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# The effects of feedback protocol and learning environment perceptions on self -regulated learning

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# THE EFFECTS OF FEEDBACK PROTOCOL AND LEARNING ENVIRONMENT PERCEPTIONS ON SELF-REGULATED LEARNING

by

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A dissertation submitted in partial fulfillment
of the requirements for the

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# Dissertation Approval

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ABSTRACT

**The Effects of Feedback Protocol and Learning Environment Perceptions on Self-Regulated Learning**

by

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The current research investigated the effects of differing feedback protocols in a multimedia learning environment to determine if changes would occur over time in goal orientation, self-regulation, self-efficacy or achievement. Subjects from an traditional undergraduate chemistry course were assigned to either a norm-referenced or self-referenced feedback group. Goal orientation and self-efficacy were measured via self-report surveys pre-post instruction, self-regulation was measured as the cumulative number of times each subject opened a worked example/self-explanation prompt while engaged in weekly web-based quizzes, and achievement was measured using final semester course grades. Perceptions of the learning environment were also probed as a potential mediating variable via self-report surveys by using a median split to assign subjects to either a class-task group, where learners believed that the instructor valued

effort more than ability or a class-ability group, where learners believed that the instructor valued innate ability more than effort.

Results revealed that subjects did not significantly change their goal orientation type or magnitude as a result of the differing feedback protocols, even with the addition of learning environment perception as a potential mediating variable. Overall, subjects made significant decreases along the mastery approach and performance approach goal orientation subscales. While this was not anticipated, the results are consistent with other recent research within this context (Senko & Harackiewicz, 2005). Subjects also did not demonstrate significant differences in self-regulation, although a trend did emerge with those from the norm-referenced feedback group with a class-task perception of the learning environment less likely to use worked examples. Subjects from this group also demonstrated the greatest gains in self-efficacy over the course of the semester; however these changes failed to meet the criterion for statistical significance and these differences did not lead to any notable differences in achievement. While it remains unclear as to why these subjects used worked examples less, the increase in self-efficacy is contrary to other studies along this line of research (Crippen & Earl, 2007). However, increases in self-efficacy from subjects with a class-task learning environment perception are supported in the literature (Midgley, Maehr, Hicks, Urdan, & Roeser, 1995).

Recommendations for future research within this context such as authenticating subjects' perceptions of their assigned treatment condition, introducing additional feedback protocols such as a combined, choice, or control condition and building in a better gauge to track the time and context of potential changes in goal orientation, self-regulation, and self-efficacy are also discussed.

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It doesn't get any better than this. As I sit in my backyard on an eighty-four degree Las Vegas evening in October of 2008, I reflect on the last five years of living with an array of articles littering my space, a web search open to a scholarly database, and an APA manual in the middle of it all. By now most of these items have been neatly put away, but probably not for long. While the degree is complete, it feels as though I have just begun.

The first sign of a dissertation afterlife is here to my right, a small glass of bourbon with ice. It represents several important things to me. First, it was a gift from Dr. Kent Crippen, an advisor, a mentor, a sounding board, a source of stabilizing confidence, and a reality check, all dependent on the timing and context of what this journey has thrown my way. Clearly, all of the aforementioned descriptions represent only a fraction of the gratitude that I wish to express and pride that I feel as one of the first of many, many lucky doctoral students to come. Indeed, my key to survival through an 18-month period of A.B.D. was his best piece of advice "Fortitudine vincimus."

But the bourbon reaches far beyond the last five years of my life. It would have been the drink of choice on a night like tonight for my grandfather Edward Charles McCluskey who passed away on April 29 of this year at the ripe old age of 89. A man who valued education, served our country in World War II, fathered eight children, loved his family, remained humble yet confident, he represents what I hope to become. Luckily, I have at least the remainder of my life to catch up, as I will need it.

At the crux of my support system is my immediate family. To my girls, Lisa and Madison, I say thank you for your support. Madi, seeing you start kindergarten this year with such vigor and desire to learn has encouraged me to enjoy this turn on my academic journey. To you I say, follow your own advice and enjoy the ride of learning; even the struggles. Lisa, you have provided this source of pride, both to Madi and me, for which I am most grateful. I love you and I enjoy our life together. I am lucky to have not only a person to share my life with, but scholarly discussion and academic debate.

To my family, Mom, Dad, and Susan, thank you. It was you who established education as the cornerstone of my life. From the time I was very young, the advice that "no one could ever take a man's education, once achieved" has resonated with me along the way, and a message which I am happy to see making its way into another generation.

Lastly, to the remaining members of my committee, Dr. Randall Boone, Dr. Kendall Hartley, and Dr. Jeff Shih, I thank you for your time and efforts. It was about 30 minutes into my defense when it was no longer a "defense" but a scholarly discussion, when I knew that this degree was the right path to take. I am also thankful to Curriculum and Instruction and Educational Psychology faculty members. I am proud to be one of the first graduates of the Learning and Technology program and hope to remain actively engaged in not only creating quality research, but interpreting it into a framework capable of using educational technology as a catalyst for change and restoring K-12 education into the greatest equalizer in the world.

# CHAPTER 1

## INTRODUCTION

The theoretical framework for this research is derivative of an eclectic model of self-regulated learning (SRL) influenced by the work of Pintrich (2000b), Winne and Hadwin (Hadwin & Winne, 2001; Winne & Hadwin, 1998) and Zimmerman (2000). This research was framed within social cognitive theory (Bandura, 1997) which depicts the learner as a deliberating agent in the learning process who approaches academic tasks based on motivational dispositions. Additional influence from information processing theory has also influenced the framework, describing the learning process as a set of recursive phases. Choices in regard to the strategies employed are ideally within the learners own volition and best monitored via trace methods to inform research. For purposes of the current research, a self-regulated learner is characterized as metacognitive, motivated for learning and strategic (Zimmerman, 1990; Winne & Perry, 2000). Prior work within this theory first established a set of phases which shaped initial definitions of self-regulated learning (Zimmerman, 1990). Later work added another layer to this framework, supporting the notion that goal orientation is malleable over time and context and most importantly, established motivational constructs as a major driving force behind self-regulated learning (Pintrich, 2000a). Finally, the work of Winne (1998) and others (Hadwin & Winne, 2001) revised the recursive properties posited by earlier

research and added another data dimension to the theory, trace methods. This new dimension gave researchers access to more authentic artifacts of learner behavior and introduced new analyses (i.e., calibration bias; a measurement which enumerated the difference between the perceptions, expectations, behaviors and outcomes on the part of the learner).

This chapter will review, compare, and contrast the three main models of self-regulated learning theory as they pertain to the theoretical framework to be used for the current project. Furthermore, this chapter will contextualize these theoretical models and outline how the current project will use self-reports and trace methods via the Web to investigate change patterns in goal orientation and self-efficacy (i.e., motivation), self-regulated strategy usage (i.e., worked examples), and achievement (semester grades) in a undergraduate chemistry course. Subjects from the course will be exposed two distinct feedback protocols used to display their results from weekly quizzes. Significant theoretical contributions to be highlighted in this chapter include a set of recursive phases within self-regulated learning, the establishment of the learner's agency and volition as major components of the learning process, and the use of trace methods to gauge authentic learner behaviors in addition to self reports.

## Self-regulated Learning

Pintrich (1995) defined self-regulated learners as those who regulate their own learning by deliberately engaging cognitive, metacognitive and motivational efforts to attend to tasks with perseverance while incorporating prior knowledge efficiently. By taking responsibility for one's own learning (and not because of some external source

such as a teacher or extrinsic reward), these learners are typically more successful in making recurring accurate assessments of their progress towards a clear and predefined goal. More recent theoretical developments reflect the influence of social cognitive theory (Bandura, 1997) and remain grounded in the triadic reciprocal causation model (Bandura, 1986), whereby the agency of a learner represents an interdependent relationship between behavior, personality factors (cognition, motivation and biology) and the learning environment. Events and dispositions from each of these three factors "operate as interacting determinants that influence one another bi-directionally" (Bandura, 1997). Although other sub-factors such as feedback (Winne & Hadwin, 1998; Zimmerman, 1990) and goal orientation (Pintrich, 2000b) have shed new light on the theory, most variation in recent models of self-regulated learning have involved changes to the structure of similar constructs from each of Bandura's three main social cognitive arenas and the relative influence or contribution attributed to each.

A review of the three main theoretical frameworks related to the current project (Pintrich, 2000b; Winne & Hadwin, 1998; Zimmerman, 2000) by Puustinen and Pulkkinen (2001) identified theoretical background as an important differentiating feature and concluded that the models of Pintrich (2000b) and Zimmerman (2000) were most similar to each other, both demonstrating a strong influence of social cognitive theory. The authors note Winne and Hadwin's model (1998) as strikingly unique, defining SRL as both an aptitude as well as an event with an omnipresent and recurring influence of feedback across all phases of the process. This recurring influence of feedback makes their work a practical addition for purposes of the current research.

## Foundations in Self-regulated Learning

Earlier research conducted with SRL (Zimmerman, 1990) emphasized three components; a deliberate set of strategies employed to make best use of the relationship between the self regulatory processes and the desired outcomes, a recurring system of feedback whereby this set of strategies is refined, and a concern for how and why learners self-regulate in regard to both metacognitive and motivational factors. This model is based unequivocally upon social cognitive theory (Bandura, 1986) and defines SRL as a cyclic event, where thoughts, feelings and actions are planned and systematically adapted to personal goals. This involves forethought (task analysis and motivation), performance (self-control and self-observation) and self-reflection (self-judgment and self-reaction) which make up the three phases of self-regulation as a recursive process commensurate with each of Bandura's (1986) three interdependent constructs: covert, behavioral and environmental. Self-regulation involves monitoring activities within each arena and making adjustments to work towards personal goal attainment. These adjustments are believed to be made continuously throughout the learning process as factors can change frequently. Furthermore, the theory is referred to as recursive since self-reflection is believed to influence future processes of forethought. This tenant will serve as a main component of the current research to investigate if changes in feedback protocol can also facilitate adjustments in motivation, self-efficacy and the use of self-regulation tactics.

The different theoretical perspectives discussed here contain similar constructs (cognition, motivation, and environment) and often only differ in the structure and attribution given to each construct. In the case of Zimmerman's model, the environment (referred to as context) and the amount of control exercised by the learner to manipulate

it are held in high regard (i.e., volition). The concept of SRL itself is thought of as a set of skills to be obtained by the learner at four levels; modeling, imitating, self-control and self-regulation.

The results of a path analysis by Zimmerman and Bandura (1994) contributed more predictive power to this model only when a goal setting measure was introduced, thus substantiating a need for additional investigation with motivational constructs. Additionally, self reports alone do not provide a comprehensive depiction of SRL and should be used in conjunction with distinct data points obtained through other methods such as trace to best triangulate a more complete scenario of self-regulated learning behaviors (Winne & Hadwin, 1998).

This is not to say that original SRL models neglected to account for motivation entirely. Indeed, motivational variables such as self-efficacy, goal setting, and confidence have been and remain key research components. Furthermore, the lack of authentic indicators of self-regulatory learner behaviors now obtainable through trace methods was an admitted shortcoming of this line of research and opened the door for future research in SRL with new data points. Specifically, the work of Winne (Winne, Muis, & Jamieson-Noel, 2006; Winne & Perry, 2000) makes extensive use of trace methods to better gauge and triangulate authentic student behaviors. Thus, motivational constructs will serve as dependent variables in this research with trace methods used to collect data points specific to learner behaviors.

The groundwork in SRL discussed here was important in that it established a foundation for which self-regulated learning could be framed within the context of social cognitive theory. Additionally, the learner was emphasized as a deliberating agent in the

educational process, selecting and adapting different strategies based on feedback and motivation in a recursive fashion. Still, the relative attribution of the learner's motivation was small in comparison to that of the environment. Furthermore, the theoretical model defined recursion as a linear process (whereby learners progress through the stages in a well-defined sequence) and was constructed primarily through self-reports.

## Motivational Theory

While earlier publications give considerable attention to the context of learning, later research was extensively focused upon the inclusion and incorporation of motivational constructs. Although newer perspectives do not present an explicitly recursive theory, the components and framework composing them were quite similar to earlier ones and remained grounded in social cognitive theory (Puustinen & Pulkkinen, 2001). This framework for SRL (Pintrich, 2004) consists of four phases with each one containing self-regulatory activities categorized under four different types. The phases are forethought, monitoring, control and reflection. Activities under each phase are categorized as cognitive, motivational, behavioral, or contextual. This additional layer within the theory not only maintains the recursive function proposed by prior theorists, but lends a better understanding to the omnipresence and interactions of variables from each of the four categories (Table 1).

Historically, SRL was conceived as a motivational learning theory with its roots derived from information processing (Pintrich, 2000b). While information processing was presented in a top-down manner, applying and testing cognitive concepts in learning environments quantitatively, it was quickly criticized due to a weak focus on

motivational constructs. SRL theory matured as motivational constructs were supported empirically offering additional explanatory power to previous theoretical frameworks. The work of Pintrich and Winne brings motivation to the forefront and frames it through additional sub-constructs such as goal orientation (Pintrich, 2000a, 2000b; Puustinen & Pulkkinen, 2001). Pintrich also noted a distinction between intrinsic and extrinsic goal orientation, allowing for multiple goals within and between learners over time or domain (Pintrich, 2000a; Wolters, Yu, & Pintrich, 1996). This finding is significant as it was the first of its kind to consider goal orientation as a malleable construct which can be (to a degree) contextually defined. Although the current research attempted to test the conditions under which changes of this nature can occur, it also responds to prior research in that it conducts these tests in a different environment (undergraduate chemistry) and does so in a repeated testing (i.e., mastery learning) situation. Furthermore, Pintrich conceptualizes self-regulatory activities as mediators between personal and contextual characteristics, suggesting that learners adopt views of the learning environment and the task demands based on their experiences with these activities.

The additional influence attributed to motivational constructs is evident throughout the four assumptions shared by most SRL models (Pintrich, 2004), particularly goal orientation. First, social cognitive theory assumes the learner to be an active participant in the learning process who constructs their own meaning of a task based on both external (i.e., environment) as well as internal (i.e., motivational) factors. Indeed, the current research assumes the learning context to be a powerful determining factor behind changes in learner characteristics. Second, SRL theory assumes that the

learner is capable of controlling one's own cognitive activities, metacognition and motivation as well as the external environment (to a degree). The third assumption involves a goal, standard or criterion. Before engaging in any learning activity, SRL theory assumes that the learner will attempt to formalize a vision of what a successful outcome would look like. Again, goal orientation will set the stage for this activity and provide a personal standard through which progress will be monitored. These perceptions were gauged in the current project and used to group subjects to test them as a mediating variable behind changes in motivation, self-regulation, and achievement. The final assumption is similar to the third one; specifically that SRL activities will serve as intervening variables between personal/contextual factors and achievement outcomes. The use of SRL strategies and activities can better inform the current model of learning theory moving beyond individual differences and background variables.

In summary, commensurate with other SRL theories under review and within the framework of social cognitive ideals, the learner is seen as an active participant in the process, constructing knowledge in conjunction with the environment. In addition, the theoretical influences of social cognitive theory place a significant focus on the potential for control. SRL activities are defined largely as attempts by the learner to monitor, control and adjust their cognition, metacognition, motivation and even certain aspects of the environment. This research will test the parameters as well as the direction of this relationship. Specifically, while it has been established that a learner will engage in self-regulation activities and practices to attempt to control their environment, this project will test the degree to which a minor controlled manipulation within the learning context will in turn create change in a learner's motivation, metacognition, and behavior. Lastly, this

theory assumes that a clear and well-deined goal or desired outcome is necessary in order for the learner to effectively monitor, compare and regulate learning activities, thus making goal orientation a paramount component of the theory. Perceptions of the learning environment will incorporate these definitions of success into the research design.

Prior empirical work which demonstrates that goal orientation can differ depending upon the context (Mangos & Steele-Johnson, 2001; Pintrich, 2000a; Wolters et al., 1996), task (Mangos & Steele-Johnson, 2001) or learner characteristics (Patrick, Ryan, & Pintrich, 2000) supports the notion that SRL investigations can only be interpreted within context, bringing into question research that might attempt to globalize motivation or other constructs within SRL. Thus, the generalizability of research conducted with regard to these constructs is difficult to sustain and measurements collected at more rudimentary levels in domain specific environments will most likely provide the most utility. In addition, self-reports are limited as these often can only give indications of learner behaviors at a broad level and are best interpreted in terms of a learner's propensity to include certain strategies in their repertoire of learning tactics. The current research aimed to collect learner perceptions and behaviors at these rudimentary levels and did so in a domain specific environment (undergraduate chemistry). This domain specific approach to measuring SRL characteristics has proven to be empirically fruitful when disaggregated at the course level (Wolters et al., 1996) and along similar lines of data parsing such as task specificity (Winne & Perry, 2000), task demands (Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000), or task complexity (Mangos & Steele-Johnson, 2001).

