to teaching IDNT improve diagnostic skills and use of IDNT in already licensed and practicing nutrition professionals? (3)

Does this approach also work as students move to 300-400 level courses and complexity of diagnosis and intervention increase?

Conclusions

In this study students were able to accomplish the diagnostic tasks with some participants performing extremely well. Modular worked examples used in this study appear well suited to the skill of the diagnostic reasoning specific to nutrition professionals. Further research is necessary to determine if modular worked examples offer an advantage over other educational approaches to teach nutrition diagnosis. Results suggest an application of worked examples for training nutrition professionals.

List of Appendices

Appendix A – Demographics

Please answer the following questions related to demographics.

1. What is your age _____ (years)?

2. In which ethnic group would you categorize yourself?
    a. White (non-Hispanic)
    b. Black
    c. Asian
    d. Native American/Alaska Native
    e. Pacific Islander
    f. Hispanic
    g. Other

3. What is your gender?
    a. Female
    b. Male

4. Do you intend to pursue a career as a nutrition professional (Registered Dietitian, Dietetic Technician, Food Service Manager, or Public Health Nutritionist)?
    a. Yes
    b. No

5. Which nutrition course made you eligible for participating in this study?
    a. Nutrition 2110 (CNM)
    b. Nutrition 1015 (CNM)
    c. Nutrition 244 (UNM)

6. What grade do you expect to earn in the nutrition course indicated above?
    a. A
    b. B
    c. C
    d. D
    e. F

7. How many college level nutrition courses have you taken? _____(number of courses)

Appendix B – General Nutrition Knowledge Test

For the following questions related to general clinical nutrition knowledge, please circle the best answer.

1. Which of the following are the correct six categories of nutrients needed for human consumption?
    a. Fat, alcohol, carbohydrate, protein, vitamins, minerals
    b. Fat, carbohydrate, fiber, protein, vitamins, minerals
    c. Fat, carbohydrate, protein, water, vitamins, minerals
    d. Fat, carbohydrate, protein, fiber, water, vitamins
    e. Fat, carbohydrate, protein, fiber, water, alcohol

2. The four leading nutrition-related causes of death of late adulthood include:
    a. heart disease, pneumonia, cancer, and obesity
    b. heart disease, cancer, obesity, and inadequate exercise
    c. heart disease, cancer, stroke and diabetes mellitus
    d. unintentional injury, cancer, stroke and diabetes mellitus

3. How many kilocalories are there in one gram of protein, fat, and carbohydrate, respectively?
    a. 5, 9, 7
    b. 9, 4, 4
    c. 7, 9, 5
    d. 4, 9, 4
    e. 5, 7, 9

4. The term that describes recommended intake levels of nutrients (reference standards) for planning and assessing diets in all healthy persons is known as:
    a. Adequate Intake Levels.
    b. Tolerable Upper Limits.
    c. Essential Nutrients.
    d. Dietary Reference Intakes.

5. A food label ingredient list reads: wheat flour, vegetable shortening, sugar, salt, and cornstarch. What item would be found in the HIGHEST amount in that food?
    a. Salt
    b. Sugar
    c. Wheat flour
    d. Cornstarch
    e. Vegetable shortening

6. What food serving below does NOT provide significant amounts of iron?
    a. Round steak, 3 oz
    b. Pork and beans, ½ cup
    c. Peaches, ½ cup
    d. Iron-fortified breakfast cereal, 1 cup

7. What is the acceptable/normal range of BMI in adults (kg/m^2)?
    a. 4-10
    b. 19-25
    c. 24-30
    d. 29-35
    e. 9-15

8. The Estimated Average Requirement (EAR) means:
    a. intake level meets the nutrient needs of 98% of healthy people.
    b. intake value meets the nutrient needs of half the healthy individuals in a group.
    c. upper limits of a nutrient compatible with health.
    d. nutrient intake standards for healthy people.
    e. this is a "tentative" RDA.

9. Which vitamins act as antioxidants?
    a. Vitamin B12
    b. Vitamin C
    c. Vitamin E
    d. a and b
    e. b and c

10. What is the daily caloric intake level that the daily values on the food nutrition label are based on?
    a. 1000 calories
    b. 1200 calories
    c. 1800 calories
    d. 2000 calories

11. A practical guideline to help identify a meat serving (cooked) according to the *Choose my Plate model* is a portion that equals the size of a deck of cards. How many ounces of meat would this be?
    a. 1 ounce
    b. 2 ounces
    c. 2 ½ - 3 ounces.
    d. 4-5 ounces

12. The Food and Nutrition board recommends ______ of water per Calorie of food ingested.
    a. 1 milliliter
    b. 1 ounce
    c. 1 liter
    d. 1 cup

Appendix C – Task Load Index - Learning Phase

Put an X on the line scale to indicate your answer for each question

Task demand — How complex were the clinical case examples?

Not Very Complex ... Very Complex

Time demand — How rushed or hurried did you feel when studying the clinical case examples?

Not Very Rushed ... Very Rushed

Success — How successful were you in completing what you were asked to do with the clinical case examples?

Not Very Successful ... Very Successful

Effort — How hard did you have to work to understand the clinical case examples?

Not Very Hard ... Very Hard

Stress — How stressed did you feel while studying the clinical case examples?

Not Very Stressed ... Very Stressed

Adapted with permission from Hart and Staveland's NASA Task Load Index (TLX).

1. What was the hardest part of studying the clinical case examples and why?

2. Were the situations depicted in the clinical case examples familiar to you and why?

Appendix D – Task Load Index – Practice Phase

Put an X on the line scale to indicate your answer for each question

Task demand — How complex were the clinical cases?

Not Very Complex — Very Complex

Time demand — How rushed or hurried did you feel when working with the clinical cases?

Not Very Rushed — Very Rushed

Success — How successful were you in completing what you were asked to do with the clinical cases?

Not Very Successful — Very Successful

Effort — How hard did you have to work to understand the clinical cases?

Not Very Hard — Very Hard

Stress — How stressed did you feel while working with the clinical cases?

Not Very Stressed — Very Stressed

Adapted with permission from Hart and Staveland's NASA Task Load Index (TLX).

1. What was the hardest part of working with the clinical cases and why?
2. Were the situations depicted in the clinical cases familiar to you and why?

Appendix E – Task Load Index – Maintenance Practice Phase

Put an X on the line scale to indicate your answer for each question

Task demand — How complex were the clinical cases?

Not Very Complex — Very Complex

Time demand — How rushed or hurried did you feel when working with the clinical cases?

Not Very Rushed — Very Rushed

Success — How successful were you in completing what you were asked to do with the clinical cases?

Not Very Successful — Very Successful

Effort — How hard did you have to work to understand the clinical cases?

Not Very Hard — Very Hard

Stress — How stressed did you feel while working with the clinical cases?

Not Very Stressed — Very Stressed

Adapted with permission from Hart and Staveland's NASA Task Load Index (TLX).

1. What was the hardest part of working with the clinical cases and why?

2. Were the situations depicted in the clinical cases familiar to you and why?

Appendix F – Directions and Practice Case #1 Scoring PES

Directions for Using Scoring Charts for PES

P=Diagnosis	**E=Related To (Etiology)**	**S=As evidenced by (signs and symptoms)**
There are **8** possible points in this section for assigning a diagnosis code. Use the points listed in front of each diagnosis to score the diagnosis. The number of the diagnosis is sufficient (e.g. 1.1 or 5.11.2) instead of writing out the diagnosis.	There are **2** possible points in this section for identifying an etiology. **2** points for a match on the scoring rubric, **1** point for related, but not the root cause, and **0** if not an etiology, related, or blank.	There are 2 possible points in this section. **2** points for a match on the scoring rubric, **1** point for related, but missing objective measurable signs (BMI% etc., and **0** if not a symptom or sign, or blank.
If there are 2 PES statements for a case, each is scored separately.	If there are 2 PES statements as part of the case, each is scored separately. Line numbers from the case instead of written out answers are acceptable.	If there are 2 PES statements as part of the case, each is scored separately. Line numbers from the case instead of written out answers are acceptable.
Example: **8** if diagnosis name and number is the highest possible if the diagnosis matches the rubric. **4** is scored if not as precise a diagnosis, **2** if related but more broad and less specific than the diagnosis that would have scored 4, and **0** if it does not match anything on the rubric or is not present.	If diagnosis not present or incorrect can still score etiology since being able to distinguish issues in the case is a different skill than using the diagnosis codes.	If diagnosis not present or incorrect can still score signs and symptoms since being able to distinguish issues in the case is a different skill than using the diagnosis code.
Score recorded in this section should be written on the student's work as each section will be entered into analysis for errors separately.	Score recorded in this section should be written on the student's work as each section will be entered into analysis for errors separately.	Score recorded in this section should be written on the student's work as each section will be entered into analysis for errors separately.

Practice Case #1 Scoring PES

P=Diagnosis	E=Related To (Etiology)	E=Related To (Etiology)
Practice Case #1 (isomorphic)		
Protein 8 Inadequate protein intake 5.7.1	↑ needs leg fracture (L1) ↓ motivation to cook meals (L11) Avoids milk and eggs (L28)	↓prealbumin, 11 (range 16-40) (L8) Protein intake 47g (L30) estimated needs 64-95 g (L34)
Energy Balance 8 Inadequate Energy Intake 1.2 8 Predicted suboptimal energy intake 1.4	Ill-fitting dentures and dry mouth (L10) Estimated energy needs 1746.5 kcal/d (L33) and current intake 1313 kcal/d (L30)	Weight 87% usual (L3) Weight 140# was 160# 6 months ago (L2-3)
Oral or Nutrition Support Intake 4 Inadequate oral intake 2.1	Ill-fitting dentures and dry mouth (L10)	Estimated energy needs 1746.5 kcal/d (L33) and current intake 1313 kcal/d (L30) Weight 140# was 160# 6 months ago (L2-3)
Nutrient 8 Inadequate protein-energy intake 5.3 4 Increased nutrient needs 5.1 2 malnutrition 5.2	Avoids milk and eggs (L28) ↑ needs leg fracture (L1) ↓ motivation to cook meals (L11) Estimated energy needs 1746.5 kcal/d (L33) and current intake 1313 kcal/d (L30) Protein intake 47g (L30) estimated needs 64-95 g (L34)	Protein intake 47g (L30) estimated needs 64-95 g (L34) Estimated energy needs 1746.5 kcal/d (L33) and current intake 1313 kcal/d (L30) Protein intake 47g (L30) estimated needs 64-95 g (L34)
Multi-nutrient 8 Predicted suboptimal nutrient intake 5.11.1 Energy and protein	↑ needs leg fracture (L1) ↓ motivation to cook meals (L11) Estimated energy needs 1746.5 kcal/d (L33) and current intake 1313 kcal/d (L30) Protein intake 47g (L30) estimated needs 64-95 g (L34 ↑ needs leg fracture (L1)	Protein intake 47g (L30) estimated needs 64-95 g (L34 Estimated energy needs 1746.5 kcal/d (L33) and current intake 1313 kcal/d (L30)

Appendix G – Practice Case #2 Scoring Rubric PES

P=Diagnosis	E=Related To (Etiology)	S=As evidenced by (signs and symptoms)
Practice Case #2 (novel)		
Oral or Nutrition Support Intake 8 excessive oral intake 2.2	Taking Twin Lab Supplement (L 14, 15) 4 caps/d in addition to eating regular meals and snacks (L2, 3)	Multiple (can list) vitamins/minerals >100% DV on label
Vitamin 8 Excess vitamin intake 5.9.2	Taking Twin Lab Supplement (L 14, 15) 4 caps/d	
Bioactive substance 8 excessive bioactive substance intake 4.2	Taking Twin Lab Supplement (L 14, 15) 4 caps/d	Vitamin A, C, E, B1, B2, Niacin (B3),B6, B12, > 100% DV on label
Mineral 8 Excessive Mineral intake 5.10.2	Taking Twin Lab Supplement (L 14, 15) 4 caps/d	Multiple (can list) vitamins/minerals >100% DV on label
Multi nutrient 8 Predicted excessive nutrient intake 5.11.2	Taking Twin Lab Supplement (L 14, 15) 4 caps/d in addition to eating regular meals and snacks (L2, 3)	Selenium, Manganese, Chromium >100% DV Multiple (can list) vitamins/minerals >100% DV on label

Appendix H – Maintenance Case #1 Scoring PES

P=Diagnosis	**E=Related To (Etiology)**	**S=As evidenced by (signs and symptoms)**
Maintenance Case #1 (isomorphic)		
Energy Balance 8 excessive energy intake 1.3 8 predicted excessive energy intake 1.5	Intake of 2955 kcal/d (L26,27) > estimated needs of 2411 kcal/d (L 29) Cafeteria meals (L3) and/or ↑ calorie bottled pasta sauce meal at home (L22)	BMI at 26.2 (L7) target 18.5-24.9 Intake of 2955 kcal/d (L26,27) > estimated needs of 2411 kcal/d (L 29)
Oral or Nutrition Support Intake 8 excessive oral intake 2.2	Limited physical activity with long commute (L1) and golf w/cart as exercise (L 5,6) Cafeteria meals (L3) and/or ↑ calorie bottled pasta sauce meal at home (L22)	Intake of 2955 kcal/d (L26,27) > estimated needs of 2411 kcal/d (L 29)

Appendix I – Maintenance Case #2 Scoring PES

P=Diagnosis	**E**=Related To (Etiology)	**S**=As evidenced by (signs and symptoms)
Maintenance Case #2 (Novel)		
Energy Balance		
8 Inadequate energy intake 1.2	↓eating (L4,5) and/or↓ eating because of fatigue (L6)	Wt loss of 4 # (L4) in 3 weeks 95.4% of usual body weight (L8)
8 predicted suboptimal energy intake 1.4	↓eating (L4,5) and/or↓ eating because of fatigue (L6) and continued training (L4)	BMI % is 2% (range 5-85%) (L9)
Oral or Nutrition Support Intake		
8 inadequate oral intake 2.1	↓eating (L4,5) and/or↓ eating because of fatigue (L6) Limited iron rich foods in diet Iron intake 8 mg/d < estimated needs of 15-18 mg/d (L25, 30)	Estimated energy needs of 2600 kcal/d > current intake of 1970 kcal (L22, 26) Estimated needs of 2600 kcal/d > current intake of 1970 kcal (L22, 26) Hct 33%<acceptable 37-47% (10)
Nutrient		
8 increased nutrient needs 5.1 Energy and/or iron	Estimated needs of 2600 kcal/d > current intake of 1970 kcal (L22, 26)	Iron intake 8 mg/d < estimated needs of 15-18 mg/d (L25, 30)
2 malnutrition 5.2	↓eating (L4,5) and/or↓ eating because of fatigue (L6) and/or limited iron rich foods in diet ↓	Wt loss of 4 # (L4) in 3 weeks BMI % is 2% (range 5-85%) (L9)
4 Imbalance of nutrients 5.5	limited iron rich foods in diet	Estimated needs of 2600 kcal/d > current intake of 1970 kcal (L22, 26) Hct 33%<acceptable 37-47% (10)
Protein		
4 Excessive Protein intake	diet ↑ protein rich foods	Iron intake 8 mg/d < estimated needs of 15-18 mg/d (L25, 30)
Bioactive Substance		
8 Inadequate bioactive	↓eating (L4,5) and/or↓	Estimated protein needs 47-

substance (iron) 4.2	eating because of fatigue (L6) and/or limited iron rich foods in diet ↓	57 g and current intake 79 g/d (L24, 29)
Mineral		
8 Inadequate mineral intake 5.10.1 Iron	Limited iron rich foods in diet	Hct 33%<acceptable 37-47% (10) Iron intake 8 mg/d < estimated needs of 15-18 mg/d (L25, 30) Hct 33%<acceptable 37-47% (10)
Multi-nutrient		
8 predicted suboptimal nutrient intake 5.11.1 Iron , energy	Limited iron rich foods in diet ↓eating (L4,5) and/or↓ eating because of fatigue (L6) and/or limited iron rich foods in diet	Iron intake 8 mg/d < estimated needs of 15-18 mg/d (L25, 30) Hct 33%<acceptable 37-47% (10) Iron intake 8 mg/d < estimated needs of 15-18 mg/d (L25, 30) Iron intake 8 mg/d < estimated needs of 15-18 mg/d (L25, 30) Estimated needs of 2600 kcal/d > current intake of 1970 kcal (L22, 26)

Appendix J – Nutrition Diagnostic Terminology *

Each term has an alpha-numeric IDNT code. Include the alpha-numeric IDNT code in this exercise.[1]

INTAKE

Defined as “actual problems related to intake of energy, nutrients, fluids, bioactive substances through oral diet or nutrition support” [1]

Energy Balance (1) *Defined as “actual or estimated changes in energy (calorie/kcal/kJ) balance*

- ☐ Increased energy expenditure NI-1.1
- ☐ Inadequate energy intake NI-1.2
- ☐ Excessive energy intake NI-1.3
- ☐ Predicted suboptimal energy intake NI-1.4
- ☐ Predicted excessive energy intake NI-1.5

Oral or Nutrition Support Intake (2) *Defined as “actual or estimated food and beverage intake from oral diet or nutrition support compared with patient goal”*

- ☐ Inadequate oral intake NI-2.1
- ☐ Excessive oral intake NI-2.2
- ☐ Limited food acceptance NI-2.9

Fluid Intake (3) *Defined as “actual or estimated fluid intake compared with patient goal”*

- ☐ Inadequate fluid intake NI-3.1
- ☐ Excessive fluid intake NI-3.2

Bioactive Substances (4) *Defined as “actual or observed intake of bioactive substances, including single or multiple functional food components, ingredients, dietary supplements, alcohol”*

- ☐ Inadequate bioactive substance intake (*specify*) ______________________ NI-4.1
- ☐ Excessive bioactive substance intake (*specify*) ______________________ NI-4.2
- ☐ Excessive alcohol intake NI-4.3

Nutrient (5) *Defined as “actual or estimated intake of specific nutrient groups or single nutrients as compared with desired levels”*

- ☐ Increased nutrient needs (specify) ______________________ NI-5.1
- ☐ Malnutrition NI-5.2
- ☐ Inadequate protein-energy intake NI-5.3
- ☐ Decreased nutrient needs (*specify*) NI-5.4
- ☐ Imbalance of nutrients NI-5.5

Fat and Cholesterol (5.6)

- ☐ Inadequate fat intake NI-5.6.1
- ☐ Excessive fat intake NI-5.6.2
- ☐ Less than optimal intake of types of fats (*specify*) ______________________ NI-5.6.3

Protein (5.7)

- ☐ Inadequate protein intake NI-5.7.1
- ☐ Excessive protein intake NI-5.7.2
- ☐ Less than optimal intake of types of proteins or amino acids (*specify*) ______________________ NI-5.7.3

Carbohydrate and Fiber (5.8)

- ☐ Inadequate carbohydrate intake NI-5.8.1
- ☐ Excessive carbohydrate intake NI-5.8.2
- ☐ Less than optimal intake of types of carbohydrate (*specify)* ______________________ NI-5.8.3
- ☐ Inconsistent carbohydrate intake NI-5.8.4
- ☐ Inadequate fiber intake NI-5.8.5
- ☐ Excessive fiber intake NI-5.8.6

Vitamin (5.9)

- ☐ Inadequate vitamin intake (*specify*) ______________________ NI-5.9.1
- ☐ Excessive vitamin intake (*specify*) ______________________ NI-5.9.2

Mineral (5.10)

- ☐ Inadequate mineral intake (*specify*) ______________________ NI-5.10.1
- ☐ Excessive mineral intake (*specify*) ______________________ NI-5.10.2

Multi-Nutrient (5.11)

- Predicted suboptimal nutrient intake *(specify*) ______________________ NI-5.11.1
- Predicted excessive nutrient intake *(specify*) ______________________ NI-5.11.2

This list has omitted some IDNT codes for the purposes of this exercise.

[1] International Dietetics and Nutrition Terminology (IDNT) Reference Manual (2013) Fourth Edition, American Dietetic Association, Chicago, IL.

Appendix K – Product Oriented Worked Examples (PDWE)-Learning Phase

You are a student enrolled in a program to train you to be a nutrition professional in the United States health care system. Nutrition professionals design nutrition care plans for prevention, treatment, and management of nutrition problems in humans. They function as part of a healthcare team that typically includes doctors, nurses, and other health professionals. Nutrition professionals are the nutrition experts and are integral to successful medical care of individuals.

The following worked examples outline the steps taken when establishing a nutrition diagnosis and labeling that diagnosis using International Dietetics and Nutrition Terminology (IDNT) and writing a Problem, Etiology, and Signs/Symptoms (PES) statement consistent with that diagnosis. The PES statement is the format required to document the nutrition diagnosis in the patient's medical record. The purpose of using standardized language such as IDNT is to describe nutrition problems consistently so that they are clear to all who care for a particular individual patient. Enhanced communication and documentation leads to improved patient care.

A nutrition diagnosis identifies a specific nutrition problem that can be treated or managed by a nutrition professional using a nutrition intervention. Nutrition professionals write a PES statement to describe the problem, its root cause, and the assessment data that provide evidence for the diagnosis. The format for the PES statement is *"**___________*** *(nutrition problem (**P**) using IDNT)* ***related to _________*** *(Evidence (**E**))* ***as evidenced by _________*** *(Signs and Symptoms (**S**))*".

The nutrition diagnoses presented in the examples will be within the intake domain, though other domains exist for IDNT. A one-page abridged handout listing the IDNT for the intake domain is included for your reference as you study the examples.

Case Study #1 Product Oriented Worked Example (PDWE)-Learning Phase

Case details adapted from Emery, E. Z. (2012) *Clinical Case Studies for the Nutrition Care Process,* pg. 53-59.

Case Study #1 Mae Jones-PDWE

Mae Jones, a 41 year old mother of two, was referred by her doctor for nutrition therapy. She is 5 feet 6 inches tall (167.64 cm) and weighs 178 pounds (80.9 kg). Her BMI is 28.9 (target BMI range for adults is 18.5-24.9). She reports she does not engage in any regular physical activity; however, she was an athlete in high school. She gained 40-50 pounds (18.2-22.7 kg) with each of her pregnancies (usual weight gain is ~30 pounds (13.6 kg)) and was unsuccessful returning to her usual weight after each pregnancy. She has tried multiple weight loss diets over the years without long term success. She wants to set a good example for her children. “My kids don’t want to eat anything but “junk” and I don’t want to prepare separate meals”

Biochemical studies (labs) reveal a Hemoglobin A1C of 5.1% (normal range 4.0% to 5.5%); Total Cholesterol of 193 mg/dl (acceptable <200 mg/dl); HDL Cholesterol 38 (desirable >50 for women); LDL Cholesterol 119 mg/dl (acceptable <130); Hematocrit 41% (acceptable range 36-47%, females); Fasting Glucose of 105 mg/dl (acceptable range 70-110 mg/dl); and Blood Pressure of 140/90 mm Hg (acceptable <120/80 mm Hg for adults). Mae reports a family history of obesity on her father’s side. She does not smoke and drinks wine occasionally at social events. She is taking no routine medications, however, she does take a daily women's multivitamin.