## Information Processing Theory

The work of Winne and others (Winne & Hadwin, 1998; Winne et al., 2006; Winne & Perry, 2000) expounded upon the interactive recursive features and added authentic behavior indicators (Pintrich, 2000b). In addition, this theoretical perspective has kept a crucial emphasis on motivation and empirically demonstrated the utility for technology to accurately gauge learner behaviors (i.e., trace methods). While the multi-layer framework is strikingly similar to motivational perspective, it is unique in that the influence of social cognitive theory is not as deeply embedded and SRL is primarily proposed as a set of strategies containing properties of an aptitude as well as an event (Puustinen & Pulkkinen, 2001).

As simplistic as this set of strategies may seem, the selection, monitoring and evaluation of each given the context and desired outcome quickly presents a much more complex picture. Indeed, many obstacles to learning often arise from incorrect interpretations of the task (Briggs, 1990), a poor selection of strategies (Hattie, Biggs, & Purdie, 1996), measuring one's progress against goals which are incongruent with the desired outcome (Morgan, 1987), or engaging in a set of ineffective self-monitoring activities (Schraw, 1998; Winne & Hadwin, 1998). This theory positions the self-monitoring, evaluation and adoption of strategies at the crux of SRL with a four-phase model of learning; task definition, goal setting, strategy selection and implementation as well as strategy revision as a result of self-monitoring. While learners will self-regulate, evaluate and make adjustments at each phase in a repetitive fashion, the phases do not necessarily occur in a linear sequence. In fact, given the level of expertise of the learner, one or more of these phases may be skipped all together while still preserving an

effective means of learning. For example, when encountering a familiar task (particularly one at which the learner has experienced past success), it may be unnecessary to define the task. In an effort to conserve limited cognitive resources therefore, the learner may proceed directly to phase three, strategy selection and implementation. If however, the leaner (through self-monitoring) notes one or more unsuccessful attempts with the task, they may react to their own evaluation by returning to one of the initial stages, perhaps in an effort to re-define their understanding of the task or to view it through a different perspective defined by one's personal goal orientation.

Learner perceptions of the environment remain an important consideration within the practice of research on goal orientation as a motivational construct under self-regulated learning theory. The current research takes this into consideration, gauging perceptions of the learning environment as a "class task" vs. "class ability" whereby those with a "class task" perception view the instructor as one who values student motivation most and remain likely to posses an internal locus of control. Learners with a "class ability" perception however, believe the instructor to hold innate ability in higher regard and are more likely to adopt an external locus of control. Commensurate with prior research, both learner behaviors (obtainable via trace methods) as well as these perceptions were incorporated into the design of the project. Specifically, perceptions of the learning environment were used to divide subjects (with a median split) into two groups, allowing the researcher to incorporate perception as a blocking variable and to investigate it's potential role as a mediating variable between feedback and the outcome variables of interest (motivation, self-regulation, and achievement).

The CoNoteS2 system has served as the primary data collection vehicle for Winne's more recent work with self-regulation (Hadwin & Winne, 2001) and served as a model for the intervention used in the current study (in a much more narrow context). The system is a multimedia user interface where learners interact with text (chapters). Each chapter contains a set of learning objectives, indexes, a glossary and links to other information. A series of organizer tools allow the user to highlight, categorize and prioritize text encountered in the reading assignment. One can also use the system to expound on salient details within the text, raise questions and build themes within the content. Learner behaviors are tracked and later compared to assessment results to indicate the effectiveness of the cognitive and metacognitive study strategies employed. Winne and colleagues have more recently pointed out some additional advantages of what is now referred to as "gStudy" (Perry & Winne, 2006). These include tracking capabilities over multiple academic episodes, complex task designs that address multiple goals and large-scale projects (individual or cooperative learning settings) and variation in the amount of feedback received from the system that is regulated by the learner. While many of these components have been incorporated into the current system (Crippen & Earl, 2004), it is confined to undergraduate Chemistry and uses a weekly quiz to draw students into using worked examples as an explicit self-regulation technique.

## Summary of Relevant Self-regulated Learning Research

The theoretical emphasis adopted for purposes of the current research provides a rich history of investigations within self regulation and their contributions to current learning theory. In addition, the work of these individuals demonstrates a high degree of

similarity with regard to the pertinent constructs and inter-relationships that exist between them. Chronologically, more recent work within SRL and the tools and systems used for data collection have evolved based on the limitations described by earlier authors. Zimmerman developed one of the first recursive SRL frameworks, giving utmost attention to the environment and attempts by the learner to control it. While the development and research conducted with his structured interview instrument (SRLIS) established a set of key inter-related concepts, it was empirically determined that the addition of a goal orientation measure significantly re-defined the structural framework of SRL theory. Eventually, additional research prodded further into the self-regulatory activities of the learner, thus bringing motivation to the forefront as an omnipresent construct. Thus the theory was redefined as a deliberate set of strategies by describing the interactive relationships of motivation, cognition and metacognition at each phase under four discrete levels. Pintrich cautioned the field to keep generalizations within the context under which they were formulated and to develop data collection tools that behave as such by gauging rudimentary elements in domain specific learning environments. Future directions for research within SRL identified by Pintrich made way for others such as Winne to develop and implement data collection systems capable of capturing authentic learner behaviors. Winne also exaggerated the concept of interactivity within SRL by noting that a learner can revert to other phases of the theory at any step in the learning process, particularly if the learner judges a strategy or tactic to be ineffective, adopts a revised goal orientation to better navigate the learning environment, or re-defines the task. This notion that recursion is not only on-going but interactive within each phase of

learning has been supported by the development of trace methods made possible through technology.

While these theoretical dispositions are somewhat distinct in their interpretations of social cognitive and information processing theory and the relative contributions and interactions of the pertinent constructs, all acknowledge the underlying importance and omnipresent influence of goal orientation dispositions within the learner. From early stages of engagement such as task definition and perceptions of instructor expectations to evaluative activities at task completion, it is goal orientation that sets the stage on which a learner's standards for success are built. This construct also shapes the perspective of the learner through which they will continually process their progress against these standards, making cognitive, meta-cognitive and motivational adaptations due to fluctuations in the environment, the task and themselves. Thus, goal orientation has served as a key construct for the current research.

## Goal Orientation

The categories of goal orientation utilized in the current research are derivative of a two by two matrix (Table 2) which outlines two dimensions, perceived task definition and valance (Elliot & McGregor, 2001). This theoretical construct has evolved from the work of Dweck (1986), who suggested that individuals possess either a learning (i.e., mastery) goal orientation where the goal of learning is to master the material, or a performance goal orientation where individuals strive to obtain favorable evaluation from others. Individuals with a performance goal orientation typically prefer normative feedback and gage their accomplishments based on ability and performance relative to

others. These constructs have been assigned different labels across varying research environments such as task, mastery, or learning and performance, ability or ego goal orientations, but have fairly consistent operational definitions and will be accepted as equivalent for purposes of the current research.

Later research added another dimension to the theory by re-defining the performance goal orientation as one with distinct characteristics at both ends of a continuum. The new dimension, valance, was conceptualized by approach versus avoidance. Approach behaviors are those that strive to achieve successful judgments from others or themselves and are thought of as having a positive valance. Conversely, avoidance behaviors refer to intrinsic motivations that stem from the evasion of failure and appearing incompetent in front of others. Avoidance orientations are regarded as containing a negative valance. Mastery Avoidance has only recently been introduced as an addition to the original trichotomous framework to describe the learner who strives for perfection and avoidance of negative self-evaluations (Elliot & McGregor, 2001). Therefore, the four categories (Table 2) are (a) mastery approach (where a person is driven to achieve for the sake of learning how to successfully complete a task), (b) mastery avoidance (where a person strives to avoid misunderstanding or making an error), (c) performance approach (marks the goals of achievement to outperform others) and (d) performance avoidance (individuals who are most likely motivated for the sake of avoiding embarrassment compared to others on the same task).

Although prior research has used exploratory and confirmatory factor analyses to empirically demonstrate the categories as mutually exclusive (Elliot, 1999; Elliot & McGregor, 2001), other research has made differing conjectures which suggest that

individuals can possess combinations of goal orientation types and may progress through them over time (Pintrich, 2000a). Adoption of different goal orientations may also be contextually dependent (Pintrich, 2000a). These conjectures however, are convoluted by the use of different instruments to make this comparison, often using distinct item loadings (positive or negative). Subjects may therefore be more inclined to engage in "cooperative conversational conduct" where subjects from an academic based research environment tend to respond to items in a way that will perhaps receive favorable judgments from the instructor or researcher (Shultz & Whitney, 2005).

Commensurate with these findings, the current research will utilize the two by two goal orientation matrix devised by Elliot and McGregor (2001) and gauge learner perceptions of this construct with the Achievement Goals Questionnaire developed in the same line of research. In addition, trace methods will provide an additional data point to inform this research by validating authentic learner behaviors. Discussion of other key constructs and the mediating characteristics of their relationships to one another will be discussed further in chapter two.

The interaction of goal orientation with motivation, cognition, metacognition and performance is still a debated issue. While studies indicate that a mastery approach orientation will demonstrate positive relationships with these variables (Wolters et al., 1996) and that performance goal orientation has a negative effect (Ames, 1992; Dweck & Leggett, 1988), Wolters et al (1996) also found a positive relationship between performance goal orientation and motivation, cognition, metacognition and performance. Although using survey inventories to gauge measures of self-regulated learning has been done frequently in this line of research, it is important to note that these instruments can

only tell us a learner's perceptions of their self-regulated learning strategies. The onset of multimedia learning environments now make it possible to collect records of academic behaviors, an entirely different variable that remains sparse in current goal orientation literature with the exception of Winne's work. Whereas prior research in goal orientation contexts have used somewhat arbitrary median splits and randomly assigned subjects to differing environments where goal orientation was artificially manipulated, the current research considers goal orientation as a continuous trait variable and uses statistical modeling techniques to detect relationships between goal orientations, self-regulated learning strategies, motivation and performance.

## Purpose of the Current Study

The purpose of this research was to investigate changes in (1) goal orientation and self-efficacy over time, (2)self-regulated strategy usage, and (3) achievement when learners are exposed to unique feedback protocols (norm-referenced vs. self-referenced). A need exists for additional controlled investigations with these constructs in a multimedia learning environment. Specifically, while the effects of feedback on achievement and motivation have been mostly inconclusive, a majority of scholarly work within this field provided the same type of feedback for all learners (Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Winne et al., 2006). Furthermore, other research which did manipulate feedback protocol failed to include motivational variables (Bower, 2005) or implemented large scale environmental differences (Bong, 2004; Linnenbrink, 2005) making it difficult to attribute empirical findings to one single condition (i.e., an entirely different classroom and instructor as opposed to changes in feedback alone). In addition,

the lack of a pre-test in one of these related studies (Linnenbrink, 2005) adds additional spurious possibilities to treatment effects. Hence, the current study made only one subtle change in the feedback protocol received. Learners were also pre-post tested to measure the type and magnitude of goal orientation as well as self-efficacy. After exposure to one of two distinct feedback scenarios, changes in these variables were expected to occur. In addition, self-regulated strategy usage (i.e., the cumulative total number of times a learner prompts the system for a worked example) was also tabulated. It was anticipated that different usage patterns would exist for learners with unique goal orientation types and perceptions of the learning environment (collected as a potential mediating variable).

## Research Questions

The current study will address the following three research questions:

1- Are changes in goal orientation over time mediated by differences in feedback protocol?

   a. If so, do these change patterns differ based on perceptions of the learning environment and their alignment to the feedback protocol used?

2- Do learners adopt different self-regulation strategy usage patterns when they are exposed to differing feedback protocols?

   a. If so, are these unique patterns dependent upon perceptions of the learning environment?

3- Do distinctions in feedback protocol, perceptions of the learning environment and their alignment with one another interact to produce notable differences in self-efficacy and achievement?

## Significance of the Current Study

This research attempts to investigate the effects of feedback protocol upon goal orientation, self-efficacy, self-regulation and achievement in a multimedia repeated testing environment. The design of this research randomly assigned undergraduate chemistry students to a self or norm-referenced group to determine the type of weekly quiz feedback received via the Web. All subjects were pre-post tested in goal orientation and self-efficacy to determine if a causal relationship exists between these variables and feedback protocol. Perceptions of the learning environment were also probed as a mediating variable to determine if these change patterns were dependent upon the beliefs subjects hold in regard to their instructor and the learning environment. In addition, usage frequencies of worked example/self explanation prompts (self-regulation) and course achievement were compared based on group assignment and learning environment perceptions.

The current research was crafted based on the ideal that portrays the learner as a primary and deliberating agent in the learning process with his or her motivation at the crux of selecting effective cognitive and metacognitive strategies. Motivation is also largely dictated by the context of each learning activity as knowledge is thought of as a co-constructive activity between the environment as well as the individual characteristics

of the learner. Thus, indications of motivation are malleable and unique in comparison to learner behaviors.

The onset of multimedia learning in many K-16 learning institutions has made it possible to deliver continuous, timely, individualized and pedagogically relevant feedback to learners while maintaining an efficient use of limited resources. However, the effects of feedback as well as the optimal conditions which make best use of it represent a fairly new direction in scholarly research. Additional controlled investigations which aim to establish a framework for optimal feedback delivery systems within multimedia learning applications is a practical undertaking and one which is well grounded in current literature. Indeed, it was only very recently established that accounting for learner preferences in regard to the type of feedback received was not an empirically fruitful endeavor, and can even serve as a deterrent in some cases (Bower, 2005). In addition, Winne et al (2006) "urge researchers to further examine whether tasks, feedback, or both change students' goal orientation framework" (p.39) and Linnenbrink (2005) states that "a developmental perspective assessing personal goals and underlying dispositions and using objective measures of the goal context would allow one to more carefully trace the unique effects of these predictors to learning-related outcomes and the potential of a given classroom goal context to alter personal goal orientations over time" (p. 209).

The practical implications of this research are equally appealing as the conclusions give instructors, software companies, and instructional designers empirically sound advice as to how to effectively build feedback protocol into multimedia learning programs. Even the lack of a significant interaction can tell these audiences that a delivery system with several unique feedback protocols may not be necessary and a "one

size fits all" system may be better suited. If this is the case, it is anticipated that this research will identify the most effective type of feedback protocol to be used. However, if there are individual learner characteristics that merit the use of slightly unique feedback protocols, this research will identify what they are.

# CHAPTER 2

## LITERATURE REVIEW

In recent years, relationships between self-regulated learning constructs and the effects of each on academic performance have become an increasingly salient line of research (Bell & Kozlowski, 2002; Bong, 2004; Gupta & Sinha, 2002; Mangos & Steele-Johnson, 2001; Steele-Johnson et al., 2000; Wolters et al., 1996). Prior research has empirically established performance antecedents such as goal-orientation (Elliot & Church, 1997; Elliot & McGregor, 2001; Harackiewicz, Barron, Tauer, & Elliot, 2002; VandeWalle, Brown, Cron, & Slocum, 1999; Wolters et al., 1996), self-efficacy (Bandura, 1997), cognitive, and metacognitive strategies (Bandura, 1997; Pawley, Ayres, Cooper, & Sweller, 2005; Schraw, 1998). However, when using worked examples (Tarmizi & Sweller, 1988) and feedback (Bower, 2005; Melis & Andres, 2005) as self-regulation tools, conclusions have been complex in the nature of their predictive validity and can exhibit differing results based on the context and combinations of variables.

This chapter will accomplish three tasks. First, pertinent research which has supported inter-relationships between self-regulated learning, self-efficacy, and motivation will be reviewed. Second, this chapter will provide a more focused dialogue with regard to changes in goal orientation mediated by context, feedback and worked example usage as a self-regulation tool. Finally, the chapter will establish gaps in this line of scholarly literature that the current research will address.

## Inter-relationships between Goal Orientation and Other Key Constructs

The role of ability and its contribution to the interactions of task, goal orientation, achievement and self-efficacy has received considerable attention in recent scholarly literature. While Mangos and Steele-Johnson (2001) found no effect of cognitive ability between the interactions of task complexity, goal orientation, self-efficacy and performance, Bell and Kozlowski (2002) found an adaptive pattern of learning orientation (i.e., a trend indicating higher levels of academic achievement) for high ability individuals and no effects for low ability individuals, demonstrating that the relationship between performance orientation and achievement was mitigated by cognitive ability. A crucial difference between the two studies is that Mangos and Steele-Johnson altered the learning environment to artificially manipulate goal orientation whereas Bell and Kozlowski assigned subjects to experimental groups based on authentic subject characteristics (i.e., goal orientation) measured prior to group assignment.

Other exploratory research has demonstrated strong connections between goal orientation and epistemology, the theory of knowledge and knowing (Dweck & Leggett, 1988). Those more inclined to adopt a mastery orientation view knowledge as malleable, where continuously high levels of effort are exerted and more challenging tasks are sought as the learner deems these to be most beneficial. In contrast, those with a performance orientation usually see ability as a fixed construct and therefore fail to see value in additional effort. In fact, individuals who demonstrate above average indications of performance goal orientation will often see increased effort as a useless venture and a sign of weakness that may lead to undesirable evaluations from others. Individuals such

as these are most concerned with proximal outcomes, such as grades and normative feedback.

Self-efficacy (Bandura, 1977, 1997), under the implication of social cognitive theory, is defined as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997 p. 3). The influence of perceived self-efficacy as a significant predictor of behavior is supported in the literature (Kennett & Keefer, 2006). Bandura's review of research also confirms the predictive validity of self-efficacy while accounting for other variables such as locus of control and ability. Similar to goal orientation, individuals with higher self-efficacy typically view successful task completion as highly dependent upon effort and persistence and will often choose more challenging tasks due to their perceived benefits (Dweck & Leggett, 1988; VandeWalle et al., 1999). Individuals with a lower self-efficacy may view increased effort as an indicator of lower ability and be drawn to the simplest of tasks as a coping mechanism to avoid failure (Dweck, 1999).

While a majority of research has demonstrated consistent empirical evidence of stronger relationships between a mastery approach goal orientation and intrinsic motivation, self-efficacy and deep processing cognitive strategies (Ames, 1992), its predictive power for self regulated learning has been restricted to self-reported measures (Pintrich, 2000b). The discussion of performance goal orientation as an antecedent of the same outcomes however, has received a mixture of results. While some research has focused on the maladaptive patterns that follow from a performance approach goal orientation (Dweck & Leggett, 1988), recent research has challenged this position when other factors such as context and motivation are considered. While VandeWalle et al

(1999) found a positive relationship between performance goal orientation and sales commissions, Harackiewicz, Baron, Pintrich, Elliot and Thrash (2002) have also noted positive relationships with task value, academic concept, effort and performance. Furthermore, Pintrich (2000a) demonstrates some adaptive patterns for performance approach goals under a revised theory that allows for learners to progress through different goal orientations dependent upon the context and desired outcome. Elliot et al (1997, 2001) also identified performance approach goals as a significant predictor for graded performance with subjects high on performance approach goal orientation and low on mastery approach goal orientation receiving the highest grades. In fact, Harackiewicz et al (2002b) have gone so far as to claim that in a typical academic setting mastery approach goals will only predict interest and enjoyment of a course but performance goals will predict grades and subsequent GPA.

The advantages or disadvantages of a mastery or multiple goal perspective continue to be debated by current learning theorists. While some advocate for a purely mastery based goal orientation (Ames, 1992; Dweck & Leggett, 1988) others have found instances where a more eclectic goal orientation is beneficial (Barron & Harackiewicz, 2001; Linnenbrink, 2005). Two theories proposed by Linnenbrink and Pintrich (2001) have supported the eclectic goal orientation; buffering (where the advantageous characteristics of personal goal orientation and the learning environment can compliment one another) and matching (whereby mastery or performance orientations can be adaptive, provided that the learning environment accommodates the orientation). While these two positions have been validated by other research (Barron & Harackiewicz, 2001), findings in support of the theories have not been consistent. Contrary to both

theories, Linnenbrink (2005) found no changes in goal orientation based on the learning environment. However, her research was comprised of a field experiment with a small number of classrooms (n=10) and control over the learning environment was difficult to sustain.

Conclusions regarding the maladaptive patterns of mastery avoidance and performance avoidance orientations have been much more consistent, with performance avoidance orientations showing negative relationships with performance (Elliot, 1999; Elliot & McGregor, 2001; Elliot, McGregor, & Gable, 1999; Middleton & Midgley, 1997), as well as deep processing strategies (Elliot & McGregor, 2001). Elliot et al (2001) also noted a positive relationship between performance avoidance orientation and fear of failure, test anxiety, worry and disorganization with similar relationships between these four constructs and mastery avoidance.

## Learning Context

As recent learning theory research supports the notion that goal orientation can change over time (Pintrich, 2000a), investigations attempting to discern additional factors that account for distinct patterns within these changes have been successful in establishing the learning environment as one of the key mediating variables. These change patterns in goal orientation can be due to manipulations in task demands (Steele-Johnson et al., 2000), individual differences or subject domain (Bong, 2004).

Steele-Johnson et al (2000) stressed the importance of matching goal orientations with the nature of the task. The authors set out to challenge prior convictions that advocated a mastery-performance goal orientation as the optimal predictor of adaptive

behavior. Button, Mathieu and Zajac (1996) acknowledge that while goal orientation is a relatively stable construct, it may be influenced by situational characteristics. Steele-Johnson et al. (2000) point out that the mitigating effects of task demand over goal orientations have largely been ignored and extend the suggestion of Button et al (1996) by incorporating variations in task demand and consistency into their experimental design. By randomly manipulating goal orientation as a situational construct, their research was successful in identifying task conditions as a mitigating factor between goal orientation with performance, self-efficacy and affect. Using university students and work related tasks, subjects assigned to a performance approach goal orientation group outperformed those from a mastery approach goal orientation group when asked to complete simple tasks. On difficult tasks however, goal orientation had no effect on performance. Results measuring affect (satisfaction with one's own performance) indicated that subjects from the mastery approach condition were equally satisfied on both simple and complex tasks whereas those in the performance approach condition indicated higher levels of satisfaction on simple tasks. Subjects also demonstrated greater levels of self-efficacy when the cognitive load requirements of the task best resembled their goal orientation condition. Specifically, when tasks were assigned requiring the learner to use elaboration strategies, subjects from the mastery approach group reported higher levels of self-efficacy. Conversely, when the conditions of the task were consistent and best suited to rehearsal strategies, subjects from the performance approach group indicated higher levels of self-efficacy. Their conclusions are indicative of prior research and support the argument that mastery oriented learners will "insist" on a more cognitively demanding task which they view as an opportunity to increase their

knowledge (Ford, Smith, Weissbein, Gully, & Salas, 1998), whereas those with a performance frame of reference will prefer simpler tasks which present an opportunity to demonstrate success (Bar-Eli et al., 1997). Their research includes the artificial creation of mastery and performance conditions and the use of realistic tasks in a controlled laboratory setting. As the authors note, future research approaching goal orientation as a trait in other contexts is needed to support the theory. Although other research has used this technique of superficially creating different goal orientations and highlighted the importance of considering the effects of the prevalent conditions of each classroom (Butler, 1993; Harackiewicz & Elliot, 1993), learners may very well be more anchored to their own personal goal orientations and it is the contention of the current research that goal orientation conceptualized as a trait would carry greater merits in predictive and external validity. In other words, questions about the influence of one's own personal goal orientations and that of the learning environment still exist and require additional research to conclude the relative influence of each. This research will contribute to questions such as this. Commensurate with this view, the authors call for field research to test the theory. Furthermore, since their research employed a "çomplex task simulation that is similar to administrative tasks performed by employees in work settings" (Steele-Johnson et al., 2000), the current research addresses more typical tasks involved in K-16 education to further the theoretical and instructional implications of their research.

The notion of performance approach goal orientation as an adaptive learning pattern is not an isolated occurrence. In addition to earlier discussions in this chapter about optimal learning behaviors with learners who hold this orientation, Wolters et al (1996) have replicated the findings of Steele-Johnson et al. (2000). Furthermore, they

employed authentic learner characteristics in a more typical academic environment noting adaptive patterns for learners who adopt a performance approach orientation. In a repeated measures field experiment using a regression analysis with 434 students in grades 7 and 8, their work successfully replicated the adaptive academic patterns resulting from a performance approach goal orientation posited by Elliot and Harackiewicz (1996). Accordingly, their results also rebut the conclusions of Ames (1992) stating that a performance goal orientation has harmful academic consequences. In fact, performance goal orientation exhibited positive relations with motivation, cognition, performance, task value, self-efficacy, cognitive strategy use and indicators of self-regulated learning, similar to the predictions of a mastery approach orientation. This research was pivotal in the development and understanding of the effects of goal orientation in that it opened the door for performance approach philosophies to be accepted as beneficial under certain contexts and classroom settings. While the specific conditions of the task were not manipulated as was done by Steele-Johnson et al (2000), their study advances the theory by using an academically focused task, doing so in a realistic environment and assuming goal orientation as a trait rather than manipulating it as a situational construct. One weakness of their study is the assumption of goal orientation as too stable a construct. The static and independent measures of goal orientation used by Wolters et al. (1996) and limitations of arbitrary median splits fail to accommodate other widely accepted explanations of the construct as one that is, to a significant degree, defined by the situation and one that individuals can progress through over time (Pintrich, 2000a).

Other work conducted by Bong (2004) noted the contextual and domain specific limitations proposed by Pintrich with regard to the generalizability of goal orientation change patterns and attempted to further investigate changes in these key constructs over time and domain. A confirmatory factor analysis with middle and high school Korean students used the Patterns of Adaptive Learning Survey (PALS ) (Middleton & Midgley, 1997; Midgley et al., 1995), the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & DeGroot, 1990) and an independent instrument constructed by the researcher to measure goal orientation, self-efficacy and task value, respectively. Her results confirmed that relationships between goal orientation and other motivational constructs do change over time. In this case, the transition from middle to high school was identified as a mediating variable and Bong attributes this to the deeper emphasis on college entry in high school. Although these changes could have also been attributed to the additional diversity in course offerings that exist in secondary academics, self-efficacy and task value were positively correlated across domain and school level (time). Performance approach goal orientation was positively correlated with both mastery approach goal orientation and self-efficacy. Performance avoidance goal orientation was not correlated with achievement in any of the subjects except for science where a positive correlation existed. While this is consistent with the findings of Middleton and Midgley (1997), Elliot and Church (1997) found a negative relationship for science.

Although the work of Bong lends additional support to the notion that performance approach goal orientations can produce adaptive learning behavior patterns, the stability differences between mastery vs. performance goal orientation constructs across domains and the vulnerability of students' goal orientations as a circumstance of

the learning environment are most intriguing. Both performance approach and avoidance goal orientations were highly stable across all learning domains while mastery goal orientations tended to differ depending upon academic domain, especially in high school students. This finding is somewhat contrary to prior research convictions where the construct of goal orientation is depicted as one which is sensitive to change. Learners who prefer normative opportunities to outperform others and avoid negative judgments from their peers tend to consistently keep this desire across diverse academic domains whereas those with a mastery based goal orientation tend to be more inclined to adopt different goal orientations depending upon the subject matter. The vulnerability of goal orientation constructs was also attributed to the conditions of the learning environment. Consistent with prior research (Anderman & Midgley, 1997; Roeser, Midgley, & Urdan, 1996), Bong (2004) concludes "school environments that stress normative success in turn orient students to performance goals" (p. 31). Her research also supports a similar concern that a competitive learning environment will increase the propensity for learners to "sacrifice learning opportunities for better performance" (Lam, Yim, Law, & Rebecca, 2001). While these contentions serve as a key resource in the development of the current research hypotheses, the conclusions made by Bong were obtained within contexts too broad to pinpoint specific causal relationships, specifically, the transition to another school environment (i.e., elementary to middle or middle to high school).

## Feedback

Although the context of the learning environment has proven to be an empirically fruitful research endeavor, the study by Bong (2004) utilized too broad of an operational definition for this construct (the transition from elementary to middle school), thus making focused relationships difficult to sustain. For this reason, the current research focused specifically on feedback protocols and did so within a controlled learning environment to better gauge their effects. In addition, goal orientation was established as a key variable since this construct serves as a personal reference point through which learners interpret feedback (Bobko & Colella, 1994) with mastery oriented learners viewing all feedback as useful and performance oriented learners viewing it as evaluative or judgmental. Much of this phenomenon is also due to correlations between goal orientation and epistemology since views of knowledge as fixed or malleable will greatly influence a learners perceived benefit of receiving feedback and could also set the stage for the type of feedback which is preferred (as investigated by the current research). Additional research has noted different patterns depending upon the type of feedback, particularly with performance oriented learners viewing negative feedback unfavorably by attributing failure to a lack of ability (Dweck & Leggett, 1988) and positive feedback as useless since additional effort will only increase the risk of receiving negative feedback (VandeWalle, Cron, & Slocum, 2001). In addition, VandeWalle and Cummings (1997) found that learners were more likely to seek feedback as the disparity between mastery and performance indicators scores grew larger. However, their conclusions were based solely on self-reports.

The VandeWalle et al study (2001) is of particular interest for the current research. Using a structural equation modeling technique to analyze goal orientation, goal setting and self-efficacy data collected from undergraduate students, the authors found significantly different performance patterns for learners depending upon their goal orientation preferences. After feedback on two academic events, the relationship between mastery performance orientation and achievement remained positive, the relationship between performance approach and achievement decreased from positive to non-significant and the relationship between performance avoidance and achievement remained negative. These relationships are consistent with Elliot and McGregor (1999) and were mediated by self-efficacy, goal orientation and effort. Performance approach orientation showed no relationship with negative performance. Their results support the notion that goal orientation is more complex than simply equating mastery performance with successful academic achievement and performance orientation with sub-par achievement. However, in a context where feedback-seeking behaviors are required, performance oriented individuals will typically prevail compared to mastery oriented ones.

A similar study by Winne, Muis and Jamieson-Noel (2006) found no relationship between mastery orientation and feedback. This finding was contradictory to their prediction that mastery avoidance would demonstrate a negative relationship with feedback. Furthermore, although learners adjusted their goal levels over time, their goal orientation types did not change significantly as a result of receiving traditional feedback (i.e., grades). However, performance oriented learners altered their level of performance approach or avoidance based on their achievement predictions in combination with the

feedback they received. Those who under-estimated their achievement received positive feedback and decreased their indications of performance avoidance goal orientation. Those who over-estimated their achievement however, received negative feedback and decreased their performance approach indications. It is important to note here that all participants received a similar feedback protocol based on each individual's obtainment of course criteria benchmarks.

Feedback protocol is defined as the type of feedback that the learner receives; individualized (based on incremental benchmarks and the learner's own personal growth) or competitive (also referred to as normative, when the learner is informed of his or her progress in comparison to the performance of their peers). Historically, research into the effects of differing feedback protocols on achievement has been inconclusive. A meta-analysis of 122 studies showed no significant effects of feedback protocol upon achievement (Johnson et al., 1981). Still, within these effects there have been noted gender differences (Lewis & Cooney, 1987). An investigation into feedback effects by Bower (2005) with high school students using a computer based math program to learn the quadratic equation randomly assigned students to a normative or mastery based feedback scenario after asking subjects for their preferred feedback format and tracked their practice attempts (i.e., effort), ability self-ratings (i.e., self-efficacy) and quiz scores (i.e., achievement). Denying learners of their feedback preference was negatively related to self-efficacy but unrelated to effort and showed differing (and indeed intriguing) effects on achievement. Specifically, learners with a preference for competitive feedback and who were assigned to this group made no significant gains in achievement. Learners with a mastery preference assigned to this group did however realize significant gains in

achievement (even though their assigned group did not match their preference). These findings are contrary to the matching concept proposed by Linnenbrink and Pintrich (2001) since assigning learners to their preferred method of feedback did not lead to increases in achievement.

These interesting and yet inconsistent findings will be used to guide the current research. While the work of Bower (2005) differentiated between the type of feedback received and the feedback preferences of the learner, a dependent measure for goal orientation was not incorporated. Winne et al (2006) did include such a measure, but used a traditional feedback protocol for all subjects in their study. In a similar fashion, Linnenbrink (2005) obtained goal orientation indicators, but manipulated the classroom structures themselves *a priori*. As discussed with regard to the Bong (2004) study, the differences between classrooms in the Linnenbrink study were quite broad and included variations in six factors: tasks, authority, recognition, grouping, evaluation and time (Maehr & Midgley, 1996), but did not differentiate feedback protocol in her research design.