Her usual food intake includes:

- **Breakfast:** 1 large latte or cappuccino after dropping the kids off at school
- **Morning snack:** 1 donut and small glass of 2% milk
- **Lunch:** Peanut butter and jelly sandwich on white bread, 1 apple or orange, 1 can of cola
- **Afternoon snack:** cookies and milk with the kids after school
- **Dinner:** beef or chicken entrée (prepared at home), potatoes (various recipes), corn or peas, green salad with ranch dressing, ice cream, pudding, or Jell-O dessert with water to drink
- **Evening snack:** fruit juice, snack crackers or chips

Estimated energy intake from usual dietary intake (using the exchange method): 2610 Kcal/day

Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity): 1490.5 x 1.2 = 1788.6 Kcal/day + 15% (range 1520.3-2056.9 Kcal/day)

(Mifflin, et al., 1990)

Step 1: Determine the portions of the case study that correspond to each of these components of a nutrition assessment: Anthropometric (A), Biochemical (labs) (B), Clinical (C), Dietary (D), Environmental (E), and Functional (F).

NUTRITION ASSESSMENT	
Anthropometric (A) • *Height: 5 feet 6 inches tall **(167.64 cm):*** • *weight 178 pounds **(80.9 kg)*** • *BMI: **28.9** (target BMI range for adults is 18.5-24.9) **(Lines 3, 4)***	***Biochemical (labs) (B)*** • *Hemoglobin A1C of **5.1%** (normal range 4.0% to 5.5%);* • *Total Cholesterol of **193 mg/dl** (acceptable <200 mg/dl); HDL Cholesterol **38** (desirable >50 for women);* • *LDL Cholesterol **119 mg/dl** (acceptable <130);* • *Hematocrit **41%** (acceptable range 36-47%, females);* • *Fasting Glucose of **105 mg/dl** (acceptable range 70-110 mg/dl); **(Lines 10-13)***
Clinical (C) • *Blood Pressure of **140/90 mm Hg** (acceptable <120/80 mm Hg for adults).**(Line 14)*** • *gained **40-50 pounds** (18.2-22.7 kg) with each of her pregnancies (usual weight gain is ~30 pounds (13.6 kg)) and was unsuccessful returning to her usual weight after each pregnancy **(Line 5-7)*** • *family history of obesity **(Line 15)***	***Dietary (D)*** • *Has tried multiple weight loss diets without success **(Line 7)*** • *takes a daily women's multivitamin **(Line 16)*** • *Estimated energy intake from usual dietary intake (using the exchange method): **2610 Kcal/day (Line 28)*** • *Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity): 1490.5 x 1.2 = 1788.6 Kcal/day ± 15% **(range 1520.3-2056.9 Kcal/day) (Lines 29-30)***
Environmental (E) • *No regular physical activity **(Line 4)*** • *She wants to set a good example for her children. "My kids don't want to eat anything but "junk" and I don't want to prepare separate meals" **(Lines 8-9)*** • *No smoking **(Line 15)*** • *Wine at social events occasionally **(Line 15)***	***Functional (F)***

Step 2: There are elements that fall outside normal values and acceptable ranges.

NUTRITION ASSESSMENT	
Anthropometric (A) • *Height: 5 feet 6 inches tall (167.64 cm):* • *weight 178 pounds (80.9 kg)* • *BMI: 28.9 (target BMI range for adults is 18.5-24.9) (Lines 3, 4)*	***Biochemical (labs) (B)*** • *Hemoglobin A1C of 5.1% (normal range 4.0% to 5.5%);* • *Total Cholesterol of 193 mg/dl (acceptable <200 mg/dl);* • *HDL Cholesterol 38 (desirable >50 for women);* • *LDL Cholesterol 119 mg/dl (acceptable <130);* • *Hematocrit 41% (acceptable range 36-47%, females);* • *Fasting Glucose of 105 mg/dl (acceptable range 70-110 mg/dl); Lines 10-13)*
Clinical (C) • *Blood Pressure of 140/90 mm Hg (acceptable <120/80 mm Hg for adults)(Line 14)* • *gained 40-50 pounds (18.2-22.7 kg) with each of her pregnancies (usual weight gain is ~30 pounds (13.6 kg)) and was unsuccessful returning to her usual weight after each pregnancy(Line 5-7)* • *family history of obesity(Line 15)*	***Dietary (D)*** • *Has tried multiple weight loss diets without success (Line 7)* • *takes a daily women's multivitamin (Line 16)* • ***Estimated energy intake from usual dietary intake (using the exchange method):*** *2610 Kcal/day (line 28)* • ***Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity):*** *1490.5 x 1.2 = 1788.6 Kcal/day ± 15% (range 1520.3-2056.9 Kcal/day)(Lines 29-30)*
Environmental (E) • *No regular physical activity(Line 4)* • *She wants to set a good example for her children. "My kids don't want to eat anything but "junk" and I don't want to prepare separate meals" (Lines 8-9)* • *No smoking (Line 15)* • *Wine at social events occasionally (Line 15)*	***Functional (F)***

Step 3: HDL is low, BP is elevated, and BMI is high. Mae does no regular physical activity. She has tried multiple weight loss diets without success. She gained a lot of weight with each pregnancy. She has a family history of obesity. Her energy intake from her usual food intake is greater than her estimated needs for energy.

Nutrition Diagnosis in the Intake domain: Excessive Energy Intake (NI-1.3).

Step 4: Construct a PES statement corresponding to the IDNT of Excessive Energy Intake (NI-1.3) by filling in the grid with details from the nutrition assessment that correspond to the structure of the PES statement.

<table>
<tr><td colspan="2">NUTRITION ASSESSMENT</td></tr>
<tr><td>Anthropometric (A)
• Height: 5 feet 6 inches tall (167.64 cm):
• weight 178 pounds (80.9 kg)
• BMI: 28.9 (target BMI range for adults is 18.5-24.9) (Lines 3, 4)</td><td>Biochemical (labs) (B)
• Hemoglobin A1C of 5.1% (normal range 4.0% to 5.5%);
• Total Cholesterol of 193 mg/dl (acceptable <200 mg/dl);
• HDL Cholesterol 38 (desirable >50 for women);
• LDL Cholesterol 119 mg/dl (acceptable <130);
• Hematocrit 41% (acceptable range 36-47%, females);
• Fasting Glucose of 105 mg/dl (acceptable range 70-110 mg/dl); Lines 10-13)</td></tr>
<tr><td>Clinical (C)
• Blood Pressure of 140/90 mm Hg (acceptable <120/80 mm Hg for adults)(Line 14)
• gained 40-50 pounds (18.2-22.7 kg) with each of her pregnancies (usual weight gain is ~30 pounds (13.6 kg)) and was unsuccessful returning to her usual weight after each pregnancy(Line 5-7)
• family history of obesity(Line 15)</td><td>Dietary (D)
• Has tried multiple weight loss diets without success (Line 7)
• takes a daily women's multivitamin (Line 16)
• Estimated energy intake from usual dietary intake (using the exchange method): 2610 Kcal/day (Line 28)
• Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity): 1490.5 x 1.2 = 1788.6 Kcal/day ± 15% (range 1520.3-2056.9 Kcal/day)(Lines 29-30)</td></tr>
<tr><td>Environmental (E)
• No regular physical activity(Line 4)
• She wants to set a good example for her children. "My kids don't want to eat anything but "junk" and I don't want to prepare separate meals" (Lines 8-9)
• No smoking (Line 15)
• Wine at social events occasionally (Line 15)</td><td>Functional (F)</td></tr>
<tr><td colspan="2">NUTRITION DIAGNOSIS</td></tr>
<tr><td colspan="2">Nutrition Diagnosis #1 Problem Excessive Energy Intake (NI-1.3)</td></tr>
<tr><td colspan="2">Etiology: related to current energy intake 2610 kcal/day (line 28) is greater than estimated needs of 1788 kcal/day (line 29)</td></tr>
<tr><td colspan="2">Sign/Symptoms : as evidenced by an elevated BMI: 28.9 (target BMI range for adults is 18.5-24.9) (Lines 3, 4)</td></tr>
</table>

End of Example #1

Case Study #2 Product Oriented Worked Example (PDWE)-Learning Phase

Case details adapted from Brown, J. E. (ed.) (2005) Nutrition through the lifecycle 2nd Ed. Thomson and Wadsworth, Belmont, CA.

Case Study #2. Kate Goode -PDWE

Kate Goode is 25 years old and is training for her first marathon with some college friends. She is a graduate student and has been referred to you by the staff at the university clinic because she has questions about staying healthy and strong as she trains. Kate was active in high school sports and has maintained a high level of physical activity in college by participating in recreational sports. The new training schedule for the marathon has increased her regularly planned physical activity from about one hour (1) six days per week to two hours (2) six days per week. Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg). Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9). Her immediate family has no history of chronic illness. Kate does not use any tobacco products. She drinks beer or wine socially one or two times a month. She likes most foods though she avoids fried foods and desserts except occasional ice cream. She has been eating a lot of meat and fish lately to increase her protein intake.

Current calorie and protein intake based on her 24 hour dietary recall: 2090 kcal/day and 120 g/day of protein

Estimated Energy Needs (Mifflin-St. Jeor x 2.0 for high physical activity): 1417 x 2.0= 2835 kcal/day + 15% (range 2409.8-3260.3 kcal/day)

Estimated Protein Needs (0.8-1.2 g/kg): 49-73.7g/day

Step 1: Determine the portions of the case study that correspond to each of these components of a nutrition assessment: Anthropometric (A), Biochemical (labs) (B), Clinical (C), Dietary (D), Environmental (E), and Functional (F).

NUTRITION ASSESSMENT	
Anthropometric (A) • *Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg).* ***(line 7)*** • *Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9).* ***(line 8)***	***Biochemical (labs) (B)***
Clinical (C) • *Her immediate family has no history of chronic illness****.(line 8-9)***	***Dietary (D)*** • *She likes most foods though she avoids fried foods and desserts except occasional ice cream.* • *She has been eating a lot of meat and fish lately to increase her protein intake.* • ***Current calorie and protein intake based on her 24 hour dietary recall:*** *2090 kcal/day and 120 g/day of protein* • ***Estimated Energy Intake (Mifflin-St. Jeor x 2.0 for high physical activity):*** *1417 x 2.0= 2835 ± 15% (range 2409.8-3260.3 kcal/day)* • ***Estimated Protein Needs (0.8-1.2 g/kg):*** *49-73.7g/day* ***(line 12-16)*** •
Environmental (E) • *Kate does not use any tobacco products. (line 9)* • *She drinks beer or wine socially one or two times a month.* ***(line 10)*** • *The new training schedule for the marathon has increased her regularly planned physical activity from about one hour six days per week to two hours six days per week.* ***(line 5-6)***	***Functional (F)***

Step 2: There are elements that fall outside normal values and acceptable ranges.