## Cognitive Load

Copper (1990) defined cognitive load as "the level of 'mental energy' required to process a given amount of information. As the amount of information to be processed increases, so too does the associated cognitive load. Cognitive load theory suggests that effective instructional material promotes learning by directing cognitive resources towards activities that are relevant to learning rather than to processes that are an adjunct to learning" (p. 108). Two types of cognitive load are often discussed in research

(Bruning, Schraw, Norby, & Running, 2004), intrinsic which is a characteristic of the material and content, and extrinsic which is a byproduct of the instructional design and presentation of the information. The current research followed the direction of Bruning et al (2004) and focused on extrinsic cognitive load since the content of the material to be learned usually cannot be altered. Mayer and Moreno (2003) also acknowledge that removing extraneous content information is not always feasible, and offer alternatives such as using signaling to direct a learner's attention to essential information and away from that which is extraneous. Instructional design that minimizes cognitive load can aid learners in two ways. First, by giving practice to attain automaticity, learners can build skills and schema into their long term memory. Once this is accomplished, learners can devote their limited cognitive resources to more complex tasks as they do not have to think consciously about the simpler ones. Second, multimedia instruction can reduce the demands of a learner's working memory by designing pedagogy and presentations which capitalize on the unique relationship of visual and auditory processing by presenting information in an integrated and coherent fashion.

Building sub-skills with practice can develop schema and give learners the prior knowledge that they need to be successful later in more complex learning environments. Schema-like structures are especially pertinent in the representation of declarative knowledge consistent with the ACT model (Anderson, 1995) which posits the encoding and storage of information in chunks. In addition, the onset of technology can offer superior practice in several ways. First, a computer can give consistent, accurate, and immediate feedback. By doing so, students working independently can gain access to unlimited amounts of practice and can maximize efficiency by eliminating the "down

time" of having to wait for the rest of the class to finish a problem or for an instructor to make the time to assist them. By keeping practice exercises close to the ability of the learner, one can ensure that they will not become overwhelmed and discouraged and yet remain challenged enough to remain interested in continuing to develop the skill.

## Worked Examples

Worked examples is an effective learning strategy for decreasing extraneous cognitive load (Paas & Van Merrienboer, 1994; Sweller, 1988; Van Merrienboer, Kirschnet, & Kester, 2003). Choosing to use worked examples during the learning process is an exemplary self-regulation strategy. In recent years, self-regulation strategies to aid in the reduction of cognitive load have seen a resurgence for instructional design considerations (Pawley et al., 2005; Van Merrienboer et al., 2003) particularly within the context of multimedia learning applications (Mayer & Moreno, 2003). Prior research recommends worked examples with an integrated structure, (Marcus, Cooper, & Sweller, 1996; Pillay, 1994; Tarmizi & Sweller, 1988), a non-specific goal approach (Lim & Dixon, 1996; Sweller, 1988), an optimal balance between visual and auditory modes (Mousavi, Low, & Sweller, 1995) and high variability (Paas & Van Merrienboer, 1994). More recent publications have attempted to replicate these theoretical implications in e-learning contexts (Mayer & Moreno, 2003). However, learner characteristics (such as expertise and development) and the desired outcome can produce different conclusions from varying formats of worked examples.

The learning environment and other contextual factors such as the type of self-regulated strategies encouraged can serve as a mediating variable between goal

orientation and achievement. This research has attempted to give additional insight to the conclusions of Wolters et al (1996) by focusing on the use of worked examples that reduce cognitive load and encourage subjects oriented towards performance goals to use more simplistic forms of self-regulation such as rehearsal. Interactions of self-regulated learning, self-efficacy, goal orientation and performance can very well depend on the type of self-regulated learning strategy employed. Since studying worked examples present a distinct advantage to subjects with a lower level of knowledge, a performance goal orientation can be a positive predictor of worked example usage (Crippen, Biesinger, & Muis, 2008). The work of Steele-Johnson et al (2000) supports this prediction in that performance oriented students would flourish in a worked example environment. The worked examples in the current line of research were used to give learners the opportunity to reduce extraneous cognitive load and if those with a performance approach orientation prefer simpler tasks (Steele-Johnson et al., 2000) it follows that those who adopt higher levels of performance approach goal orientations would benefit most from worked examples as a self regulated learning strategy. Performance approach goal orientation then should lead to the increased use of rehearsal strategies. Worked examples such as those used in the current research should also be most helpful to subjects with less knowledge (Pawley et al., 2005).

Mastery approach goal orientation however, predicts a preference for the use of elaboration strategies (Fisher & Ford, 1998). These same subjects who exhibit higher levels of a mastery approach orientation would likely avoid strategies such as worked examples, recognizing them as low skill tasks. In fact, mastery-oriented students who use

worked examples may be even more likely to adopt maladaptive academic patterns and thus hamper achievement as a result.

Accepting worked examples as a self-regulation strategy and doing so in an multimedia learning environment lends the current research an opportunity to investigate authentic learner behaviors (via trace methods) in an undergraduate e-learning context. Additional variables which have been previously established as reliable indicators such as self-efficacy and goal orientation will also be included to serve as mediators between predictions of performance and patterns in learner behaviors framed within goal orientation.

## The Current Investigation

The current research investigated the effects of differing feedback protocols (self-referenced vs. norm-referenced) in a multimedia learning environment. All of the variables and measurements employed were similar to those used in other research discussed in this chapter. However, the current research accounts for combinations of these variables and the relationships that may exist between them not previously explored to inform current learning theory.

This research represents part of a large scale project that has been active at the university for several years using a Web-based interface to provide students additional practice with well structured problems from introductory chemistry through the use of worked examples and self-explanation prompts embedded into weekly quiz items. The software itself is proprietary (but not commercial) and a team of researchers at the university have worked to adapt and improve the software since it was originally

established with continual testing and research. As such, worked examples with an accompanying self-explanation prompt are made available in conjunction with weekly quiz items for students to use if they so chose. Because worked examples were offered to students as an option, use of worked examples was defined as an explicit self regulated learning strategy (of the learner's own volition) for the current research.

The current research operates within three primary assumptions which guided the project design. First of all, the feedback protocol was controlled while holding all other factors constant within a multimedia learning environment. This allowed for a more concise interpretation of the results. Bong (2004) investigated changes in goal orientation, but did so in far too broad of a context, comparing middle school and high school student trends. Indeed, many environmental factors between middle school and high school are different, making it difficult to interpret change patterns in goal orientation. The current study only manipulated feedback protocol, thus strengthening the link between goal orientation, feedback, use of worked examples, self-efficacy and achievement. In a similar vein, Anderman and Midgley (1997) noted that students exposed to more normative evaluation procedures will adopt more performance based goal orientations. Still, their context was also quite broad (the transition from elementary to middle school) making it equally difficult to precisely determine how much of this was in fact a circumstance of the environment (such as feedback) and how much of the variance might be attributed to other factors such as age, school structure, time and course.

Second, the current research collected authentic goal orientation measures from the participants and assume the construct to be trait-like. Perceptions of the learning

environment and feedback protocol preferences were also collected and incorporated into the research design, but assignments to feedback protocol have been randomized. Roeser et al (1996) used goal orientation measures as a mediating variable between perceptions of the learning environment, efficacy and achievement, but did not consider if consistencies between personal goal orientation and the perceived goal orientation of the learning environment were a contributing factor. In addition, Steele-Johnson et al (2000) did not consider personal goal orientation. Instead, the researchers made controlled changes to each learning environment to artificially manipulate goal orientation. The authors admit that goal orientation may be more trait-like and thus attempts to artificially manipulate goal orientation should receive replication within the research arena by incorporating personal goal orientation into the design. The current research has addressed these recommendations by incorporating both personal goal orientation indicators as well as perceptions of the learning environment into the design.

Third, the changes in feedback protocol were used to test predictions in goal orientation change patterns. Whereas Winne et al (2006) investigated changes in goal orientation over time, an identical feedback protocol was used for all subjects. Conversely, Bower (2005) made controlled changes to feedback protocol and factored feedback preferences into his experimental design, however no indication of goal orientation was included. Thus, the current research proposes to generate a hybrid of these two studies while including other key mediating variables such as self-efficacy and worked example usage.

The current research addresses these gaps from recent scholarly literature within the context of self-regulation as a learning theory. The research questions formulated

respond directly to recent publications within this line of work (Linnenbrink, 2005). Indeed, as evidenced by Linnenbrink, manipulating the goal context rather than artificially manipulating personal goal orientation has produced conflicting conclusions for interest and help seeking behaviors which are not consistent with prior research. In addition, the "competitive" learning contexts used only fostered competition between groups of learners and not individuals, perhaps not an accurate depiction of most authentic learning environments. Linnenbrink (2005) makes the following recommendations for future research:

> [F]uture research should examine the stable effects of personal goals, perhaps based on motives or views of intelligence, as well as the changing nature of personal goal orientations based on the classroom environment. In this future research, researchers may be better served by moving away from subjective perceptions of the goal context to more objective measures such as observations or experimental designs...Finally, a developmental perspective assessing personal goals and underlying dispositions and using objective measures of the goal context would allow one to more carefully trace the unique effects of these predictors to learning-related outcomes and the potential of a given classroom goal context to alter personal goal orientations over time. (p.209)

Based on these recommendations, the current research uses a complex experimental design to address several research questions equipped to better inform the theory of self-regulated learning with an intense focus upon goal orientation as a motivational construct.

# CHAPTER 3

## METHODOLOGY

### Purpose of the Current Study

This chapter will outline the methods used to conduct the current study. Specifically, this study was aimed to gauge the effects of a subtle difference in feedback protocol accessed via the Web by undergraduate students enrolled in an introductory chemistry course for science majors. Subjects used the Web-based system to complete weekly quizzes and to receive personalized feedback to inform them of their progress. Feedback was randomly assigned and consisted of either a norm-referenced protocol (where feedback displayed weekly quiz scores in comparison to their peers) or a self-referenced protocol (where feedback displayed weekly quiz scores in comparison to their own previous scores). Goal orientation and self-efficacy (measured via self report pre-post instruction), self-regulatory behaviors (measured via trace methods), and final course grades were analyzed to determine if changes had occurred as a result of the differing feedback protocols. Learning environment perceptions (measured via self report) were also incorporated into the design as a potential mediating variable.

Additional research is needed to investigate the effects of feedback within multimedia learning environments with a focus on potential changes in motivation and metacognition as well as academic achievement (Steele-Johnson et al., 2000). Some research within this domain has tracked change patterns in motivation (i.e., goal

orientation) and metacognition (i.e., self-regulation) but failed to differentiate the type of feedback received (Linnenbrink, 2005; Winne et al., 2006). Other investigations administered unique feedback protocols and examined academic achievement but neglected to include motivation and metacognitive outcome variables in the design (Bower, 2005).

The current research design makes the necessary adaptations to better account for controlled manipulations in feedback protocol. These adaptations have allowed the current inquiry to make a meaningful contribution to what is known about the changing role of goal orientation and self-regulation as motivational constructs within self-regulated learning. The purpose of this research was to investigate changes in goal orientation and self-regulated strategy usage over time when learners were exposed to unique feedback protocols (norm-referenced vs. self-referenced). Learners were tested pre-post to measure the type and magnitude of goal orientation as well as self-efficacy. After exposure to one of two distinct feedback scenarios, changes in these variables were expected to occur. In addition, self-regulated strategy usage (i.e., the cumulative number of times a learner prompts the system for a worked example) was also tabulated. It was anticipated that different usage patterns would exist for learners with unique goal orientation types and perceptions of the learning environment (an additional data point collected as a potential mediating variable).

The current research used random assignment to place undergraduate chemistry students into one of two feedback groups; a norm-referenced group, where weekly quiz scores were compared to the class average or a self-referenced group, where the same quiz scores were compared to each learner's own average from all prior quiz attempts.

Subjects were pre/post tested for goal orientation and self efficacy to investigate if changes differed between groups. In addition, the cumulative number of times each learner launches a worked example/self-explanation prompt was tracked as an explicit self-regulation strategy to determine if usage patterns differed by group. Perceptions of the learning environment, assessed with the PALS instrument, was also tested as a mediating variable to see if group differences along each of the dependent variables were related to a learner's impression of the learning environment. Specifically, results from the PALS tell the researcher if subjects view the environment as one in which the instructor values students who are innately intelligent or those who exhibit a high level of effort. Finally, achievement was compared across feedback group and learning environment perception to investigate the presence of a potential differential effect of the two unique feedback protocols used.

The design of this study placed a great deal of emphasis on the "alignment" or "misalignment" of feedback group assignment with learning environment perception and deserves additional explanation (Table 3). Subjects who believed the instructor to place a high value on students who exhibit a great deal of effort were referred to as those with a class-task perception. Conversely, those who believed that the instructor values students with innate ability in chemistry were considered to possess a class-ability perception. Subjects who exhibited a class-task perception and were assigned (randomly) to the self-referenced feedback group were considered to be aligned. Since these students place a high degree of value on effort and learning for more idealistic reasons, being assigned to a feedback condition that compares current performance to their own past performance should have been a comfortable situation for these learners. Subjects with similar

indications of a class-task perception but placed into the norm-referenced feedback group were in a sense out of their comfort zone and indications of goal orientation, self-efficacy, and achievement should show maladaptive patterns. Likewise, subjects with a class-ability perception should benefit most from being assigned to the norm-referenced group (aligned) and benefit least from exposure to the self-referenced feedback group (misaligned).

Three prior studies guided the design of the current project; namely, that of Bower (2005) Linnenbrink (2005) and Winne (2006). While Bower made controlled manipulations to the feedback protocol used and compared these manipulations to subjects' self-reported feedback preferences, his outcome variables were limited to self-efficacy and achievement; no measure of goal orientation was included. In addition, as acknowledged by the author, feedback preferences were gauged with only one item, demonstrating the need for a more comprehensive inquiry of learning environment perceptions in addition to feedback preferences alone. Other studies investigated changes in goal orientation but did so without specific manipulations in feedback protocol (Linnenbrink, 2005; VandeWalle et al., 2001; Winne et al., 2006). Design limitations made it impossible to discern changes that might have occurred due to the type of feedback received by the learner. All subjects in these studies received a similar type of feedback and in most cases, the feedback was limited and traditional in nature (i.e., the number of items correct on an exam). Linnenbrink did alter classroom structures and showed that learners' personal goal orientations typified their learning environment, but did so with a post-test only measurement to validate the fact that her learning environments were indeed unique. The lack of a pre-test makes it impossible to trace

changes in goal orientation specifically as a circumstance of the environment. In addition, the distinctions between learning environments were omnipresent in nature and inclusive of many factors in addition to feedback.

The current research therefore aimed to create a time by feedback by environment experimental design and used multivariate statistics and analysis of variance (ANOVA) procedures to investigate change patterns in goal orientation and self-efficacy, occurrences of self-regulation behaviors and achievement based on the type of feedback provided. Learners were exposed to either a self- or norm-referenced feedback situation.

The debate regarding the benefits of adopting a mastery goal perspective as compared to a multiple goals perspective also continues to fuel current discussion around learning theory and motivation (Barron & Harackiewicz, 2001; Linnenbrink, 2005). While several studies (Elliot & McGregor, 2001; VandeWalle et al., 2001) agree that mastery oriented individuals will respond favorably to feedback (thus maintaining a positive relationship between goal orientation and achievement) and performance oriented learners will not (thus decreasing the relationship between goal orientation and achievement), the type of feedback employed was not noted in their research. Recent work by the researcher (Crippen et al., 2008) continues to call into question the maladaptive patterns assumed to be associated with a performance approach goal orientation, especially when worked examples are offered to the learner as an explicit self-regulation tool whereby simplistic and "consistent" examples present an opportunity to reduce extraneous cognitive load. Investigations into the effects of these differing feedback protocols will be framed within the following research questions:

1- Are changes in goal orientation over time mediated by differences in feedback protocol?

    a. If so, do these change patterns differ based on perceptions of the learning environment and their alignment to the feedback protocol used?

2- Do learners adopt different self-regulation strategy usage patterns when they are exposed to differing feedback protocols?

    b. If so, are these unique patterns dependent upon perceptions of the learning environment?

3- Do distinctions in feedback protocol, perceptions of the learning environment and their alignment with one another interact to produce notable differences in self-efficacy and achievement?

## Participants

A sample of 184 undergraduate students from a large, urban southwestern university consented to the study. Informed consent and all subsequent measures were collected via the Web. This sample size is in agreement with currently accepted practice (Lipsey, 1990) assuming that effect sizes are moderate in size (no less than .25). Additional communications with the chemistry instructor using this system (M. Orgill, personal communication, August 2, 2007) indicated that one section of General Chemistry I was available each semester, with approximately 150 students registering for the fall 2007 term. Making accommodations for attrition and non-consent, it was anticipated that data collection over the course of two semesters would provide more than

enough subjects to detect any statistically meaningful changes in the outcome variables of interest. Subjects were drawn from a General Chemistry I course (CHEM 121) during the fall 2007 and spring 2008 semesters.

The current study represents one part of a series of on-going research and the instructor from which the subject pool was drawn was aware of the procedures and measures to be used prior to conducting the study. In addition, a preliminary meeting between the researcher and the instructor was held to review the measures to be used, the timeline for data collection and the consent process to be employed. The researcher visited each class at the start of the academic term to review the purpose of the study and the informed consent process with all potential subjects (Appendix C). In addition, permissions with the university's institutional review board were secured (Appendix D).

## Procedure

Students met on a traditional semester calendar with weekly face-to-face class meetings and used WebCampus as an instructional supplement to communicate with other students or the instructor and to access the quizzing system, notes, homework assignments, extra practice problems, and solution sets. The quizzing system software used for the current study (Crippen & Earl, 2004) is a proprietary (but not commercial) program developed to provide learners an opportunity to practice and build well-structured problem solving skills (e.g. developing and implementing one clear methodology to arrive at a known solution).

The system is theoretically grounded within salient lines of research which have demonstrated support for the use of worked examples and self-explanation prompts

(Sweller, 1988). Indeed, these instructional strategies have been empirically demonstrated to effectively reduce extraneous cognitive load and help students to build well-structured problem solving skills. The system is currently part of a large scale effort at the university to explore the effectiveness of these pedagogical techniques with academic performance as well as latent variables such as motivation. Lack of adequate sample size has precluded past efforts to detect statistically significant changes in motivation. However, trends in data from initial research within the system have shown positive relationships with achievement, problem solving skills and self-efficacy (Crippen & Earl, 2004, 2007). In addition, prior research from these authors indicates that students make extensive use of the worked examples as well as the self-explanation prompts. These efforts have been used to make helpful adaptations based on both qualitative as well as quantitative data elements such as the pairing of worked examples and self-explanation prompts as opposed to offering them separately.

The software offers learners the opportunity to interact with worked examples and each one is paired with a self-explanation prompt (Figure 1). These worked examples/self-explanation prompts are embedded into weekly quizzes that students take on-line as a set of three buttons labeled "Example 1", "Example 2", and "Example 3". Performance on the weekly quizzes was used in calculating each learner's final grade. Prompts that allow the learner to view a worked example and self-explanation prompt were made available on well-structured quiz items, but the worked example/self explanation was not revealed unless prompted by the learner (i.e., by clicking on one of the worked example buttons). Hence, the choice to use said worked examples/self-

explanation prompts resides within each learner's volition and is therefore viewed as a self-regulated learning strategy for purposes of the current research.

Once one of the worked example buttons was clicked, a new window opened containing a self-explanation prompt (called a suggestion) and a worked example with the same format and content as the current quiz item. The designers of the system have worked since the inception of the project to ensure that the worked examples and self-explanation prompts are aligned with the course content and that the language used parallels that of the lectures and textbook.

Students were given access to quizzes for one week via the Web and could modify their responses at any time for that week. At the close of each week, the quizzes were graded (number correct). For students failing to reach the desired mastery level of 80% a quiz retake option was available for another week. Items given on the quiz retake contained different item stems but remained parallel in form and content to those on the original quiz and the worked example/self explanation prompts were identical. Students have indicated that this assessment system has aided their learning (Crippen & Earl, 2004) and prior research has demonstrated that the use of a combined self-explanation prompt/worked example best maximizes gains made in self-efficacy (Crippen & Earl, 2007).

Data collection consisted of three self-report surveys, a tally of worked example hits usage, and overall course grades (Table 4). Once consent was secured, subjects completed two surveys (pre-post); once at the beginning of the semester and again at the close of the semester. The instruments were identical for each administration in order to accurately measure changes in self-efficacy and goal orientation. Additionally, the

Patterns of Adaptive Learning Survey (PALS) (Midgley et al., 1995) was administered three weeks into each semester to gauge perceptions of the learning environment (pre only). In addition to these three measures, a cumulative total representing the number of times each subject prompted the system to launch a worked example/self-explanation prompt was tracked. Cumulative quiz raw score and final course grades were also obtained to indicate achievement for purposes of analysis. A complete discussion of the data elements to be included follows in the measures section.

Subjects were randomly assigned to one of two feedback protocol groups which served as the treatment to be tested with each of the three research questions (Table 5). The protocols used the same design as Bower (2005) with feedback given to all subjects continuously (at will) and updated after each of the weekly quizzes. The first group, referred to as the norm-referenced feedback group, received feedback in relation to all other learners in the course section (Figure 2). In addition to their raw score, subjects from the norm-referenced feedback group received their raw score in comparison to the average raw score achieved for all learners. The second, referred to as the self-referenced feedback group, received feedback on assessments in comparison to their own prior attempts (Figure 3). In addition to receiving their own raw score, subjects from the self-referenced group received their quiz score in relation to the average of their own prior attempts on all quizzes. In addition, the format (user interface) for presenting the feedback was similar for both groups. The only distinction between the two feedback protocols was the data used to calculate each comparison. Specifically, feedback information for the norm-referenced group used raw scores from all learners and feedback for the self-referenced group used scores from their own past assessments.

Additionally, the system communicated to each subject if the feedback represented their scores compared to other learners or themselves, so learners were made aware of which feedback group they were in.

## Measures

### *Goal Orientation*

The Achievement Goals Questionnaire (AGQ) was utilized to measure goal orientation (Table 6). The 12-item instrument was developed by Andrew Elliot, Marcy Church and Holly McGregor over the course of several years and numerous experiments (Elliot, 1999; Elliot & Church, 1997; Elliot & McGregor, 2001) to assess individual goal orientation factors on four different (although not mutually exclusive) categories. The instrument (in its most current form) is a 12-item Likert style survey (*1 = not at all true of me, 4 = somewhat true of me, 7 = very true of me*), with three items grouped for each of four achievement goal categories. The target population for the instrument could potentially be all learners from elementary school through adult, but current practices typically focus on undergraduate students. The premise of the instrument is that relationships between individual goal orientations and achievement can be used to make informed pedagogical decisions and therefore shape instructional techniques to best assist students learn.

Results from several administrations of the Achievement Goals Questionnaire found it to be correlated with other previously validated measures of the same constructs such as the Personality Research Form (Jackson, 1974), Fear of Failure Measure (Herman, 1990) and a subset of items selected from several measures of intrinsic

motivation (Elliot & Harackiewicz, 1994; Harackiewicz & Elliot, 1993). Zero order correlations confirmed significant relationships between the constructs in both positive and negative directions for 12 of the 15 pairs. The three cases without evidence of a significant correlation were achievement motivation and performance avoidance (-.11), fear of failure and mastery approach (-.07) and performance avoidance and mastery approach (.11). Other research also confirmed the validity of the additional construct, with mastery avoidance demonstrating a significant correlation with related constructs such as mastery approach (.37) and performance avoidance (.27) and no relationship to the exclusive construct performance approach (.04) (Elliot & McGregor, 2001).

*Learning Environment Perceptions*

Perceptions of the learning environment were gauged with two scales adopted from the *Patterns of Adaptive Learning Survey (PALS)* (Midgley et al., 1995). The two scales used for the current research measure learner perceptions of a class-task goal structure (mastery orientation) with six items and learner perceptions of a class-ability structure (performance orientation) with five items (Table 7). Prior research conducted with the instrument (Roeser et al., 1996) has indicated the two sub-scales are reliable ($\alpha$ =.81 for class-task and $\alpha$ =.80 for class-ability) and meet the assumptions of multicollinearity. Items for both scales will be measured on a 7-point Likert scale (*1 = not at all true in this class, 4 = somewhat true in this class, 7 = very true in this class*). Subjects were grouped through median splits for purposes of analysis based on their perceptions of the learning environment as a high/low degree of mastery ( i.e., "*In this class, understanding the work is more important than getting the right answers"*) or a

high/low degree of performance (i.e., *"In this class, the instructor only cares about the smart kids"*).

A difference score between the two subscales of the PALS instrument (class-task and class-ability) was tabulated in an effort to assign subjects a single numeric value to represent their classroom ability goal perception. This method is commensurate with prior research (VandeWalle & Cummings, 1997) and was calculated by subtracting the total score for the class-ability subscale (5 items, minimum score = 5, maximum score = 35) from the total score for the class-task subscale (6 items, minimum score = 6, maximum score = 42). This resulted in a synthetic variable which will be referred to as "perception" with a potential range of -29 to 37. A score closer to 37 indicates a greater propensity to adopt a class-task (i.e., mastery) perception of the classroom goal structures present. A score closer to -29 indicates a greater propensity to adopt a class-ability (i.e., performance) perception of the classroom goal structures present. Next, a median split on the difference score was used to assign subjects to either a class-task or class-ability perception group.

*Self-Efficacy*

In addition to the AGQ, subjects completed a self-efficacy measure (Crippen & Earl, 2004, 2007) which pertains specifically to the Chemistry content of the worked examples (herein referred to as Self Efficacy Chemistry or SEC) given pre and post instruction (Table 8). Likert responses ranged from 1 (*"Not Confident"*) to 6 (*"Totally Confident"*). Participants were asked to rate their confidence in their current abilities to successfully complete tasks such as "Use a given rate law equation to determine concentrations under different conditions", "Use the value of the equilibrium constant

($K_{eq}$) to calculate a reactant or product concentration", "Identify a Bronsted-Lowry reaction", and "Identify the anode and cathode from an oxidation-reduction reaction used for a battery." Commensurate with prior research (Bandura, 1997; Pintrich, 2000b) the items are focused within the context of the course under examination to provide maximum utility.

*Worked Example Usage*

Worked example usage is a self-regulated learning strategy measure and represents the cumulative total number of times that each student elected to view a worked example/self-explanation prompt. Each worked example/self-explanation prompt was created by the authors of the system (Crippen & Earl, 2004) to parallel the quiz items and includes a unique prompt to encourage self-explanation (Atkinson, Derry, Renkl, & Wortham, 2000). A single number to indicate the total number of prompts was used for purposes of analysis to indicate a measurement of self-regulated strategy use commensurate with prior research (Crippen et al., 2008; Crippen & Earl, 2004, 2007).

*Achievement*

Final course grades were reported as the total number of raw points earned by each learner. This total represented a cumulative aggregate of all quizzes, exams, graded assignments, and lab-work. Although eventually converted to a letter grade by each instructor, the number of total points earned will be used for purposes of analysis with the current research to sustain the highest degree of accuracy and statistical variance. It should be noted that this value did not account for the number of quiz re-takes, although subjects who improved their quiz scores did increase their total points earned.

## Method for Analysis

Upon consent at the beginning of the semester, subjects who agreed to participate in the study completed the goal orientation and self-efficacy measures. Approximately two to three weeks later, subjects completed the two subscales from the PALS instrument to gauge their perceptions of the learning environment (as to give them time to formulate a meaningful opinion of the learning environment). Research questions were addressed as follows (for a schematic of the research design/logic model, see Figure 4):

1- *Are changes in goal orientation over time mediated by differences in feedback protocol?*

   a. *If so, do these change patterns differ based on perceptions of the learning environment and their alignment to the feedback protocol used?*

To address the first research question, the researcher conducted a doubly multivariate repeated measures experimental design, consisting of feedback protocol (norm-referenced vs. self-referenced) and perception of the classroom goal structure (class-task vs. class-ability) as the between-subjects factors, time (pre-post) as the within-subjects factor and goal orientation sub-factors as the multivariate dependent measures (mastery approach, mastery avoid, performance approach and performance avoid). An interaction between the dimensions (feedback X perception X time) would indicate that the type of goal orientation did in fact change over time based on perceptions of the learning environment and their alignment to the feedback protocol used. Follow-up ANOVA tests were also conducted to discern specific changes in goal orientation type as well as the conditions that prompted these changes. A comparison of the change patterns

would inform current learning theory about the effects of differing feedback protocols upon goal orientation change patterns and do so while considering an important learner characteristic (classroom goal structure perceptions). The lack of a significant interaction would prompt an investigation of main effects to investigate if changes in goal orientation levels over time occurred and if these changes differ for subjects exposed to differing feedback protocols or for those with unique perceptions of the learning environment.

2- *Do learners adopt different self-regulation strategy usage patterns when they are exposed to differing feedback protocols?*

   a. *If so, are these unique patterns dependent upon perceptions of the learning environment?*

To address this question, a factorial ANOVA was conducted to test for a significant interaction in the 2 (perception) X 2 (feedback) matrix (similar to question one). Significant interactions for these tests indicate unique patterns for subjects across the 2 (perception) X 2 (feedback) continuums and appropriate follow up *t*-tests were conducted to determine which combination of these conditions (if any) optimized self-regulated strategy usage. The lack of a significant interaction prompted the researcher to conduct an independent samples *t*-test to investigate statistically significant differences in self-regulated strategy usage for learners based on the main effects of perceptions of the learning environment and feedback protocol employed. Significant main effects were followed up by a simple inspection of the means to determine which conditions produced a significantly higher frequency of self-regulation.

*3- Do distinctions in feedback protocol, perceptions of the learning environment and their alignment with one another interact to produce notable differences in self-efficacy and achievement?*

Two additional factorial ANOVAs from the 2 (perception) X 2 (feedback) matrix were conducted, one repeated measures ANOVA test for self-efficacy (pre-post) and another (standard ANOVA) for achievement (similar to the analysis used for question two). Significant differences were followed up with t-tests to determine optimal conditions which maximize achievement or changes in self-efficacy. The lack of a significant interaction prompted the researcher to conduct significance tests for main effects of feedback and learning environment perception. Significant main effects were then followed up by a simple comparison of the means to discover optimal conditions for achievement or changes in self-efficacy.

## Hypotheses

*Question 1*

Based on the prior research used to design the current investigation, it was predicted that learners would adopt a goal orientation that most closely resembled that of their feedback protocol. In other words, those assigned to the norm-referenced feedback protocol group would adopt higher indications of performance goal orientation and those assigned to the self-referenced feedback protocol group would adopt higher levels of mastery goal orientation. Emulations towards an approach or avoid valence were predicted to be mediated by self-efficacy, with a positive relationship between self-efficacy and approach constructs and a negative relationship between self-efficacy and

avoidance constructs. Contrary to the findings of Bower (2005), exposing learners to feedback protocols that are aligned or not aligned with their perceptions of the learning environment would also contribute to differences in goal orientation patterns, mainly because the current research uses perceptions of the learning environment and not preferences for feedback protocol as was done by Bower. Thus emulations in goal orientation would occur in alignment with the feedback protocol to which subjects were assigned, commensurate with the conclusions of Linnenbrink (2005). However, the addition of a post-test allowed the current research to confidently attribute a significant portion of the variance to the effects of feedback protocol by controlling other factors of the learning environment (to the greatest extent possible). These aligned or misaligned environments were predicted to demonstrate positive relationships with self-efficacy (and therefore higher approach orientations) in those environments which were aligned with perceptions of the learning environment and negative relationships with self-efficacy (and therefore higher avoidance orientations) in those environments which were misaligned with learning environment perceptions.

In other words, while pre-test indications of goal orientation type will indicate no significant difference between subjects from each of the four cells, differences will emerge on the post-test. Specifically, subjects with a class-task perception of the learning environment and assigned to the self-referenced feedback group will show significantly greater levels of mastery approach goal orientation. Those with a class-ability perception of the learning environment and assigned to the norm-referenced feedback group will show significantly greater levels of performance approach goal orientation. Subjects with a class-task perception of the learning environment assigned to the norm-referenced

feedback group will show significantly higher indications of mastery avoidance goal orientation. Finally, subjects with a class-ability perception of the learning environment and assigned to the self-referenced feedback group will show significantly higher indications of performance avoidance goal orientation compared to their counterparts.

*Question 2*

Consistent with prior research (Elliot et al., 1999; VandeWalle et al., 2001) subjects who adopt a new goal orientation will therefore demonstrate changes in their use of self-regulated strategies. Namely, learners from the norm-referenced feedback group with indications of a class-ability environment goal structure perception will adopt significantly higher levels of performance approach orientations and therefore be more inclined to use worked examples/self-explanations thus showing a significantly higher frequency of self-regulation strategy usage. Conversely, learners assigned to the self-referenced feedback group with indications of a class-task environment goal structure perception whose goal orientations evolve to reflect a mastery approach orientation will thus be significantly less inclined to use worked examples/self-explanations since self-regulated strategies of this nature have been shown to be more appealing to performance oriented learners (Crippen et al., 2008; Crippen, Biesinger, & Orgill, 2007). In summary, subjects from the class-ability perception, norm-referenced feedback cell will demonstrate a significantly higher level of self-regulation than all other subjects. Conversely, subjects from the class-task perception, self-referenced feedback cell will demonstrate a significantly lower level of self-regulation than all other subjects. Subjects from both the class-ability perception, self-referenced feedback cell as well as the class-

task perception, norm-referenced feedback cell will show no significant difference in self-regulation.