<table>
<tr><td colspan="2">NUTRITION ASSESSMENT</td></tr>
<tr><td>Anthropometric (A)
• Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg). (line 7)
• Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9). (line 8)</td><td>Biochemical (labs) (B)
•</td></tr>
<tr><td>Clinical (C)
• Her immediate family has no history of chronic illness.(line 8-9)</td><td>Dietary (D)
• She likes most foods though she avoids fried foods and desserts except occasional ice cream.
• She has been eating a lot of meat and fish lately to increase her protein intake.
• Current calorie and protein intake based on her 24 hour dietary recall: 2090 kcal/day and 120 g/day of protein
• Estimated Energy Intake (Mifflin-St. Jeor x 2.0 for high physical activity): 1417 x 2.0= 2835 ± 15% (range 2409.8-3260.3 kcal/day)
• Estimated Protein Needs (0.8-1.2 g/kg): 49-73.7g/day (line 12-16)
•</td></tr>
<tr><td>Environmental (E)
• Kate does not use any tobacco products. (line 9)
• She drinks beer or wine socially one or two times a month. (line 10)
• The new training schedule for the marathon has increased her regularly planned physical activity from about one hour six days per week to two hours six days per week. (line 5-6)</td><td>Functional (F)</td></tr>
</table>

Step 3: Calorie intake is below what estimated needs will be for training and weight maintenance and protein intake is greater than estimated needs.

Nutrition Diagnoses in the Intake domain: Predicted suboptimal energy intake (NI 1.4) and Excessive protein intake (NI 5.7.2)

Step 4: Construct a PES statement corresponding to the IDNT of Predicted suboptimal energy intake (NI 1.4) and Excessive protein intake (NI 5.7.2) by filling in the grid with details from the nutrition assessment that correspond to the structure of the PES statement.

NUTRITION ASSESSMENT	
Anthropometric (A) • *Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg). (line 7)* • *Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9). (line 8)*	***Biochemical (labs) (B)*** •
Clinical (C) • *Her immediate family has no history of chronic illness.(line 8-9)*	***Dietary (D)*** • *She likes most foods though she avoids fried foods and desserts except occasional ice cream.* • *She has been eating a lot of meat and fish lately to increase her protein intake.* • ***Current calorie and protein intake based on her 24 hour dietary recall:*** *2090 kcal/day and 120 g/day of protein* • ***Estimated Energy Intake (Mifflin-St. Jeor x 2.0 for high physical activity):*** *1417 x 2.0= 2835 ± 15% (range 2409.8-3260.3 kcal/day)* • ***Estimated Protein Needs (0.8-1.2 g/kg):*** *49-73.7g/day (line 12-16)*
Environmental (E) • *Kate does not use any tobacco products. (line 9)* • *She drinks beer or wine socially one or two times a month. (line 10)* • *The new training schedule for the marathon has increased her regularly planned physical activity from about one hour six days per week to two hours six days per week. (line 5-6)*	***Functional (F)***
NUTRITION DIAGNOSIS	
Nutrition Diagnosis #1 Problem **Predicted suboptimal energy intake (NI 1.4)**	
Etiology: ***related to*** increased training for a marathon (lines 5-6)	
Sign/Symptoms: as ***evidenced by*** usual intake of energy of 2090 kcal/day compared to estimated needs of 2835 kcal for day for training and weight maintenance. (lines 12-15)	
NUTRITION DIAGNOSIS	
Nutrition Diagnosis #2 Problem **Excessive protein intake (NI 5.7.2)**	
Etiology: ***related to*** eating a lot of meat and fish lately to increase her protein intake (line	

11)
Sign/Symptoms: ***as evidenced by*** estimated protein needs between 49-73.7 g/day (line 16) compared to current dietary protein of intake at 120g/day (line 13)

End of Example #2

Appendix L – Process Oriented Worked Example (PSWE)-Learning Phase

You are a student enrolled in a program to train you to be a nutrition professional in the United States health care system. Nutrition professionals design nutrition care plans for prevention, treatment, and management of nutrition problems in humans. They function as part of a healthcare team that typically includes doctors, nurses, and other health professionals. Nutrition professionals are the nutrition experts and are integral to successful medical care of individuals.

The following worked examples outline the steps taken when establishing a nutrition diagnosis and labeling that diagnosis using International Dietetics and Nutrition Terminology (IDNT) and writing a Problem, Etiology, and Signs/Symptoms (PES) statement consistent with that diagnosis. The PES statement is the format required to document the nutrition diagnosis in the patient's medical record. The purpose of using standardized language such as IDNT is to describe nutrition problems consistently so that they are clear to all who care for a particular individual patient. Enhanced communication and documentation leads to improved patient care.

A nutrition diagnosis identifies a specific nutrition problem that can be treated or managed by a nutrition professional using a nutrition intervention. Nutrition professionals write a PES statement to describe the problem, its root cause, and the assessment data that provide evidence for the diagnosis. The format for the PES statement is *"*___________ *(nutrition problem (**P**) using IDNT)* ***related to*** _________ *(Evidence (**E**))* ***as evidenced by*** _________ *(Signs and Symptoms (**S**))*".

The nutrition diagnoses presented in the examples will be within the intake domain, though other domains exist for IDNT. A one-page abridged handout listing the IDNT for the intake domain is included for your reference as you study the examples.

Case Study #1 Process Oriented Worked Example (PSWE)-Learning Phase

Case details adapted from Emery, E. Z. (2012) *Clinical Case Studies for the Nutrition Care Process,* pg. 53-59.

Case Study #1

Mae Jones PSWE

Mae Jones, a 41 year old mother of two, was referred by her doctor, for nutrition therapy. She is 5 feet 6 inches tall (167.64 cm) and weighs 178 pounds (80.9 kg). Her BMI is 28.9 (target BMI range for adults is 18.5-24.9). She reports she does not engage in any regular physical activity; however she was an athlete in high school. She gained 40-50 pounds (18.2-22.7 kg) with each of her pregnancies (usual weight gain ~30 pounds (13.6 kg) and was unsuccessful returning to her usual weight after each pregnancy. She has tried multiple weight loss diets over the years without long term success. She wants to set a good example for her children. "My kids don't want to eat anything but "junk" and I don't want to prepare separate meals"

Biochemical studies (labs) reveal a Hemoglobin A1C of 5.1% (normal range 4.0% to 5.5%); total cholesterol of 193 mg/dl (acceptable <200 mg/dl); HDL cholesterol 38 (desirable >50 for women); LDL Cholesterol 119 mg/dl (acceptable <130); Hematocrit 41% (acceptable range 36-47%, females); fasting glucose of 105 mg/dl (acceptable range

70-110 mg/dl); and blood pressure of 140/90 mm Hg (acceptable <120/80 mm Hg for adults). Mae reports a family history of obesity on her father's side. She does not smoke and drinks wine occasionally at social events. She is taking no routine medications, however she does take a daily women's multivitamin.

Her usual food intake includes:

- **Breakfast:** 1 large latte or cappuccino after dropping the kids off at school
- **Morning snack:** 1 donut and small glass of 2% milk
- **Lunch:** Peanut butter and jelly sandwich on white bread, 1 apple or orange, 1 can of cola
- **Afternoon snack:** cookies and milk with the kids after school
- **Dinner:** beef or chicken entrée (prepared at home), potatoes (various recipes), corn or peas, green salad with ranch dressing, ice cream, pudding, or Jell-O dessert with water to drink
- **Evening snack:** fruit juice, snack crackers or chips

Estimated energy intake from usual dietary intake (using the exchange method): 2610 Kcal/day

Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity): 1490.5 x 1.2 = 1788.6 Kcal/day + 15% (range 1520.3-2056.9 Kcal/day)

(Mifflin, St Jeor, Hill, Scott, Daugherty, & Koh, 1990)

Step 1: Determine the portions of the case study that correspond to each of these components of a nutrition assessment: Anthropometric (A), Biochemical (labs) (B), Clinical (C), Dietary (D), Environmental (E), and Functional (F).

Assessment data can come from patients directly through interview, observations, and measurement or from the medical record or referring healthcare provider. Anthropometric data is height, weight, weight history and any calculations made with that data such as BMI. It can also include other data focused on body composition such as measuring body fat or lean body mass. Biochemical data comes from laboratory tests or other metabolic studies. Clinical data comes from your own observations or by other healthcare providers and includes other tests that are communicated in the medical record or in direct conversation with other members of the healthcare team. Clinical data may also include any past medical or family history. Dietary data includes food and fluid intake, supplement use, and any food beliefs or behaviors. Environmental data outlines daily living and working conditions that may impact nutrition related problems. Functional data relates to any difficulties an individual might have with oral food consumption such as limited motor skills for preparing and eating meals. The personal history in a case may provide information that enhances or clarifies the information in the other portions of the assessment.

NUTRITION ASSESSMENT	
Anthropometric (A) • *Height: 5 feet 6 inches tall* ***(167.64 cm):*** • *weight 178 pounds* ***(80.9 kg)*** • *BMI:* ***28.9*** *(target BMI range for adults is 18.5-24.9)* ***(Lines 3, 4)***	***Biochemical (labs) (B)*** • *Hemoglobin A1C of* ***5.1%*** *(normal range 4.0% to 5.5%);* • *Total Cholesterol of* ***193 mg/dl*** *(acceptable <200 mg/dl);* • *HDL Cholesterol* ***38*** *(desirable >50 for women);* • *LDL Cholesterol* ***119 mg/dl*** *(acceptable <130);* • *Hematocrit* ***41%*** *(acceptable range 36-47%, females);* • *Fasting Glucose of* ***105 mg/dl*** *(acceptable range 70-*

	110 mg/dl); ***(Lines 10-13)***
Clinical (C) • *Blood Pressure of* ***140/90 mm Hg*** *(acceptable <120/80 mm Hg for adults).***(Line 14)*** • *gained* ***40-50 pounds*** *(18.2-22.7 kg) with each of her pregnancies (usual weight gain is ~30 pounds (13.6 kg)) and was unsuccessful returning to her usual weight after each pregnancy****(Line 5-7)*** • *family history of obesity****(Line 15)***	***Dietary (D)*** • *Has tried multiple weight loss diets without success* ***(Line 7)*** • *takes a daily women's multivitamin* ***(Line 16)*** • *Estimated energy intake from usual dietary intake (using the exchange method):* ***2610 Kcal/day*** *(Line 28)* • *Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity): 1490.5 x 1.2 = 1788.6 Kcal/day ± 15%* ***(range 1520.3-2056.9 Kcal/day)(Lines 29-30)***
Environmental (E) • *No regular physical activity****(Line 4)*** • *She wants to set a good example for her children. "My kids don't want to eat anything but "junk" and I don't want to prepare separate meals"* ***(Lines 8-9)*** • *No smoking (Line 15)* • *Wine at social events occasionally* ***(Line 15)***	***Functional (F)***

Step 2: There are elements that fall outside normal values and acceptable ranges.

Unexpected results or those that fall outside acceptable ranges should be considered further as signs and symptoms of a nutrition problem. Considering how the elements that are outside the acceptable range are related to each other, especially if there is a pattern that would suggest an underlying cause, provides the clues needed to determine a nutrition diagnosis. Specifically look at the relationship between the assessment data of anthropometrics, biochemical, and clinical and how this relates to dietary information. These should be related if a diagnosis in the intake domain is made. If a nutrition intervention occurs, measuring these elements indicates at a later date whether or not a problem has been resolved or managed.