*Question 3*

Subjects who are exposed to a feedback protocol which is misaligned with their learning environment perception will demonstrate significantly greater decreases in self-efficacy compared to subjects placed in groups where perceptions and feedback protocol are aligned. In other words, subjects from the class-ability perception, self-referenced feedback cell as well as those from the class-task perception, norm-referenced feedback cell will demonstrate a significant decrease in self-efficacy compared to those from the from both the class-ability perception, norm-referenced feedback cell as well as the class-task perception, self-referenced feedback cell. A significant difference in self-efficacy change levels will not be evident between each pair of cells (aligned or misaligned). Again, while pre-test indications of self-efficacy should indicate no significant difference across all cells, differences will emerge on the post-test.

Changes in achievement will remain consistent with the trends identified by Bower (2005). Namely, learners who are exposed to an environment where perceptions and feedback protocol are aligned will realize no significant differences in achievement compared to their peers. Also commensurate with his findings, subjects from the class-ability, self-referenced feedback group will realize no significant differences in achievement. However, those from the class-task, norm-referenced cell will be the only subjects to realize significantly higher achievement on overall course grades.

## Potential Impact on Learning Theory

The current research shows the value of assigning differing feedback protocols based on personal goal orientation and perceptions of the learning environment, building on the conclusions made by Bower (2005); specifically that using learner preferences alone is not a wise pedagogical method. This research also confirms the contention of Pintrich (2000a) which states that goal orientation is a malleable construct and that feedback makes a significant contribution to change patterns within this variable. Lastly, the current research demonstrates the value of technology to gauge authentic learner behaviors and compare these to more traditional "perceptions" used in typical research conducted within the field of motivation and learning theory.

While the measures and constructs used as well as the methods for collecting, analyzing and interpreting pertinent data for the current research have been well-established, the design allowed the researcher to add to the body of knowledge. Specifically, a tighter control over the experimental conditions compared to the research of Bong (2004)and Linnenbrink (2005) allowed for a stronger allocation of variance explained over time to be attributed to feedback protocol. In addition, this research employed a clever design similar to Bower, but used more universally accepted constructs typically associated with motivational theory as well as traditional indications of achievement. Finally, the current research appropriately utilized technology to gain additional insight (via trace methods borrowed from Winne and others) into authentic learner behaviors as well as subject perceptions obtained through self-reports. Indeed, most of the recommendations of Winne for building software technologies that can effectively engage students (Winne, 2006) are apparent in the system used for the current

research. Specifically, a longer treatment period over multiple lessons and topics allowed learners adequate time to become comfortable with the system. Secondly, an adequate sample size was employed, thus giving the current research the statistical muster that it needed to make definitive and valid conclusions. More importantly, the current research followed the recommendations of all three theoretical perspectives mentioned in chapter one and brings motivation to the forefront of the equation recognizing the learner as an agent acting upon their own volition. Thus, learners who prompt the system for assistance were assumed to be engaged in an explicit self-regulatory activity.

## Limitations of the Current Research

Potential limitations of the current research and the system to be implemented include a sole focus on individualized efforts (i.e., cannot account for cooperative learning activities), concentration on well-defined problem solving (as opposed to the complex learning activities that are the primary use of gStudy) and large grain self-reports that did not allow the researcher to attribute learner responses to a specific lesson or class activity.

Winne's theoretical work would also regard the implementation of a single treatment (in this case, changes to the feedback protocol employed) as a potential weakness as the investigation since interactions that might have been present from multiple treatments occurring simultaneously were not able to be detected. Although the researcher acknowledges that the simultaneous application of multiple treatments is a more authentic representation of contemporary educational research, it is believed (based on prior research within this arena) that the sole manipulation of the feedback protocol

employed was a fruitful endeavor and allowed the current investigation to attribute a large amount of variance to a simple instructional technique. The results of this research therefore inform instructors as to the advantages of assigning different feedback protocols (with a great deal of ease using the current system) to learners based on what has been empirically demonstrated as effective given the dominant individual motivational constructs.

Additionally, the primary communication vehicle for this course was a face-to-face lecture format, making the on-line quizzing component of the course minor in comparison and perhaps minimizing the potential effects of a single webpage where feedback was viewed. Indeed, a myriad of other interactions with the instructor and their peers could have had much more profound effects of the dependent variables of interest in the current study and were beyond the scope of this study.

# CHAPTER 4

## RESULTS

The current project randomly assigned undergraduate chemistry students to one of two feedback conditions; a norm-referenced group or a self-referenced group. Subjects in the norm-referenced group viewed their progress on weekly quiz assessments in comparison to their peers while subjects assigned to the self-referenced group viewed their progress on these same assessments in comparison to their own past performance. It was predicted that those from the norm-referenced group would adopt higher levels of performance goal orientation and that those assigned to the self-referenced group would adopt higher levels of mastery goal orientation. It was also predicted that changes in goal orientation would result in unique usage patterns in self-regulatory behaviors (i.e., the number of worked example/self explanation prompts launched on the quizzing system) with subjects who migrated to a mastery orientation using them less frequently and those who adopted a performance orientation to use them more often. Approach and avoidance orientations would be mediated by self-efficacy with higher indications of self-efficacy resulting in an approach orientation and lower indications of self-efficacy resulting in an avoidance orientation. Perceptions of the learning environment were also probed as a potential mediating variable resulting in an aligned or misaligned 2 X 2 factorial. Subjects were assigned to either a class-task perception group (the instructor is more concerned with students learning the material) or a class-ability perception group (the

instructor is more concerned with students earning favorable grades). Assignment to feedback and learning environment perception groups resulted in an aligned/misaligned condition where those in the self-referenced/class-task and the norm-referenced/class-ability groups were considered to be aligned and subjects from the self-referenced/class-ability and norm-referenced/class-task groups were consider to be misaligned. It was also anticipated that alignment would result in favorable trends in both self-efficacy and achievement but that misalignment would result in maladaptive patterns along these variables.

The research design for the current project utilized one independent variable, feedback protocol (randomly assigned, self-referenced or norm-referenced) and four independent variables: self-efficacy (pre-post using the Self-Efficacy in Chemistry survey (SEC)), goal orientation (pre-post, using the Achievement Goals Questionnaire (AGQ)), self-regulation (determined by the cumulative number of "example" clicks), and achievement (overall semester grade in Chemistry 121). In addition, perceptions of the learning environment were probed as a mediating variable three weeks into each semester using the Patterns of Adaptive Learning Survey (PALS). The SEC and AGQ were administered during the first two weeks (pre-test) and last two weeks of each semester (post-test).

The researcher visited each of the two classes at the beginning of each academic term to review the measures and to ensure informed consent. Data collection was conducted over the fall 2007 and spring 2008 semesters and yielded a sample of 184 subjects who consented to the study and completed all the required surveys. Missing items were replaced with mean values for subjects failing to complete fewer than four

items on the AGQ (12 items total) as well as the PALS (11 items total). Mean values were also entered for subjects with fewer than six incomplete items from the SEC (34 items total). Overall, 37 subjects had one or more missing item but remained under the threshold of 4 and six missing items, respectively. Those with a higher occurrence of missing items were removed from the sample (n=84). A visual inspection of each case indicated no obvious anomalies in subjects' responses. Since subjects were randomly assigned to a feedback group at the onset of each semester, the groups were unequal due to attrition with n=88 in the self-referenced group and n=96 in the norm-referenced group. In addition, since a median split was used to assign subjects to a class-task or class-ability learning environment perception group, 10 subjects attaining a difference score equal to the group median (27.0) on the PALS were removed from all hypotheses involving the mediating variable. Of the remaining 174 subjects assigned to either the class-task or class-ability perception group, 90 were assigned to the class-ability group while 84 were assigned to the class-task group (Table 9).

Data were also screened for normality, homogeneity, reliability, as well as the potential presence of univariate or multivariate outliers. Means, standard deviations, skewness and kurtosis values from each of the dependent measures as well as the PALS (mediating variable) are presented in Table 10. All item totals were well within acceptable normality parameters of +/- 3.0 for skewness and +/- 8.0 for kurtosis (Kline, 1998) with skewness values ranging from -1.96 to 2.47 and kurtosis values ranging from -.72 to 6.92. Box's M tests (multivariate) and Levene's tests (univariate) of homogeneity were not significant, indicating that the error variance from each of the dependent variables was equal across groups (Table 11). When the second grouping was assigned

based on the mediating variable (learning environment perception), the null hypothesis for homogeneity of variance was rejected for several of the dependent variables including the combined (multivariate) goal orientation variable (pre-test), mastery approach (pre-test), performance approach (post-test), performance avoidance (pre-test and post-test), and self-regulation (Table 12). Since this indicates unequal error variances across groups on these dependent measures, interpretation of the hypotheses in regard to the mediating variable will be reported cautiously. This is most likely due to a significantly smaller sample size when subjects were split into a 2 X 2 factorial design due to the introduction of the mediating variable.

Reliability estimates were also calculated using Cronbach's Alpha test for each of the dependent item inventories (Table 13). With the exception of the (overall) PALS instrument ($\alpha$=.63), all other measures were within acceptable parameters ($\alpha$>.70) as per Shultz & Whitney (2005). The lower level of overall reliability on the PALS instrument is most likely due to a smaller sample size when learning environment perception is introduced as a mediating variable. Hence, data analysis and interpretation in regard to the effects of learning environment perceptions are made with additional discretion.

Scores from each of the dependent measures of interest were also converted to z scores to identify potential outliers (four standard deviations above or below the group mean). Three subjects were identified as potential univariate outliers, two from scores on the PALS and another from scores on the mastery approach AGQ subscales (pre and post). In spite of this, the identification of these subject as potential outliers was based on the PALS (which demonstrated questionable overall levels of reliability) and the AGQ (with a small range of possible scores, min=3, max=21). Conventional research currently

recommends that standardized scores in excess of 3.29 standard deviations above or below the mean are considered univariate outliers, however, when working with large data sets, some scores of this magnitude are to be expected (Tabachnick & Fidell, 2007). Therefore, these subjects were included in the analysis.

Finally, Malahanobis distance estimates were calculated for each of the multivariate dependent variables (goal orientation pre and post). Malahanobis distances are used to identify potential multivariate outliers. Multivariate outliers occur as the result of a combination of variables. For example, someone who earns an annual salary of $70,000K might not be considered an outlier, but a six year old child with this salary would indeed be considered an outlier. Tabachnick & Fidell (2007) recommend that Malahanobis values greater than a critical $\chi^2$ for $p<.0001$ should be removed from the sample prior to multivariate analysis. Using this method, three cases exceeded the recommended critical value of 18.467 and were not included in the multivariate analysis.

Prior to analysis, the two feedback groups were also compared on each of the pre-tests to ensure that no significant differences in goal orientation or self-efficacy existed prior to treatment. An independent samples t-test confirmed that the two groups were homogeneous on all five pre-test scores prior to treatment with values ranging from $p=.086$ to $p=.958$ (two-tailed). An additional series of comparisons was also conducted on each of the dependent measures of interest to ensure that no significant differences were found between subjects from each semester (spring and fall). Both groups were statistically equivalent on goal orientation (pre-post), self-efficacy (pre-post), self-regulatory strategy usage, and achievement with all p values ranging between .082 and .855. One difference that was noted was a significant difference between subjects from

the fall and spring semesters was class-task learning environment perception $F_{(2,182)}$=.617, $p$=.002. However, since subjects were grouped on this variable and not on semester, this difference was disregarded.

## Research Question 1: Changes in Goal Orientation

A multivariate repeated measured analysis of variance was conducted on all four subscales of goal orientation. The between-subjects factor was feedback group assignment, with one group exposed to the norm-referenced group and the other exposed to the self-referenced group. The within-subjects factor was time with each of the four subscales measured pre and post instruction. Since the within subjects factor was comprised of only two levels (pre/post) tests of sphericity were not necessary. Means and standard deviations for each of the four goal orientation subscales by group are listed in Table 14. Univariate and multivariate homogeneity of variance tests were upheld with Box's M=37.189, $p$=.496 for multivariate measures and F values ranging from less than .001 to 3.38 (with p values ranging from .068 to 1.00) for univariate measures.

Results from the multivariate repeated measured analysis indicated no significant interaction between feedback group and time, $F_{(4, 176)}$=0.253, $p$=.907, $\eta^2$=0.006 indicating that subject's goal orientation type did not change over time as a result of their feedback protocol. Since the interaction was not significant, inspections of the main effects were completed. Results of the main effects tests revealed no statistically detectable effect for the between subjects factor (feedback group). However, two significant main effects did exist for the within-subjects factor (time). Specifically, significant changes were noted from pre to post test on the mastery approach subscale, $F_{(1, 179)}$=16.13, p<.001, $\eta^2$=.083 as

well as the performance approach subscale, $F_{(1, 179)}$=16.40, p<.001, $\eta^2$=.084, indicating a small effect size in both cases. In other words, subjects demonstrated significant decreases over time on both subscales.

The second part of research question 1 introduced the mediating variable of learning environment perception, adding another between-subject factor. Subjects were assigned to one of four groups creating a 2 x 2 factorial with feedback group (norm or self referenced) by learning environment perception (class-task or class-ability). Results from the second multivariate repeated measures analysis indicated no significant interaction between feedback group, learning environment perception, and time, $F_{(8, 346)}$=0.744, $p$=.653, $\eta^2$=0.017 indicating that subject's goal orientation type did not change over time as a result of their feedback protocol, even with the introduction of the mediating variable. Since the interaction was not significant, additional inspections of the main effects were conducted. Univariate follow up tests were inconclusive, with no significant interaction from the combined between-subjects factors (feedback group x learning environment perception group) and no main effect for either between-subjects factor considered in isolation. Interaction effects for the within-subjects factor (time) by learning environment perception group was also investigated, revealing no statistically detectable changes in goal orientation.

### Research Question 2: Changes in Self-Regulation Strategy Patterns

The cumulative number of times that subjects opened a worked example was tallied at the end of each semester along the feedback group by learning environment perception (2 X 2) matrix (Table 15). The first component of Question 2 required an

independent samples *t*-test to determine if subjects from unique feedback protocols demonstrated notable differences in self-regulatory behaviors, measured by the cumulative total number of "clicks" to open a worked example/self-explanation prompt (views). Results of the t-test indicated no significant difference in the number of worked example/self-explanation views between each of the feedback groups, $t_{(2, 182)}$=0.585, $p$=0.559. The second component of question two was to complete a similar investigation with the introduction of the mediating variable (learning environment perception). Hence, an ANOVA was conducted comparing the number of worked example/self-explanation views between the four groups constructed from a 2 X 2 factorial (feedback group by learning environment perception group). Results of the ANOVA indicated no significant interaction, $F_{(2, 172)}$=0.608, p=0.545, $\eta^2$=.007. Main effects for feedback group and learning environment perception group were also inconclusive, $F_{(2, 172)}$=0.056, p=0.814, $\eta^2$<.001 and $F_{(2, 172)}$=1.350, p=0.262, $\eta^2$=.015, respectively.

### Research Question 3: Changes in Self-Efficacy and Achievement

Question three was designed to investigate changes in self-efficacy (pre-post) and achievement based on feedback protocol and perceptions of the learning environment. Subjects completed a self-efficacy survey pre-post over each semester. Results were analyzed along the feedback group by learning environment perception (2 X 2) matrix (Table 16). To address changes in self-efficacy, a repeated-measures ANOVA was conducted with scores from the SEC (self-efficacy) assigned as the within subjects factor (pre-post) and feedback group and learning environment perception assigned as the between subjects factors (Table 17). Homogeneity of variance assumptions were upheld

with a Box's M value of 15.487 (F=.928, $p$=.532). Tests of the interaction approached statistical significance, $F_{(2, 178)}$=2.372, $p$=0.096, $\eta^2$=.026 with a small effect size, and a Tukey follow up test indicated no significant differences within changes in self-efficacy over time (p values ranged from 0.171 to 0.980) Follow up tests with the main effects were also inconclusive for both feedback group, $F_{(1, 178)}$=2.307, $p$=0.131, $\eta^2$=.013 as well as learning environment perception group, $F_{(2, 178)}$=2.018, $p$=0.136, $\eta^2$=.022. Power estimates for each of the ANOVA tests ranged from .327 to .413. In other words, subjects did not demonstrate significant changes in self-efficacy over time as a result of introducing the mediating variable.

Achievement was compared between subjects along the 2 X 2 learning environment perception vs. feedback group assignment through an investigation of overall course grades (total points) for the semester (Table 18). A one-way ANOVA was conducted to probe potential differences in achievement using the same 2 x 2 factorial (feedback group by learning environment perception group). A statistically meaningful interaction was not found for achievement, $F_{(2,178)}$=2.073, $p$=.129, $\eta^2$=.023. However, follow up tests did reveal a significant main effect for achievement over the learning environment perception group variable, $F_{(2,178)}$=4.071, $p$=.019, $\eta^2$=.044, with a small effect size. Since only two groups exist on this marginal variable a simple inspection of the means served as a follow up test indicating that students who demonstrated a class-task learning environment perception performed significantly better as indicated by final course (semester) grades. A second follow-up test with regard to feedback group was statistically null, $F_{(1,178)}$=0.326, $p$=.569, $\eta^2$=.002.