NUTRITION ASSESSMENT	
Anthropometric (A) • *Height: 5 feet 6 inches tall (167.64 cm):* • *weight 178 pounds (80.9 kg)* • *BMI: 28.9 (target BMI range for adults is 18.5-24.9) (Lines 3, 4)*	***Biochemical (labs) (B)*** • *Hemoglobin A1C of 5.1% (normal range 4.0% to 5.5%);* • *Total Cholesterol of 193 mg/dl (acceptable <200 mg/dl);* • *HDL Cholesterol 38 (desirable >50 for women);* • *LDL Cholesterol 119 mg/dl (acceptable <130);* • *Hematocrit 41% (acceptable range 36-47%, females);* • *Fasting Glucose of 105 mg/dl (acceptable range 70-110 mg/dl); Lines 10-13)*
Clinical (C) • *Blood Pressure of 140/90 mm Hg (acceptable <120/80 mm Hg for adults)(Line 14)* • *gained 40-50 pounds (18.2-22.7 kg) with each of her pregnancies (usual weight gain is ~30 pounds (13.6 kg)) and was unsuccessful returning to her usual weight after each pregnancy(Line 5-7)* • *family history of obesity(Line 15)*	***Dietary (D)*** • *Has tried multiple weight loss diets without success (Line 7)* • *takes a daily women's multivitamin (Line 16)* • ***Estimated energy intake from usual dietary intake (using the exchange method):*** *2610 Kcal/day (line 28)* • ***Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity):*** *1490.5 x 1.2 = 1788.6 Kcal/day ± 15% (range 1520.3-2056.9 Kcal/day)(Lines 29-30)*
Environmental (E) • *No regular physical activity(Line 4)* • *She wants to set a good example for her children. "My kids don't want to eat anything but "junk" and I don't want to prepare separate meals" (Lines 8-9)* • *No smoking (Line 15)* • *Wine at social events occasionally (Line 15)*	***Functional (F)***

Step 3: HDL is low, BP is elevated, and BMI is high. Mae does no regular physical activity. She has tried multiple weight loss diets without success. She gained a lot of weight with each pregnancy. She has a family history of obesity. Her energy intake from her usual food intake is greater than her estimated needs for energy.

Nutrition Diagnosis in the Intake domain is: Excessive Energy Intake (NI-1.3). *Of the information presented, only energy intake is a nutrition problem that can be addressed by a nutrition professional using a nutrition intervention (a change in the way nutrients are provided) for this individual. HDL is low and BP is elevated, though potentially related, cannot be solely impacted by a nutrition intervention and are outside the immediate care a nutrition professional can provide.*

Step 4: Construct a PES statement corresponding to the IDNT of Excessive Energy Intake (NI-1.3) by filling in the grid with details from the nutrition assessment that correspond to the structure of the PES statement.

The root cause or the most specific cause stands out as the etiology so that using the terms "related to" in the PES statement clearly outlines the target of the nutrition intervention. Include the signs and symptoms from the assessment data to support this etiology, which you can use to monitor the effectiveness of the nutrition intervention. These are clearly stated along with the comparison to acceptable, expected, or normal values preceded by the words "as evidenced by" from the items that were outside the acceptable ranges in the grid.

NUTRITION ASSESSMENT	
Anthropometric (A) • *Height: 5 feet 6 inches tall (167.64 cm):* • *weight 178 pounds (80.9 kg)* • *BMI: 28.9 (target BMI range for adults is 18.5-24.9) (Lines 3, 4)*	Biochemical (labs) (B) • *Hemoglobin A1C of 5.1% (normal range 4.0% to 5.5%);* • *Total Cholesterol of 193 mg/dl (acceptable <200 mg/dl);* • *HDL Cholesterol 38 (desirable >50 for women);* • *LDL Cholesterol 119 mg/dl (acceptable <130);* • *Hematocrit 41% (acceptable range 36-47%, females);* • *Fasting Glucose of 105 mg/dl (acceptable range 70-110 mg/dl); Lines 10-13)*
Clinical (C) • *Blood Pressure of 140/90 mm Hg (acceptable <120/80 mm Hg for adults)(Line 14)* • *gained 40-50 pounds (18.2-22.7 kg) with each of her pregnancies (usual weight gain is ~30 pounds (13.6 kg)) and was unsuccessful returning to her usual weight after each pregnancy(Line 5-7)* • *family history of obesity(Line 15)*	Dietary (D) • *Has tried multiple weight loss diets without success (Line 7)* • *takes a daily women's multivitamin (Line 16)* • ***Estimated energy intake from usual dietary intake (using the exchange method):** 2610 Kcal/day (Line 28)* • ***Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.2 for sedentary activity)**: 1490.5 x 1.2 = 1788.6 Kcal/day + 15% (range 1520.3-2056.9 Kcal/day)(Lines 29-30)*
Environmental (E) • *No regular physical activity(Line 4)* • *She wants to set a good example for her children. "My kids don't want to eat anything but "junk" and I don't want to prepare separate meals" (Lines 8-9)* • *No smoking (Line 15)* • *Wine at social events occasionally (Line 15)*	Functional (F)
NUTRITION DIAGNOSIS	
Nutrition Diagnosis #1 Problem **Excessive Energy Intake (NI-1.3)**	
Etiology: ***related to*** current energy intake 2610 kcal/day (line 28) is greater than estimated needs of 1788 kcal/day (line 29)	
Sign/Symptoms: ***as evidenced by*** an elevated BMI: 28.9 (target BMI range for adults is 18.5-24.9) (Lines 3, 4)	

End of Example #1

Case Study #2 Process Oriented Worked Example (PSWE)-Learning Phase

Case details adapted from Brown, J. E. (ed.) (2005) Nutrition through the lifecycle 2nd Ed. Thomson and Wadsworth, Belmont, CA.

Case Study #2 Kate Goode -PSWE

Kate Goode is 25 years old and is training for her first marathon with some college friends. She is a graduate student and has been referred to you by the staff at the university clinic because she has questions about staying healthy and strong as she trains. Kate was active in high school sports and has maintained a high level of physical activity in college by participating in recreational sports. The new training schedule for the marathon has increased her regularly planned physical activity from about one hour (1) six days per week to two (2) hours six days per week. Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg). Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9). Her immediate family has no history of chronic illness. Kate does not use any tobacco products. She drinks beer or wine socially one or two times a month. She likes most foods though she avoids fried foods and desserts except occasional ice cream. She has been eating a lot of meat and fish lately to increase her protein intake.

Current calorie and protein intake based on her 24 hour dietary recall: 2090 kcal/day and 120 g/day of protein

Estimated Energy Needs (Mifflin-St. Jeor x 2.0 for high physical activity): 1417 x 2.0= 2835 $\pm$ 15% (range 2409.8-3260.3 kcal/day)

Estimated Protein Needs (0.8-1.2 g/kg): 49-73.7g/day

Step 1: Determine the portions of the case study that correspond to each of these components of a nutrition assessment: Anthropometric (A), Biochemical (labs) (B), Clinical (C), Dietary (D), Environmental (E), and Functional (F).

Assessment data can come from patients directly through interview, observations, and measurement or from the medical record or referring healthcare provider. Anthropometric data is height, weight, weight history and any calculations made with that data such as BMI. It can also include other data focused on body composition such as measuring body fat or lean body mass. Biochemical data comes from laboratory tests or other metabolic studies. Clinical data comes from your own observations or by other healthcare providers and includes other tests that are communicated in the medical record or in direct conversation with other members of the healthcare team. Clinical data may also include any past medical or family history. Dietary data includes food and fluid intake, supplement use, and any food beliefs or behaviors. Environmental data outlines daily living and working conditions that may impact nutrition related problems. Functional data relates to any difficulties an individual might have with oral food consumption such as limited motor skills for preparing and eating meals. The personal history in a case may provide information that enhances or clarifies the information in the other portions of the assessment.

NUTRITION ASSESSMENT	
Anthropometric (A) • *Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg).* ***(line 7)*** • *Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9).* ***(line 8)***	***Biochemical (labs) (B)***
Clinical (C) • *Her immediate family has no history of chronic illness* ***.(line 8-9)***	***Dietary (D)*** • *She likes most foods though she avoids fried foods and desserts except occasional ice cream.* • *She has been eating a lot of meat and fish lately to increase her protein intake.* • ***Current calorie and protein intake based on her 24 hour dietary recall:*** *2090 kcal/day and 120 g/day of protein* • ***Estimated Energy Intake (Mifflin-St. Jeor x 2.0 for high physical activity):*** *1417 x 2.0= 2835 $\pm$ 15% (range 2409.8-3260.3 kcal/day)* • ***Estimated Protein Needs (0.8-1.2 g/kg):*** *49-73.7g/day* ***(line 12-16)*** •
Environmental (E) • *Kate does not use any tobacco products.* ***(line 9)*** • *She drinks beer or wine socially one or two times a month.* ***(line 10)*** • *The new training schedule for the marathon has increased her regularly planned physical activity from about one hour six days per week to two hours six days per week.* ***(line 5-6)***	***Functional (F)***

Step 2: There are elements that fall outside normal values and acceptable ranges.

Unexpected results or those that fall outside acceptable ranges should be considered further as signs and symptoms of a nutrition problem. Considering how the elements that are outside the acceptable range are related to each other, especially if there is a pattern that would suggest an underlying cause, provides the clues needed to determine a nutrition diagnosis. Specifically look at the relationship between the assessment data of anthropometrics, biochemical, and clinical and how this relates to dietary information. These should be related if a diagnosis in the intake domain is made. If a nutrition intervention occurs, measuring these elements indicates at a later date whether or not a problem has been resolved or managed.

NUTRITION ASSESSMENT	
Anthropometric (A) • *Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg). (line 7)* • *Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9). (line 8)*	***Biochemical (labs) (B)*** •
Clinical (C) • *Her immediate family has no history of chronic illness.(line 8-9)*	***Dietary (D)*** • *She likes most foods though she avoids fried foods and desserts except occasional ice cream.* • *She has been eating a lot of meat and fish lately to increase her protein intake.* • ***Current calorie and protein intake based on her 24 hour dietary recall:*** *2090 kcal/day and 120 g/day of protein* • ***Estimated Energy Intake (Mifflin-St. Jeor x 2.0 for high physical activity):*** *1417 x 2.0= 2835 $\pm$ 15% (range 2409.8-3260.3 kcal/day)* • ***Estimated Protein Needs (0.8-1.2 g/kg):*** *49-73.7g/day (line 12-16)* •
Environmental (E) • *Kate does not use any tobacco products. (line 9)* • *She drinks beer or wine socially one or two times a month. (line 10)* • *The new training schedule for the marathon has increased her regularly planned physical activity from about one hour six days per week to two hours six days per week. (line 5-6)*	***Functional (F)***

Step 3: Calorie intake is below what estimated needs will be for training and weight maintenance and protein intake is greater than estimated needs.

Nutrition Diagnoses in the Intake domain: Predicted suboptimal energy intake (NI 1.4) **and** Excessive protein intake (NI 5.7.2)

Of the information presented, only the energy intake and protein intake are nutrition problems that can be addressed by a nutrition professional using a nutrition intervention (a change in the way nutrients are provided) for this individual.

Step 4: Construct a PES statement corresponding to the IDNT of Predicted suboptimal energy intake (NI 1.4) and Excessive protein intake (NI 5.7.2) by filling in the grid with details from the nutrition assessment that correspond to the structure of the PES statement.

The root cause or the most specific cause stands out as the etiology so that using the terms "related to" in the PES statement clearly outlines the target of the nutrition intervention. Include the signs and symptoms from the assessment data to support this etiology, which you can use to monitor the effectiveness of the nutrition intervention. These are clearly stated along with the comparison to acceptable, expected, or normal values preceded by the words "as evidenced by" from the items that were outside the acceptable ranges in the grid.