## Summary

Results from the first analysis indicated no significant changes in goal orientation type or magnitude over time as a result of differing feedback protocol. Change patterns in goal orientation remained statistically undetectable even when the mediating variable of learning environment perception was introduced. Alignment between feedback protocol and learning environment perceptions did not predict changes in goal orientation meaning that using learning environment perception to determine the type of feedback a student receives is not a worthy endeavor. As a whole, students (regardless of feedback group or learning environment perception) did demonstrate significant decreases in both mastery approach and performance approach subscales from pre to post test.

An additional investigation into the self-regulatory behaviors also yielded no significant results. Using the cumulative number of times each subject opened a worked example/self explanation prompt as the dependent variable, subjects from either feedback group did not demonstrate unique self-regulatory behavior patterns. The addition of the mediating variable also did not alter these results, indicating that using learning environment perception as a precursor to assigning students to a norm-reference or self-referenced feedback group will not impact self-regulatory behaviors.

The final set of analyses indicated that subjects did not experience significant changes in self-efficacy over time as a result of being assigned to one of two unique feedback groups. The addition of the mediating variable did not change these results. Therefore, changing the feedback protocol did not impact changes in self-efficacy and doing so based on learning environment perceptions also did not yield any changes in self-efficacy. An additional analysis also indicated that subjects did not perform

differently on overall course grade based on feedback protocol. The addition of the mediating variable also did not impact differences in overall course grade. However, subjects with a class-task perception of their learning environment outperformed those with a class-ability perception.

Since median splits can often fail to provide ample differentiation between groups, the analyses were repeated after breaking subjects into three groups based on difference scores from the PALS (low, medium, and high). Using this method, subjects with a PALS difference score of 23.0 or less were placed into the "low" group (n=63), subjects with a PALS difference score of 30.0 or more were placed into the "high" group (n=61), and all other subjects were placed into the "medium" group and ultimately removed from the sample (n=60). All analyses were run again with subjects from the low group placed into the class-ability learning environment perception group and subjects from the high group placed into the class-task learning environment perception group. Using the new grouping, a significant main effect was found for learning environment perception group when considering changes in mastery avoidance goal orientation magnitude over time. Specifically, subjects from the class-ability learning environment perception group exhibited significantly greater increases in mastery-avoidance over time compared to their peers from the class-task group, $F_{(1, 120)}=4.712$, $p=.032$, $\eta^2=.038$. All other analyses yielded similar results to when the original grouping assignments were used.

# CHAPTER 5

## DISCUSSION

Results from the current investigation confirmed that changes in goal orientation, self-regulation, self-efficacy, and achievement as a result of differing feedback protocol were not statistically detectable, even with the addition of learning environment perception as a potential mediating variable. However, all subjects (regardless of their feedback group assignment) demonstrated significant decreases along both the mastery approach and performance approach subscales. This was an unanticipated outcome.

As predicted, subjects from the self-referenced feedback, class-ability perception group as well as the norm-referenced feedback, class-task perception group did not demonstrate unique patterns in self-regulatory behaviors, however, subjects from the remaining two groups (norm-referenced feedback, class-ability perception group and the self-referenced feedback, class-task perception group) also demonstrated no significant changes in self-regulatory behaviors, contrary to the prediction made.

Similar investigations along the 2 X 2 factorial revealed no significant differences in self-efficacy or achievement. However, when subjects were assigned to three learning environment perception groups (low, medium, and high) rather than two groups (low and high via a median split along the PALS survey), a significant main effect for goal orientation was found. Specifically, subjects from the class ability perception group (high) exhibited significantly greater increases in mastery avoidance.

## Review of Results

The goal of the current research was to investigate if changes occurred over time in goal orientation, worked example usage, self-efficacy or achievement as a function of a randomly assigned feedback protocol in an online learning environment. Subjects were assigned to a norm-referenced feedback group where weekly quiz score results were revealed in comparison to their peers (class average) or a self-referenced feedback group, where weekly quiz results were compared with the learner's individual progress (average of all quizzes to date). Goal orientation and self-efficacy were measured pre-post via the Achievement Goals Questionnaire (Elliot & McGregor, 2001) and the Self-Efficacy Chemistry instrument (a measure created specifically for the quizzing system used), respectively.

Perceptions of the learning environment were also probed using the Patterns of Adaptive Learning Survey (Middleton & Midgley, 1997; Midgley et al., 1995). The 11-item instrument produces two sub-scales; class-task, where a learner believes that the instructor values effort more than ability or class-ability, where the learner believes that the instructor values innate ability more than effort. Scores from the two subscales were subtracted to determine a difference score for each subject and a median split was used to assign subjects to either a class-task or class-ability learning environment perception group.

It was hypothesized that learners would adopt goal orientation patterns most like that of their (randomly) assigned feedback protocol, with subjects from the norm-referenced group increasing their levels of performance orientation and those from the self-referenced group increasing their levels of mastery orientation. It was also

hypothesized that self-efficacy would serve as a proxy to valance, with positive changes in self-efficacy leading to an approach orientation and negative changes in self-efficacy leading to an avoidance orientation. This methodology produced a 2 X 2 factorial. As an extension of this, it should have followed that subjects in the norm-referenced, class-task group would adopt a performance approach goal orientation, and that subjects from the norm-referenced, class-ability group would adopt a performance avoidance goal orientation. Furthermore, subjects from the self-referenced, class-task group were predicted to adopt a mastery approach goal orientation while those from the self-referenced, class-ability group were hypothesized to adopt a mastery avoidance goal orientation.

It was also predicted that the number of times each subject opened (clicked) a worked example/self-explanation prompt would depend on their feedback group as well as perceptions of the learning environment. Specifically, it was posited that subjects from the norm-referenced feedback, class-ability perception group would use worked examples more often and subjects from the self-referenced feedback, class-task group would use them less often. In addition, it was predicted that subjects from the remaining two groups of the 2 X 2 factorial would demonstrate no significant differences in worked example usage patterns.

Finally, a prediction for research question three proposed significant differences in self-efficacy changes over time for those who were placed in a misaligned feedback/perception group compared to those placed in an aligned feedback/perception group along another 2 X 2 factorial. Misaligned groups were those assigned to the self-referenced feedback group with a class-ability perception of the learning environment

(i.e., the teacher favors ability rather than effort) or those assigned to the norm-referenced feedback group with a class-task perception or the learning environment (i.e., the instructor favors effort rather than ability). Aligned groups are the converse of these; those assigned to the self-referenced feedback group with a class-task perception of the learning environment or those assigned to the norm-referenced feedback group with a class-ability perception of the learning environment.

While the current research project lacked the empirical evidence needed to accept any of the hypotheses posited, the intervention and its method of delivery represents a unique approach within this line of research by using a weekly quiz to entice students to see the value that worked examples and self-explanation prompts can provide. Furthermore, other projects of this nature are sparse in current scholarly literature; namely, the use of differing feedback protocol while tracking learner behaviors and goal orientation over time. The current project makes a valuable contribution to instructors working in an online environment in that assigning students to different feedback groups either randomly or based on their perceptions of the learning environment is not a worthwhile endeavor.

*Changes in Goal Orientation*

Personal goal orientation was measured pre-post instruction using the AGQ to determine if exposure to unique feedback protocols would create change within this variable. Consistent with prior research within this domain, the construct was assumed to be trait-like but one that is malleable over time and context (Pintrich, 2000a). It was hypothesized that changes in goal orientation would occur as a circumstance of exposure to one of two unique feedback protocols.

Subjects did not demonstrate changes in goal orientation type or magnitude from any of the four main subscales as a function of their assigned feedback protocol over the course of the semester. However, looking at the group holistically, significant decreases were noted over time for both mastery approach and performance approach goal orientations. This could be simply due to the timing of the post-test. Indeed, near the end of an academic semester, students may feel that additional learning or achieving good grades is a moot point as most of the learning activities as well as the quizzes and assignments for their overall grades have come and gone.

In general, these mean-level group changes in goal orientation over the course of the semester are consistent with recent research conducted within similar contexts. Specifically, Fryer and Elliot (2007) found through a series of three experiments that subjects did demonstrate significant group mean-level decreases in mastery approach and no statistically detectable changes in mastery avoidance orientation magnitude. However, performance approach goal orientation endorsements did not change significantly and performance avoidance increased significantly over time. The researchers also conducted person-level analyses to confirm these findings and found that a majority of subjects were likely to decrease their mastery approach orientations and increase their performance avoid orientations. These additional analyses also confirmed that an equal number of subjects were likely to increase or decrease their levels of mastery avoidance or performance approach orientations.

However, as Fryer and Elliot (2007) acknowledge, this study was aimed to provide a "comprehensive portrait of achievement goal stability and change" (p.712), leaving more questions than answers in regard to when and under what circumstances

learners will adopt differing goal orientations. The authors site self-regulation as a theoretically sound construct which should lead to changes in goal orientation depending upon the context and treatment under investigation.

One such study did make such an investigation (Senko & Harackiewicz, 2005) administering performance feedback and tracking changes in goal orientation in an undergraduate setting. Their findings were almost identical to the current study with subjects demonstrating significant decreases in mastery approach as well as performance approach goal orientations as a result of poor performance (and subsequently receiving negative feedback). One difference was that subjects also demonstrated significant increases in performance avoidance goal orientation whereas the current study observed no such changes along this variable. It should be noted that all subjects from the study conducted by Senko & Harackiewicz (2005) received a similar feedback protocol, whereas the current study randomly assigned subjects to unique feedback environments. Also, the current study investigated changes in performance based on these unique feedback assignments. The work of Senko & Harackiewicz (2005) examined the converse of this, looking at performance (and subsequent feedback) as a predictor to changes in goal orientation.

It was hypothesized that subjects would adopt a goal orientation most like their assigned feedback protocol with those in the norm-referenced group demonstrating higher indications of performance goal orientations and those assigned to the self-referenced group increasing their propensity to adopt a mastery goal orientation. This was not the case in the current study. Furthermore, it was predicted that the approach (positive) versus avoid (negative) dimension would parallel changes in self efficacy. In

other words, gains in self-efficacy would result in gains made on the mastery approach or the performance approach orientation, depending on the feedback group assigned. Results indicated just the opposite. While all students showed increases in self-efficacy over time, significant decreases were noted in both approach goal orientations. Again, surveys completed at the end of the semester may represent a time when students feel more confident about what they know (self-efficacy), but are less motivated to master additional content and may "check out" mentally.

The addition of learning environment perception was a new endeavor within this line of research and one that proved to be inconclusive. A lack of homogeneity between subjects and low indications of reliability make it difficult to determine if this was a worthwhile addition to the study. It did not add to the current discussion as a mediating variable and even if it did, results would have been overshadowed by the weaknesses noted in the instrument. A similar replication of this study using the same instrument is needed to confidently determine its predictive value or lack thereof. Most disconcerting about the results from this survey was the negatively skewed results of learning environment perception (Figure 5), with most subjects more inclined to adopt a class-task orientation (i.e., closer to the max value, 37) as opposed to a class-ability orientation (i.e., closer to the min value, -29). What was originally anticipated to have a range of scores between -29 and 37 (a range of 66), instead resulted in 93.5% of the scores residing between 12 and 36 (a range of only 24). The homogeneity of variance observed along this variable made it difficult to make a meaningful differentiation between subjects assigned to the class-task or class-ability groups and did not allow the current project to identify

other subsequent differences between groups along goal orientation, self-efficacy, self-regulation, and achievement.

A secondary analysis to investigate the relationship between self-efficacy and perceptions of the learning environment did indicate that these two variables were related as hypothesized when changes in goal orientation were removed from the analysis. Specifically, class-task sub-scores were positively related to both the self-efficacy pre test ($r=.207$, $p<.01$) as well as the post test ($r=.229$, $p<.01$) whereas class-ability sub-scores were not related to the self-efficacy pre-test ($r=-.011$, $p>.05$) but were negatively related to the self-efficacy post-test ($r=-.187$, $p<.05$). As hypothesized, subjects from each learning environment perception group showed indications of self-efficacy which were aligned to the predictions. Specifically, subjects prone to possess a class-task perception of the learning environment also demonstrated higher levels of self-efficacy throughout the course of the semester. In addition, subjects with higher indications of a class-ability learning environment perception showed lower indications of self-efficacy over the same timeline. However, changes in the type or magnitude of goal orientation did not follow the predicted change patterns as a result.

It should also be noted that learners may be quite anchored to their own personal goal orientations (Dweck & Leggett, 1988) as was the case in this study. Indeed, since the current study took place within one content area (chemistry) changes in goal orientation over time were less likely to occur. Furthermore, a subtle manipulation in the display of their course progress may not, in and of itself, constitute a powerful enough treatment to trigger any lasting changes in motivational constructs such as those under investigation. Indeed, these subjects have been in some type of formal learning environment for at least

12 years, and shifts within personal epistemology are difficult to sustain (Dweck & Leggett, 1988). The results obtained in the current study support the argument for goal orientation as a more stable and trait-like construct, particularly when considered in a narrow subject context. The only potential exception to this might be changes in goal orientation which took place over the course of the semester which a pre and post test would have been unable to capture. In other words, subjects may have demonstrated changes in goal orientation each week or month dependent upon the topics covered in the course or the activities in which they were involved. While obtaining goal orientation measurements from subjects on a weekly or even monthly basis might be an inefficient use of resources and a tedious request to make of subjects, it would have allowed the current research to obtain information about potential change patterns within this construct. Furthermore, a fine grained investigation into these changes as a result of course content and activities would have been possible.

*Differences in Self-Regulation*

A four pronged set of hypotheses for question two was partially supported. As predicted, subjects from the class-ability perception, self-referenced feedback group did not demonstrate different frequencies in the number of worked examples launched throughout the semester (cumulative number of clicks). A similar prediction was also true for those from the class-task, norm-referenced feedback group, with no significant difference observed. However, it was anticipated that subjects from the remaining two groups would use the worked examples much differently, with subjects from the class-ability perception, norm-referenced feedback group using them more frequently and those from the class-task, self-referenced feedback group using them less frequently. The

latter two predictions were not supported as subjects from all four groups were statistically equivalent in their use of worked examples/self-explanations. Once again, unique patterns from the dependent variable of interest did not emerge over the 2 X 2 factorial as a function of the mediating variable.

Although statistical significance at the $p<.05$ level was not obtained, subjects from the class-ability, norm-referenced group did demonstrate the highest average number of worked example/self explanation prompt launches throughout the semester (98.96). However, with a standard deviation of 84.37 (compared to 53.46, 52.25, and 63.92 from the other three groups) subjects from this group also demonstrated a great deal of heterogeneity on this variable. This interesting (and indeed unanticipated) finding brings about another interesting question, what additional phenomena are occurring within subjects from this group which could create such diversity within their propensity to use worked examples? Additional open-ended and other qualitative research methods could provide more information about this anomaly in the data. Replication of the current research could also serve to establish the validity of this group's seemingly odd heterogeneity patterns in regard to their self-regulation behaviors.

Keeping conclusions cautious and remaining conscious of a lack of statistical significance, subjects from the class-task, self-referenced group did not demonstrate lower levels of self-regulation as was anticipated. Actually, it was subjects from the class-task, norm referenced group who demonstrated the lowest likelihood to use them, with an average occurrence of 72.96, much lower than the remaining three groups (89.72, 93.84, and 98.96). This finding was contrary to the predictions made; specifically that subjects from this group would demonstrate similar patterns of self-regulatory behaviors

compared to those from the class-ability, self-referenced group. Although statistical significance was not obtained, the mean for this group was considerably lower than the remaining three and is worthy of further investigation.

Overall, subjects from the norm-referenced feedback group demonstrated a much more diverse pattern in their choices to use worked examples as a function of their perceptions of the learning environment. In fact, self-regulation strategy usage seemed to vary more as a result of learning environment perception than from their assigned feedback group. Most likely, one of two major conclusions can be drawn from this. First, it may be that the relationship between feedback and self-regulation is not as pronounced as was anticipated. Or second, differences in feedback revealed to the learner through a progress chart were too subtle to be noticed. Nonetheless, seemingly unique patterns in self-regulation were more likely to occur within those assigned to the norm-referenced feedback group. These differences were much more pronounced than differences in self-regulation by perception from those assigned to the self-referenced feedback group.