<table>
<tr><td colspan="2">NUTRITION ASSESSMENT</td></tr>
<tr><td>Anthropometric (A)
• Kate is 5 feet 8 inches tall (174.1 cm) and weighs 135 pounds (61.4 kg). (line 7)
• Her Body Mass Index (BMI) is 20.3 (target BMI for adults is 18.5-24.9). (line 8)</td><td>Biochemical (labs) (B)
•</td></tr>
<tr><td>Clinical (C)
• Her immediate family has no history of chronic illness.(line 8-9)</td><td>Dietary (D)
• She likes most foods though she avoids fried foods and desserts except occasional ice cream.
• She has been eating a lot of meat and fish lately to increase her protein intake.
• Current calorie and protein intake based on her 24 hour dietary recall: 2090 kcal/day and 120 g/day of protein
• Estimated Energy Intake (Mifflin-St. Jeor x 2.0 for high physical activity): 1417 x 2.0= 2835 $\pm$ 15% (range 2409.8-3260.3 kcal/day)
• Estimated Protein Needs (0.8-1.2 g/kg): 49-73.7g/day (line 12-16)</td></tr>
<tr><td>Environmental (E)
• Kate does not use any tobacco products. (line 9)
• She drinks beer or wine socially one or two times a month. (line 10)
• The new training schedule for the marathon has increased her regularly planned physical activity from about one hour six days per week to two hours six days per week. (line 5-6)</td><td>Functional (F)</td></tr>
<tr><td colspan="2">NUTRITION DIAGNOSIS</td></tr>
<tr><td colspan="2">Nutrition Diagnosis #1 Problem Predicted suboptimal energy intake (NI 1.4)</td></tr>
<tr><td colspan="2">Etiology: related to increased training for a marathon (lines 5-6)</td></tr>
<tr><td colspan="2">Sign/Symptoms: as evidenced by usual intake of energy of 2090 kcal/day compared to estimated needs of 2835 kcal for day for training and weight maintenance. (lines 12-15)</td></tr>
<tr><td colspan="2">NUTRITION DIAGNOSIS</td></tr>
<tr><td colspan="2">Nutrition Diagnosis #2 Problem Excessive protein intake (NI 5.7.2)</td></tr>
<tr><td colspan="2">Etiology: related to eating a lot of meat and fish lately to increase her protein intake (line 11)</td></tr>
<tr><td colspan="2">Sign/Symptoms : as evidenced by estimated protein needs between 49-73.7 g/day (line 16 compared to current dietary protein of intake at 120g/day (line 13)</td></tr>
</table>

End of Example #2

Appendix M – Practice Cases

You are a student enrolled in a program to train you to be nutrition professional in the United States health care system. Read the following cases and establish a nutrition diagnosis using International Dietetics and Nutrition Terminology (IDNT) and write a Problem, Etiology, and Signs/Symptoms (PES) statement consistent with that diagnosis.

A nutrition diagnosis identifies a specific nutrition problem that can be treated or managed by a nutrition professional using a nutrition intervention. Nutrition professionals write a PES statement to describe the problem, its root cause, and the assessment data that provide evidence for the diagnosis. The format for the PES statement is *"**___________** (nutrition problem (**P**) using IDNT) **related to _________** (Evidence (**E**)) **as evidenced by _________** (Signs and Symptoms (**S**))*".

The nutrition diagnoses presented in the examples will be within the intake domain, though other domains exist for IDNT. A one-page abridged handout listing the IDNT for the intake domain is included for your reference as you establish diagnoses for the cases.

The PES statement will documented in the patient's medical record in the grid format provided. **Write out your answers in the grid or write the line number** in the case corresponding to the elements you have chosen to focus on in the diagnostic process. Either way is fine.

Case Study #1 **Practice cases**

Case details adapted from Emery, E. Z. (2012) *Clinical Case Studies for the Nutrition Care Process,* pg. 53-59.

Case Study # 1 Mrs. Cobb Practice Case

Mrs. Cobb is a 76-year old woman admitted to the hospital with a lower right leg fracture, after tripping over her cat at home. Her height is 67" (170.2 cm), and her weight is 140 pounds (63.6 kg). Her weight six months ago was 160 pounds (72.7 kg). She is 87.5% of her usual body weight. Her BMI is 22. (Target BMI range for adults is 18.5-24.9). She has lost 12.5% of her usual body weight in the past six months. She has a history of hypertension (elevated blood pressure). Her current blood pressure is 128/65 mm Hg (acceptable <120/80 mm Hg for adults). Biochemical studies (labs) reveal; albumin 3.2 g/dl (target range 3.2-5.5 g/dl), prealbumin 11 mg/dl (target range 16-40 mg/dl), and blood glucose of 108 mg/dl (target range 70-110 mg/dl) Mrs. Cobb lives alone since the death of her husband six months ago. When talking with Mrs. Cobb you notice her dentures click a lot. She also complains that her mouth is dry. She reports decreased motivation to cook meals in the last six months. She does not use any tobacco products or consume alcohol. She currently takes 20 mg/day of Furosemide (a diuretic as part of her treatment for hypertension).

Her usual diet consists of:

- **<u>Breakfast:</u>** 8 oz. decaffeinated tea with 1 T half and half, 1 t sugar,
  1 slice white toast with 1 t margarine and 1 tsp jelly ***or***
  1 frozen pancake with 1 T syrup
  4 ounces of orange juice

- **Lunch:** Canned soup, usually chicken noodle, 1 cup
  4 unsalted crackers with 2 T peanut butter
  ½ peaches, canned in light syrup
  Sweetened ice tea, 1 cup
- **Dinner:** Chicken thigh with skin, stewed
  ½ cup rice or potato with 1 t margarine
  ½ cup spinach or carrots
  8 oz. decaffeinated tea with 1 T cream and 1 t sugar
- **Snacks:** none; avoids eggs and milk due to food preferences

Estimated energy and protein intake from usual dietary intake using the exchange method:

1313 kcal/day and 47 g of protein

Estimated energy needs using Mifflin-St. Jeor Equation x 1. 5 (.2 for sedentary activity and .3 for moderate illness/injury):

1746.5 kcal/day ± 15% (1484-2008 kcal/day) on current weight of 63.3 kg

Estimated protein needs (1.0-1.5 g/kg for moderate illness): 64-95 g/day of protein

NUTRITION ASSESSMENT	
Anthropometric (A)	*Biochemical (labs) (B)*
Clinical (C)	*Dietary (D)*
Environmental (E)	*Functional (F)*
NUTRITION DIAGNOSIS	
Nutrition Diagnosis #1 ***Problem***:	
Etiology: ***related to***	
Sign/Symptoms: ***as evidenced by***	
Nutrition Diagnosis #2 ***Problem***:	
Etiology: ***related to***	
Sign/Symptoms: ***as evidenced by***	

Case Study #2 Practice cases

Case Study # 2 John Lewis - Practice Case

John Lewis is a 19 year old sophomore in college living in the dorm and consuming his meals in the college dining hall on a meal plan. His meal plan allows him 3 meals per day. He has a small refrigerator and microwave in his dorm room for snacks and beverages when the dining hall is not open. He has been concerned that the meals he chooses to eat in the dining hall may not be as balanced as they should be. He exercises with friends in the college recreation center and has heard others talk about taking a multivitamin and mineral supplement. He purchased a supplement at the local drug store and has been taking it for the past 6 months. At a recent health screening sponsored by the college student health clinic, John asked for a referral to a dietitian to discuss his diet and the supplement he is taking. John is 5 feet 11 inches tall (181.2 cm) and weighs 180 pounds (81.8 kg). His Body Mass Index (BMI) is 25.1 and is plotted at the 77% for his age (healthy BMI range is 5-85% in adolescents and young adults to age 20). John has had no major illnesses and no chronic health problems. Both his parents are well with no major health problems. John receives primary care at the student health clinic and is up to date on all his required immunizations. He is taking TwinLabs supplement for men as directed on the label (4 capsules per day). He has brought the bottle to this appointment.

Twinlab Men's Ultra Daily Multivitamin, Capsules

Ingredients: Gelatin , Rice Flour , Potassium Citrate , Medium Chain Triglycerides , Silica , Magnesium Stearate

Nutrition Facts Serving Size : 4 Capsules Serving per Container : 36	Amount Per Serving	% Daily Value*		Amount Per Serving	% Daily Value*
Boron	1 Mg		Vitamin A	15000 IU	300
Vanadium	100 Mcg		Vitamin C	400 Mg	667
Choline	25 Mg		Vitamin D	400 IU	100
Inositol	25 Mg		Vitamin E	400 IU	1333
PABA	25 Mg		Thiamin (B1)	25 Mg	1667
Alpha Lipoic Acid	5 Mg		Riboflavin (B2)	25 Mg	1471
Trace Mineral Complex	1 Mg		Niacin (B3)	75 Mg	375
Prostate Health Lend	380 Mg		Vitamin B6	25 Mg	1250
Eleuthero Root & Rhizome Extract			Folate, Folic Acid, Folacin	800 Mcg	200
Ginkgo Leaf			Vitamin B12	100	1667
Astragalus Root			Biotin	300 Mcg	100
Asian Ginseng Root			Pantothenic Acid	50 Mg	500
Shisandra			Calcium	210 Mg	21
Polygonum Root			Iodine	150 Mcg	100
Eucommia Cortex			Magnesium	100 Mg	25
Polygonatum Rhizome			Zinc	30 Mg	25
Gynostemma			Selenium	200 Mcg	286
Sargassum Leaf			Copper	2 Mg	100
Reishi Fruit			Manganese	5 Mg	250
Jujube Fruit			Chromium	200 Mcg	167
Lycium Fruit			Molybdenum	45 Mcg	60
Luo Han Guo Fruit					
Nettle Root Extract					
Pygeum Bark					
Saw Palmetto Berry Extract					
Lycopene					
Selenium					
Energy & Stamina Blend					

<table>
<tr><td colspan="2">NUTRITION ASSESSMENT</td></tr>
<tr><td>Anthropometric (A)</td><td>Biochemical (labs) (B)</td></tr>
<tr><td>Clinical (C)</td><td>Dietary (D)</td></tr>
<tr><td>Environmental (E)</td><td>Functional (F)</td></tr>
<tr><td colspan="2">NUTRITION DIAGNOSIS</td></tr>
<tr><td colspan="2">Nutrition Diagnosis #1 Problem:</td></tr>
<tr><td colspan="2">Etiology: related to</td></tr>
<tr><td colspan="2">Sign/Symptoms: as evidenced by</td></tr>
</table>

Appendix N – Maintenance Cases

You are a student enrolled in a program to train you to be nutrition professional in the United States health care system. Read the following cases and establish a nutrition diagnosis using International Dietetics and Nutrition Terminology (IDNT) and write a Problem, Etiology, and Signs/Symptoms (PES) statement consistent with that diagnosis.

A nutrition diagnosis identifies a specific nutrition problem that can be treated or managed by a nutrition professional using a nutrition intervention. Nutrition professionals write a PES statement to describe the problem, its root cause, and the assessment data that provide evidence for the diagnosis. The format for the PES statement is *"**___________** (nutrition problem (**P**) using IDNT) **related to _________** (Evidence (**E**)) **as evidenced by _________** (Signs and Symptoms (**S**))*".

The nutrition diagnoses presented in the examples will be within the intake domain, though other domains exist for IDNT. A one-page abridged handout listing the IDNT for the intake domain is included for your reference as you establish diagnoses for the cases.

The PES statement will be documented in the patient's medical record in the grid format provided. Write out your answers in the grid or write the line number in the case corresponding to the elements you have chosen to focus on in the diagnostic process.

Case Study #1 Maintenance Practice

Case details adapted from Brown, J. E. (ed.) (2005) Nutrition through the lifecycle 2nd Ed. Thomson and Wadsworth, Belmont, CA.

Case Study #1-Arthur Brandt - maintenance practice

Arthur Brandt is a 30 year old software developer. He lives alone. His commute to work takes 90 minutes each day, though some days he works from home to save on transportation costs. He enjoys his work environment and his co-workers. His company provides a cafeteria so he does not need to pack a lunch which he finds extremely convenient. His main hobby is golf; the course he regularly plays encourages players to use golf carts. He is an avid football fan. In his spare time he is restoring an old car. Arthur is 5 feet 11 inches tall (181.8 cm) and weighs 190 pounds 9 (86.4 kg). His BMI is 26.6 (target BMI range for adults is 18.5-24.9). His BP is 117/75 mm Hg (acceptable <120/80 mm Hg for adults). He has a family history of type 2 diabetes mellitus (T2DM) however a recent screen showed his Hemoglobin A1C of 4.9 % (normal range 4.0 %-5.5%). Arthur takes no routine medications. He drinks 1-2 beers if watching a weekend football game with friends or occasionally after a golf game with his fellow players. He would like to avoid developing diabetes and his doctor has suggested a nutrition consult.

His usual food intake includes:

Breakfast: Coffee from home with 2% milk added; 3 slices of whole grain toast with butter and jam

Morning coffee break: coffee with 2% milk added; 1 bagel with cream cheese from the cafeteria

Lunch: the plate special in the cafeteria, usually baked or grilled beef, pork, or chicken; side salad with blue cheese dressing; 1 dinner roll with butter; cup of the daily offered soup; a small cookie; plain ice tea

Afternoon snack: usually nothing but water or plain ice tea

Dinner: pasta dish of some kind, made at home with sauce from jar (Chicken Alfredo is a favorite); small green salad with bottled dressing; plain ice tea or water

Evening snack: ice cream or occasionally a piece of fruit; if with friends watching a football game it usually is cheese and crackers

Estimated Energy intake from usual dietary intake (using the exchange method): 2955 Kcal/day (occasional alcoholic beverages included)

Estimated energy needs based on usual physical activity (Mifflin-St. Jeor Equation x 1.3 for light activity): 1855.25 x 1.3 = 2411.8 $\pm$ 15% (range 2050 - 2773.6 Kcal/day)

NUTRITION ASSESSMENT	
Anthropometric (A)	*Biochemical (labs) (B)*
Clinical (C)	*Dietary (D)*
Environmental (E)	*Functional (F)*
NUTRITION DIAGNOSIS	
Nutrition Diagnosis #1 ***Problem***:	
Etiology: ***related to***	
Sign/Symptoms: ***as evidenced by***	

Case Study #2 Maintenance Practice

Case details adapted from Nelms, M., H., & Anderson S. L. (2004) Medical Nutrition Therapy A Case Study Approach, 2nd edition

Case Study #2 Jessica Reyes - maintenance practice

Jessica Reyes is an 18 year old female who is competes in cross country for her high school in the fall and distance running events during the spring track and field season. She has been referred to see you after a recent visit to her primary care physician revealed she has been more fatigued than usual, has lost 4 pounds in the last 3 weeks, and though training the same, has eaten less per her mother's report. Her cross country performance has suffered some as her times have increased rather than decreased. Her mother attributes the slight decrease in eating to fatigue. Jessica's height is 5 feet 5 inches (166.4 cm) and 105 pounds (47.7 kg). Her usual weight is 109 pounds (49.5 kg). Her weight is 95.4% of her usual body weight. Her BMI is 17.3 and BMI % is 2% (healthy BMI range is 5-85% in adolescents and young adults to age 20). Her Hematocrit is 33 % (acceptable range is 37-47 %) and a serum ferritin of 16 ug/dl (acceptable range 18-160 ug/dl).

Jessica takes no routine medications or supplements. Jessica does not use any tobacco products. She does not consume any alcohol.

Her usual food intake includes:

Breakfast: 6 oz. of fruit juice, 1 piece of toast with butter

Lunch: 2 pieces of fresh fruit (apple and/or orange), 1 ham or other lunch meat sandwich, 1 small bag of potato chips

Afternoon snack: 1 piece of fresh fruit (apple or orange), sport nutrition bar (230 kcals and 5 grams of protein)

Dinner: Green vegetable, cooked, 3-5 oz. of chicken or fish, 1 cup of pasta or rice

Daily after afternoon practice or competition: 40 oz. of a sport drink such as Gatorade or PowerAde

Estimated energy intake from actual dietary intake (using the exchange method): 1970 kcal/day

Estimated protein intake from actual dietary intake (using the exchange method): 79 g/day

Estimated iron intake form actual dietary intake: 8 mg/day

Estimated energy needs based on usual physical activity (DRI (2006) Total Energy Expenditure (TEE) using the very active modifier for physical activity of 2.5): 2600 kcal/day $\pm$ 15% (range 2210-2990 kcal/day)

Estimated protein needs (1.0 g/cm-1.2g/ kg for athletes): 47-57 g/day

Estimated iron needs (Daily reference intakes 2006): 15-18 mg iron/day

NUTRITION ASSESSMENT	
Anthropometric (A)	*Biochemical (labs) (B)*
Clinical (C)	*Dietary (D)*
Environmental (E)	*Functional (F)*
NUTRITION DIAGNOSIS	
Nutrition Diagnosis #1 ***Problem***:	
Etiology: ***related to***	
Sign/Symptoms: ***as evidenced by***	
Nutrition Diagnosis #2 ***Problem***:	
Etiology: ***related to***	
Sign/Symptoms: ***as evidenced by***	

Appendix O – UNM IRB Consent

The University of New Mexico Consent to Participate in Research

Using Worked Examples for Training Nutrition Professionals to Diagnose Nutrition Problems and Use International Dietetics and Nutrition Terminology

12/13/2013

Introduction

You are being asked to participate in this research study by Kirsten Bennett MS RD LD, a registered dietitian and a doctoral candidate in Educational Psychology at the University of New Mexico (UNM). The purpose of this research is to compare two different ways to teach undergraduate students to diagnose nutrition problems and use standard terminology to document the nutrition problem in the medical record. You have been selected to participate because you have taken or are currently taking an introductory course in human nutrition.

This portion of the research is a pilot study. Results obtained from your participation will help the investigator evaluate whether or not the study materials are well constructed.

This form will explain the research study, and will also explain the possible risks as well as the possible benefits to you. We encourage you to talk with your family and friends before you decide to take part in this research study. If you have any questions, please ask the study investigator.

What will happen if I decide to participate?

If you agree to participate, the following things will happen:

You will be randomly assigned to one of two experimental learning conditions using worked examples to teach you about nutrition diagnosis nutrition terminology. The experiment occurs over two sessions, two weeks apart.

The first session will take one hour and fifteen minutes and the second session, two weeks later will take 40 minutes. Sessions will take place on the University of New Mexico campus in a classroom setting. All materials for the study will be provided by the investigator. You will not need a calculator or reference books.

You will first complete a brief questionnaire that asks questions like; "What is your age" and "Do you intend to pursue a career as a nutrition professional" at the beginning of the first session. The first session asks you to study clinical case studies in a worked example format to help you learn about nutrition diagnosis and using standardized terminology and then practice using what you have learned on additional case studies.

During the second session you will be asked again practice what you learned about nutrition diagnosis with additional clinical case studies.

At the end of both the learning and practice sessions, you will be asked to estimate, on a questionnaire, how hard or easy it was studying the worked examples and practicing what you learned.

Both sessions combined will require no more than 2 hours and 15 minutes.

How long will I be in this study?

Participation in this study will take a total of 2 hours and 15 minutes. Participation involves two sessions. The first and second sessions are two weeks apart. After both sessions are completed participation ends.

What are the risks or side effects of being in this study?

There are risks of stress, emotional distress, inconvenience and possible loss of privacy and confidentiality associated with participating in a research study.

There are minimal risks with this study, though some participants may experience discomfort while studying information that is new to them and being asked to practice using this new information on their own.

For more information about risks and side effects, ask the investigator.

What are the benefits to being in this study?

Potential benefits to participants include beginning to learn to diagnose nutrition problems in humans and helping to investigate one way of teaching this skill.

This is potentially a benefit to future students learning this same skill.

What other choices do I have if I do not want to be in this study?

Participation is voluntary. The only alternative to participation is non-participation.

How will my information be kept confidential?

We will take measures to protect the security of all your personal information, but we cannot guarantee confidentiality of all study data.

No identifying information will be attached to study materials. Signed consent forms will be used to create a code sheet to link the first session results to the second session results using a unique identifier.

After the study has been completed this code sheet with the links to the unique identifiers will be destroyed by the investigator. Signed consents and study materials will be kept in a locked file cabinet in the investigators office for five years after the study is completed and then destroyed.

Information contained in your study records is used by study staff and, in some cases it will be shared with the sponsor of the study. The University of New Mexico Institutional Review Board (IRB) that oversees human subject research and/or other entities may be permitted to access your records. There may be times when we are required by law to share your information. However, your name will not be used in any published reports about this study.

Results from the study will be reported and published with no identifying information linking participants to the study outcomes.

What are the costs of taking part in this study?

There is no cost to participate in this study.

Will I be paid for taking part in this study?

Participants in the pilot study will be given a $25 gift card to a local restaurant after completing the second session.

How will I know if you learn something new that may change my mind about participating?

You will be informed of any significant new findings that become available during the course of the study, such as changes in the risks or benefits resulting from participating in the research or new alternatives to participation that might change your mind about participating.

Can I stop being in the study once I begin?

Participation is voluntary. You may withdraw participation at any time. If you withdraw, any portions of the study you have completed will be removed from the data collected during the study.

Whom can I call with questions or complaints about this study?

If you have any questions, concerns or complaints at any time about the research study, Kirsten Bennett MS RD LD, will be glad to answer them at (505) 400-3437.

If you need to contact someone after business hours or on weekends, please call (505) 400-3437 and ask for Kirsten Bennett.

If you would like to speak with someone other than the research team, you may call the UNM IRB at (505) 277-2644.

Whom can I call with questions about my rights as a research participant?

If you have questions regarding your rights as a research participant, you may call the UNM IRB at (505) 277-2644. The IRB is a group of people from UNM and the community who provide independent oversight of safety and ethical issues related to research involving human participants. For more information, you may also access the IRB website at http://research.unm.edu/IRBmaincampus.

CONSENT

You are making a decision whether to participate in this study. Your signature below indicates that you read the information provided. By signing this consent form, you are not waiving any of your legal rights as a research participant.

I have had an opportunity to ask questions and all questions have been answered to my satisfaction. By signing this consent form, I agree to participate in this study. A copy of this consent form will be provided to you.

Name of Adult Subject (print) or for Child enrollment, Name of Parent/Child's Legal Guardian	Signature of Adult Subject or for Child enrollment, Signature of Parent/Child's Legal Guardian	Date

Appendix P – CNM Student Dissertation Consent

Central New Mexico Community College and the University of New Mexico
Consent to Participate in Research

Using Worked Examples for Training Nutrition Professionals to Diagnose Nutrition Problems and Use International Dietetics and Nutrition Terminology

03/07/14

Introduction

You are being asked to participate in this research study by Kirsten Bennett MS RD LD, a registered dietitian and a doctoral candidate in Educational Psychology at the University of New Mexico (UNM). The purpose of this research is to compare two ways to teach undergraduate students to diagnose nutrition problems and use standard terminology to label the nutrition problem. You have been selected to participate because you are currently taking an introductory course in human nutrition.

This form will explain the research study, and will also explain the possible risks as well as the possible benefits to you. If you have any questions, please ask the study investigator.

What will happen if I decide to participate?

If you agree to participate, the following things will happen:

You will be randomly assigned to one of two experimental learning conditions using worked examples to teach you about nutrition diagnosis and nutrition terminology. The experiment occurs over two sessions, two weeks apart during your regularly scheduled nutrition class.

The first session will take one hour and fifteen minutes and the second session, two weeks later will take 40 minutes. Sessions will take place on the Central New Mexico Community College (CNM) campus in your regularly scheduled nutrition classroom session. All materials for the study will be provided by the investigator. You will not need a calculator or reference books.

You will first complete a brief questionnaire that asks questions like; "What is your age" and "Do you intend to pursue a career as a nutrition professional" at the beginning of the first session. The first session asks you to study clinical cases in a worked example format to help you learn about nutrition diagnosis and using standardized terminology and then practice using what you have learned on two cases. During the second session you will be asked again practice what you learned about nutrition diagnosis with two additional clinical cases.

At the end of both the learning and practice sessions, you will be asked to estimate, on a questionnaire, how hard or easy it was studying the worked examples and practicing what you learned.

Both sessions combined will require no more than 2 hours and 15 minutes.

The results of your work will be used to evaluate worked examples as educational approach to teach nutrition diagnosis.

How long will I be in this study?

Participation involves two sessions. The first and second sessions are two weeks apart. Participation in this study will take a total of 2 hours and 15 minutes. After both sessions are completed participation ends.

What are the risks or side effects of being in this study?

There are risks of stress, emotional distress, inconvenience and possible loss of privacy and confidentiality associated with participating in any research study.

There are minimal risks with this study, though some participants may experience discomfort while studying information that is new to them and being asked to practice using this new information on their own.

For more information about risks and side effects, ask the investigator.

What are the benefits to being in this study?

Potential benefits to participants include beginning to learn to diagnose nutrition problems in humans and improving understanding of the topics covered in your nutrition class.

What other choices do I have if I do not want to be in this study?

Students not wishing to participate in research and who do not consent to participate will still engage in the classroom activity of studying worked examples; however results on the exercise will not be used in the evaluation of worked examples as educational approach to teach nutrition diagnosis.

How will my information be kept confidential?

We will take measures to protect the security of all your personal information, but we cannot guarantee confidentiality of all study data.

Information contained in your study records is used by study staff and, in some cases it will be shared with the sponsor of the study. The University of New Mexico Institutional Review Board (IRB) and the Central New Mexico Community College that oversees human subject research and/or other entities may be permitted to access your records. There may be times when we are required by law to share your information. However, your name will not be used in any published reports about this study.

No identifying information will be attached to study materials. Signed consent forms will be used to create a code sheet to link the first session results to the second session results using a unique identifier. After the study has been completed this code sheet with the links to the unique identifiers will be destroyed by the investigator. Signed consents and study materials will be kept in a locked file cabinet in the investigators office for five years after the study is completed and then destroyed.

Results from the study will be reported and published with no identifying information linking participants to the study outcomes.

What are the costs of taking part in this study?

There is no cost to participate in this study.

Will I be paid for taking part in this study?

There are no payments for participation.

How will I know if you learn something new that may change my mind about participating?

You will be informed of any significant new findings that become available during the course of the study, such as changes in the risks or benefits resulting from participating in the research or new alternatives to participation that might change your mind about participating.

Can I stop being in the study once I begin?

If you consent to allow the investigator to use results on the exercise to evaluate worked examples as an educational approach to teach nutrition diagnosis and you change your mind, you may withdraw participation at any time. If you withdraw, any portions of the study you have completed will be removed from the data collected during the study.

Whom can I call with questions or complaints about this study?

If you have any questions, concerns or complaints at any time about the research study, Kirsten Bennett MS RD LD will be glad to answer them at (505) 400-3437.

If you need to contact someone after business hours or on weekends, please call (505) 400-3437 and ask for Kirsten Bennett.

If you would like to speak with someone other than the research team, you may call the UNM IRB at (505) 277-2644 or CNM IRB at (505) 224-3450.

Whom can I call with questions about my rights as a research participant?

If you have questions regarding your rights as a research participant, you may call the CNM IRB at (505) 224-3450 or the UNM IRB at (505) 277-2644. The IRB is a group of people from CNM and UNM and the community who provide independent oversight of safety and ethical issues related to research involving human participants. For more information, you may also access the UNM IRB website at http://research.unm.edu/IRBmaincampus or the CNM IRB at http://www.cnm.edu/depts/planning/instres/irb .

CONSENT

You are making a decision whether to participate in this study. Your signature below indicates that you read the information provided. By signing this consent form, you are not waiving any of your legal rights as a research participant.

I have had an opportunity to ask questions and all questions have been answered to my satisfaction. By signing this consent form, I agree to participate in this study. A copy of this consent form will be provided to you.

______________________________	______________________________	____________
Name of Adult Subject (print) or for Child enrollment, Name of Parent/Child's Legal Guardian	Signature of Adult Subject or for Child enrollment, Signature of Parent/Child's Legal Guardian	Date

INVESTIGATOR SIGNATURE

I have explained the research to the participant and answered all of his/her questions. I believe that he/she understands the information described in this consent form and freely consents to participate.

___Kirsten Bennett_________
Name of Investigator/ Research Team Member (type or print)

____ ____________________

(Signature of Investigator/ Research Team Member) Date

Appendix Q – CNM Faculty Dissertation Consent

Central New Mexico Community College and the University of New Mexico Consent to Participate in Research

Using Worked Examples for Training Nutrition Professionals to Diagnose Nutrition Problems and Use International Dietetics and Nutrition Terminology

03/07/14

Introduction

You are being asked to participate in this research study by Kirsten Bennett MS RD LD, a registered dietitian and a doctoral candidate in Educational Psychology at the University of New Mexico (UNM). The purpose of this research is to compare two ways to teach undergraduate students to diagnose nutrition problems and use standard terminology to label the nutrition problem. You have been selected to participate because you are currently teaching an introductory course in human nutrition.

This form will explain the research study, and will also explain the possible risks as well as the possible benefits to you. If you have any questions, please ask the study investigator.

What will happen if I decide to participate?

If you agree to participate, the following things will happen:

This research involving worked examples to teach about nutrition diagnosis and nutrition terminology in one of two worked example conditions will take the place during one and one half class sessions of a regularly scheduled meeting of a nutrition class you teach. It will fulfill student course requirements for class participation within the structure of the nutrition class.

Your students, in each section of the course you teach, will be randomly assigned to one of two experimental conditions using worked examples to teach them about nutrition diagnosis and nutrition terminology. The experiment occurs over two sessions, two weeks apart.

The first session will take one hour and fifteen minutes and the second session, two weeks later will take 40 minutes. Sessions will take place on the Central New Mexico Community College (CNM) campus in your regularly scheduled nutrition classroom sessions. All materials for the study will be provided by the investigator.

Your students will first complete a brief questionnaire that asks questions like; "What is your age" and "Do you intend to pursue a career as a nutrition professional" at the beginning of the first session. The first session asks your students to study clinical cases in a worked example format to help them learn about nutrition diagnosis and using standardized terminology and then practice using what they have learned on two additional cases During the second session they will be asked to again practice what they have learned about nutrition diagnosis with two additional clinical cases

At the end of both the learning and practice sessions, each student will be asked to estimate, on a questionnaire, how hard or easy it was studying the worked examples and practicing what was learned.

Both sessions combined will require no more than 2 hours and 15 minutes.

The results of your students' work will be used to evaluate worked examples as an educational approach to teach nutrition diagnosis.

Since student work is the focus of the research, no data on you or your classroom will be collected or reported.

How long will I be in this study?

Participation involves two sessions. The first and second sessions are two weeks apart. After both sessions are completed participation ends. Both sessions combined will require no more than 2 hours and 15 minutes.

What are the risks or side effects of being in this study?

There are risks of stress, inconvenience and possible loss of privacy and confidentiality associated with participating in any research study.

There are minimal risks with this study, though some instructors may experience discomfort when asked to allow an outside investigator access to their students and to the results of student work.

Since student work is the focus of the research, no data on you or your classroom will be collected or reported.

For more information about risks and side effects, ask the investigator.

What are the benefits to being in this study?

Potential benefits to student participants include beginning to learn to diagnose nutrition problems in humans and helping to investigate one way of teaching this skill.

Faculty participants have the potential benefit of enhanced student learning since the exercise asks students to apply knowledge they are currently acquiring as part of the nutrition curriculum.

What other choices do I have if I do not want to be in this study?

The only alternative to participation is non-participation

Faculty who do not wish to participate in this research and who do not consent to participate will continue their regular classroom activities and their students will not be asked to participate in this research involving worked examples to teach about nutrition diagnosis and nutrition terminology.

How will my information be kept confidential?

No data will be collected on faculty at Central New Mexico Community College since the focus of the research is student work in the study conditions that involve using worked examples to learn about nutrition diagnosis.

We will take measures to protect the security of all your personal information, but we cannot guarantee confidentiality of all study data.

Information contained in your study records for your students is used by study staff and, in some cases it will be shared with the sponsor of the study. The University of New Mexico Institutional Review Board (IRB) and the Central New Mexico Community College that oversees human subject research and/or other entities may be permitted to access your records. There may be times when we are required by law to share your information. However, your name will not be used in any published reports about this study.

No identifying information will be attached to student study materials. Signed consent forms will be used to create a code sheet to link the first session results to the second session results using a student unique identifier. After the study has been completed this code sheet with the links to the student unique identifiers will be destroyed by the investigator. Signed consents and study materials will be kept in a locked file cabinet in the investigators office for five years after the study is completed and then destroyed.

Results from student participants in the study will be reported and published with no identifying information linking participants to the study outcomes.

What are the costs of taking part in this study?

There is no cost to participate in this study.

Will I be paid for taking part in this study?

There are no payments for participation for faculty or students.

How will I know if you learn something new that may change my mind about participating?

You will be informed of any significant new findings that become available during the course of the study, such as changes in the risks or benefits resulting from participating in the research or new alternatives to participation that might change your mind about participating.

Can I stop being in the study once I begin?

Participation is voluntary. You may withdraw participation at any time. If you withdraw, any portions of the study your students have completed will be removed from the data collected during the study.

Whom can I call with questions or complaints about this study?

If you have any questions, concerns or complaints at any time about the research study, Kirsten Bennett MS RD LD will be glad to answer them at (505) 400-3437.

If you need to contact someone after business hours or on weekends, please call (505) 400-3437 and ask for Kirsten Bennett.

If you would like to speak with someone other than the research team, you may call the UNM IRB at (505) 277-2644 or CNM IRB at (505) 224-3450.

Whom can I call with questions about my rights as a research participant?

If you have questions regarding your rights as a research participant, you may call the CNM IRB at (505) 224-3450 or the UNM IRB at (505) 277-2644. The IRB is a group of people from CNM and UNM and the community who provide independent oversight of safety and ethical issues related to research involving human participants. For more information, you may also access the UNM IRB website at http://research.unm.edu/IRBmaincampus or the CNM IRB at http://www.cnm.edu/depts/planning/instres/irb .

CONSENT

You are making a decision whether to participate in this study. Your signature below indicates that you read the information provided. By signing this consent form, you are not waiving any of your legal rights as a research participant.

I have had an opportunity to ask questions and all questions have been answered to my satisfaction. By signing this consent form, I agree to participate in this study. A copy of this consent form will be provided to you.

______________________	__________________________	__________
Name of Adult Subject (print) or for Child enrollment, Name of Parent/Child's Legal Guardian	Signature of Adult Subject or for Child enrollment, Signature of Parent/Child's Legal Guardian	Date

INVESTIGATOR SIGNATURE

I have explained the research to the participant and answered all of his/her questions. I believe that he/she understands the information described in this consent form and freely consents to participate.

___Kirsten Bennett_________
Name of Investigator/ Research Team Member (type or print)

____ __________________

(Signature of Investigator/ Research Team Member) Date

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