*Differences in Self-Efficacy and Achievement*

It was predicted that subjects would differ significantly in self-efficacy over time as a function of alignment (or lack thereof) between their perceptions of the learning environment and the feedback group to which they were assigned. Specifically, it was hypothesized that subjects from the class-task, norm-referenced group as well as those from the class-ability, self-referenced group would demonstrated significantly lower levels of change in self-efficacy over the course of the semester compared to those from the class-task, self-referenced and class-ability, norm-referenced groups. The null

hypothesis was accepted for the comparison of feedback groups combined with the mediating variable, learning environment perception.

Investigations into differences on achievement (course grade) were also non-conclusive. Subjects did not differ on course grade as a result of being exposed to differing feedback protocols. Again, introducing learning environment perception as a potential mediating variable did not alter these results. However, differences in achievement were observed along the main effect of learning environment perception. Specifically, those who indicated a class-task perception of the learning environment achieved significantly higher grades, but this had nothing to do with their assigned feedback protocol.

## Impact on Learning Theory

While the overall results may seem inconclusive, there are several lessons that can be learned from this and implications that could guide both instructors working in a technology rich environment as well as researchers interested in this line of work. For instructors, randomly assigning students to a feedback group is clearly not a worthwhile endeavor. In addition, using learning environment perception as a predictor for success in a norm-referenced or self-referenced feedback group will most likely not pay academic dividends. It might be that a "combined" condition is well warranted, where students could view their progress in comparison to both their own past performance as well as that of their peers, especially if goal orientation is malleable over time and/or context. Offering choice may be a better venture, allowing learners to self select a feedback protocol at the onset of the semester or letting them "toggle" between feedback protocols as they so choose. Thus, as learners decide (through self-regulation) to adopt a different

goal orientation for reasons such as context, task, instructor, or otherwise, another option for receiving feedback would exist to support the newly adopted goal preference.

While statistical significance was not obtained, propensity to use worked examples was much more diverse across subjects from the class-task learning perception group with those from the self-referenced group demonstrating a higher average number of worked example "hits" ($M_{NORM}$=72.96 vs. $M_{SELF}$=89.72). Therefore, if encouraging learners to use worked examples is a goal of instruction, assigning those with a class-task perception of their learning environment to a self-referenced feedback situation might be worthy of further investigation. Conversely, subjects with a class-ability learning environment perception demonstrated homogeneity across the self-regulation construct ($M_{NORM}$=98.96 vs. $M_{SELF}$=93.84). This may mean that assignment of subjects with higher levels of the class-ability construct to a particular feedback group as a function of their learning environment perception would most likely not have resulted in self-regulation differences. Therefore, a "one-size fits all" method whereby all subjects with this perception are arbitrarily assigned to one feedback group or offered choice in feedback protocol would most likely not produce any changes in self-regulation. Thus, an argument might be made that obtaining indications of the learning environment perception *a priori* and then making feedback group assignments based on this variable (rather than randomly) could better encourage learners to develop self-regulation habits.

Two additional multiple choice items asking subjects to indicate their assigned feedback group and how often they used the graphs could provide an additional filter to eliminate subjects who were either unaware of their feedback protocol or chose not to use it. This could also be accomplished by creating a separate link to the feedback graphs,

allowing a count to generate usage statistics. Presuming that feedback and goal orientation are in fact related in some way, doing so could also inadvertently eliminate subgroups of subjects with certain goal orientation characteristics but this could still offer a valuable additional data point.

For researchers, the current project has opened the door to several new directions within the context of worked example usage in a technology rich learning environment. First of all, a data collection vehicle is needed to capture usage records. Since the progress charts resided on each student's "home" page for the quizzing system, they were "forced" to launch this page upon each visit to the site. Based on this, it is not possible to isolate the number of times a subject intentionally viewed their progress chart as opposed to merely passing through to get to a quiz or another domain within the site. In addition, the toggle condition would allow a researcher to track usage of both conditions and make inferences about the effectiveness of each one.

Second, a set of open ended items might provide additional information as to how subjects used the feedback and worked examples. It is apparent that they provide valuable information and can offer additional insight not attainable through traditional quantitative research methods.

## Limitations

Both statistical as well as theoretical factors contributed to the limitations from the current study. Results of the PALS survey included an overall low reliability measure. Therefore, even if significant differences were found in any of the outcome variables of interest as a result of the additional group division along this measure, interpretation of the results would have been cautious at best. Furthermore, a difference score was calculated across the two subscales (class-task and class-ability) to assign a single numeric value to each subject across both dimensions. Although this method in and of itself has been previously established as a recognized statistical procedure with current scholarly literature, a record of this method being used with the PALS has not been published to date. Indeed, this new method of analysis for this measure may not be prudent. In addition, the use of a median split along this single numeric value was used to assign subjects to a class-task or class-ability perception group. Again, although this method is well established within the field, it too has its own inherent weaknesses. Specifically (as was the case in the current study), subjects who fair close to the median were essentially equivalent on this variable. However, because of a somewhat arbitrary median split, these subjects are artificially assigned to different groups. A popular method to overcome this is to assign subjects to three groups, one low, one medium, and one high. Subjects from the middle group are discarded and those which remain in the low and high groups are compared for purposes of analysis. While this method can provide greater heterogeneity between subjects along the grouping variable, this is typically an inefficient use of sample size and brings with it other issues. Indeed, a secondary

exploratory analysis from the current study using this method did not heed any major differences in the results.

Although reliability and validity of the AGQ has been established through prior research and was done so again in the current research, placing subjects' perceptions and goal orientation on a scale of one to seven does not provide much variance, making it difficult to attain statistical significance. The number of times a worked example was launched also has some potential weaknesses in that it is impossible to know exactly what the intent of the learner is. Since each worked example is combined with a self-explanation prompt, it cannot be deduced in the current study if each subject was impartial to one or the other. In fact, just because a worked example/self-explanation prompt is opened does not mean that it was read. In addition, repeatedly launching the same example yields the same number for this variable as someone who opens a unique worked example each time they decide to use one creating additional issues in accepting a common definition of what a "click" represents.

As mentioned above, since the progress charts with a unique feedback protocol were on each subject's "home page" for the quizzing system, it cannot be assumed that they were reading them each time the page was opened. It was necessary to open this page in order to access any of the quizzes, creating a lot of traffic to this site, much of which could have been merely a pass through to get to another component within the quiz system. It may have also been the case that subjects used the worked examples more frequently at certain times of the academic term or depending upon the content of the quiz. Although this information could be easily obtained from server logs and the course syllabi, it was well beyond the scope of this study. In addition, the difference between the

two feedback protocols was so discrete it is the researcher's belief that many of the subjects were not aware of which group they were assigned to. Without an explicit question to ask this, it cannot be assumed that subjects were aware of each treatment condition.

## Directions for Future Research

The current research has established three main conclusions that should guide additional lines of research within the realm of motivational and self-regulatory constructs examined within an on-line learning environment. First, validating the treatment condition directly with the subjects should become common practice and alas, was an unanticipated consequence of working in a web-based learning environment. Even assuming that each subject's identity was authentic, it cannot be stated with confidence that the subtle difference in feedback protocol (i.e., style of each quiz progress graph) was noticed (and indeed had any impact). This could be easily assured by adding a multiple choice item to the survey currently administered with the quizzing system at the end of each academic term. Those who incorrectly identify the feedback group to which they were assigned could be filtered out of any data analysis with ease. Furthermore, additional qualitative items currently in place on the survey could be analyzed for these subjects and perhaps inform the treatment method. In other words, it might be realized from these responses that otherwise seemingly insignificant manipulations to the display graphs may produce noticeable differences in the outcomes of interest. In addition, if the number of subjects who incorrectly identify their feedback group is large, this could guide the authors of the quiz system to make structural changes to the progress graphs.

Second, offering only two types of feedback may have been short-sighted and additional conditions such as combined, control, and choice may give researchers more definitive patterns in self-regulation, motivation, or achievement. A combined condition would display the norm-referenced and self-referenced graphs simultaneously. A control condition would simply list a learner's scores from each quiz. Choice could be several conditions. For example, a user might have the ability to toggle back and forth between a norm-referenced, self-referenced, combined, or control condition to view their results at their own discretion. With similar surveys and an investigation of usage logs obtained from the web server to identify patterns and frequencies from each condition this would in and of itself be a fruitful line of research.

Finally, a better indication of time and context would be a welcome addition to the current line of research. The current research investigated changes in motivational constructs as a result of their feedback protocol. However, it is already known that changes in these variables can vary based on time and context (Pintrich, 2000a). An additional layer could be provided by examining changes in self-regulation (number of clicks) over the course of the semester. In other words, are their "peak" times throughout the semester when learners are more likely to use worked examples? If so, what types of course content are being studied at these times? It would be interesting to see if the content around times of high or low worked example usage represents topics in Chemistry where students feel confident or overwhelmed. This would allow researchers to pinpoint another component of what might motivate learners to use worked examples. In other words, do they use them as a rescue strategy when they become overwhelmed by the content of the quizzes or more as a reinforcement to reaffirm what they already

know? Differences in these behaviors might be based on other factors such as baseline indications of goal orientation or self-efficacy. In addition, although perhaps not the most efficient use of resources, other studies within this context such as that conducted by Senko & Harackiewicz (2005) measured goal orientation three times over the course of a semester as opposed to two times as was the case in the current study. Indeed, changes in goal orientation occurred at the beginning of the semester when treatment effects (such as feedback) were novel and tapered off as similar course activities became repetitive and expected.

## Conclusion

The current investigation attempted to isolate feedback from weekly quizzes administered via the Web to undergraduate chemistry students to determine if these changes would manifest change in goal orientation, self-efficacy, self-regulatory strategy usage, or performance. The results obtained did not support predictions that learners would adopt a goal orientation preference aligned to their feedback group. However, marginal means did indicate that learners decreased their mastery approach and performance approach goal orientations. This is consistent with prior research (Fryer & Elliot, 2007), especially when considered with feedback as a treatment (Senko & Harackiewicz, 2005).

Differences in self-regulatory behavior patterns also did not emerge as expected, with no statistically significant differences in the number of cumulative "clicks" by each learner to launch a worked example/self-explanation prompt. While those from the class-ability, norm-referenced group and the class-task, self-referenced group were predicted to

demonstrate higher and lower usage frequencies, both groups exhibited similar patterns. Allowing for the lack of statistical significance, an interesting and unanticipated pattern was identified as subject from the class-task, norm-referenced group used worked examples far less than the remaining three groups. As predicted, subjects from the class-ability, self-referenced group did not show differences along this variable.

Investigations into achievement and self-efficacy were also inconclusive. Subjects' grades from the course did not differ as a result of their feedback group assignment. Although no statistically detectable difference was evident, subjects from the class-task, norm-referenced group demonstrated greater increases in self efficacy ($M_{\text{norm-referenced/class-task}}$=55.69) compared to their counterparts from the remaining three groups ($M_{\text{self-referenced/class-ability}}$=46.89, $M_{\text{self-referenced/class-task}}$=43.76, $M_{\text{norm-referenced/class-ability}}$=39.98). This was contrary to the predictions made and indeed an intriguing result. While this was labeled a "misaligned" condition, the results of this research indicate that the effects of learning environment perceptions serve as a better predictor for achievement so it follows that this construct would impact changes in self-efficacy more so than feedback.

While more recent research has advocated for goal orientation as both a stable as well as a volatile construct (Fryer & Elliot, 2007), it is unclear as to the exact timing, treatment, and conditions that will create said changes in goal orientation. In addition, the current study investigated changes in performance as a function of feedback based on the premise that changes in feedback were based solely on random assignment to one of two unique conditions. However, as Senko & Harackiewicz (2005) demonstrated, learners will exhibit different perceptions of feedback based on their performance. In other words, within each feedback protocol exists another potential confounding variable;

performance. Regardless of their assigned feedback protocol, subjects most likely will change their goal orientation, self-efficacy, and self-regulation as a result of their current progress within the course. The addition of performance as a potential mediating variable is worthy of further investigation along this line of research.

Also, since it remains unclear as to the timing of when these changes might occur, the employment of multiple measurements of goal orientation over the course of the semester or a more accurate identification of events that may spark shifts within this variable is warranted. Since subjects from the current study participated on a voluntary basis and did not receive any compensation (monetary, academic, or otherwise), there are limitations as to the parameters of their willingness to complete all of the required tasks associated with the current project. Therefore, a better prediction as to the events that might be associated with potential shifts in goal orientation or self-efficacy would be a welcome addition to the current research as a more efficient and targeted administration of multiple goal orientation measures.

The current project has successfully closed several previously existing theoretical gaps from scholarly literature in regard to self-regulatory behavior patterns and motivational constructs within the realm of an online learning environment. First, learners remained anchored to their existing goal orientation and are not easily influenced to change these previously established patterns over the course of a typical semester. Second, feedback protocol might be best left to the learner through choice in how they are informed of their academic progress. What is now known is that perceptions of the learning environment and random manipulation of a learner's feedback protocol need not

be continued, opening the door for future research within this arena to further examine other patterns that have surfaced.

# APPENDIX A

# TABLES

Table 1. Phases and areas for self-regulated learning (Pintrich, 2004).

| Phases and relevant scales | Areas for Regulation | | | |
|---|---|---|---|---|
| | Cognition | Motivation/Affect | Behavior | Context |
| *Phase 1* Forethought, planning and activation | Target goal setting<br>Prior content knowledge activation<br>Metacognitive knowledge activation | Goal orientation adoption<br>Efficacy judgments<br>Perceptions of task difficulty<br>Task value activation<br>Interest activation | Time and effort planning<br>Planning for self-observations of behavior | Perceptions of the task<br>Perceptions of context |
| *Phase 2* Monitoring | Metacognitive awareness and monitoring of cognition | Awareness and monitoring of motivation and affect | Awareness and monitoring of effort, time use, need for help<br>Self-observation of behavior | Monitoring changing task and context conditions |
| *Phase 3* Control | Selection and adaptation of cognitive strategies for learning, thinking | Selection and adaptation of strategies for managing, motivation and affect | Increase/decrease effort | Change or renegotiate task |
| *Phase 4* Reaction and reflection | Cognitive judgments | Affective reactions | Choice behavior | Evaluation of task |

Table 2. Goal orientation definitions (Elliot & McGregor, 2001).

| Valence | Definition | |
|---|---|---|
| | Absolute/intrapersonal (mastery) | Normative (performance) |
| Positive (approaching success) | Mastery approach goal | Performance approach goal |
| Negative (avoiding failure) | Mastery avoidance goal | Performance avoidance goal |

Table 3. Design for tests of learning environment perception and feedback protocol alignment.

| Classroom Goal Perception | Assigned Feedback Protocol | |
|---|---|---|
| | Self-referenced | Norm-referenced |
| Class-task | Aligned | Not Aligned |
| Class-ability | Not Aligned | Aligned |

Table 4. Research methodology measures and timeline

| Measure | Construct | Administration | Timeline | |
|---|---|---|---|---|
| | | | Pre | Post |
| Achievement Goals Questionnaire (AGQ) (Elliot & Church, 1997) | Goal Orientation | Likert Survey (on-line) | September 2007<br>February 2008 | December 2007<br>April 2008 |
| Self-Efficacy Chemistry (SEC) (Crippen & Earl, 2004) | Self-Efficacy | Likert Survey (on-line) | September 2007<br>February 2008 | December 2007<br>April 2008 |
| Cumulative Tally of "Example" Clicks | Worked Example Usage | Collected on quizzing system (on-line) | Continuous | |
| Final Course Grade | Achievement | Assigned by instructor | N/A | December 2007<br>May 2008 |
| Patterns of Adaptive Learning Survey (Midgley et al., 1995) | Classroom Environment Perceptions | Likert Survey (on-line) | September 2007<br>February 2008 | N/A |

Table 5. Research table.

| Question | Intervention | Measure(s)/Construct | Analysis |
|---|---|---|---|
| Are changes in goal orientation over time mediated by differences in feedback protocol?<br><br>If so, do these change patterns differ based on perceptions of the learning environment and their alignment to the feedback protocol used? | Randomly assigned to a norm or self-referenced feedback group | AGQ (pre/post)/Goal Orientation<br><br>PALS (median split, blocking variable) / Learning Environment Perceptions | Repeated measures multivariate analysis investigates changes in the type of goal orientation |
| Do learners adopt different self-regulation strategy usage patterns when they are exposed to differing feedback protocols?<br><br>If so, are these unique patterns dependent upon perceptions of the learning environment? | Randomly assigned to a norm or self-referenced feedback group | Cumulative number of worked example/self-explanation prompt uses<br><br>PALS (median split) / Learning Environment Perceptions | Factorial ANOVA over the 2 (perception) X 2 (feedback) matrix<br><br>Follow up t-tests |
| Do distinctions in feedback protocol, perceptions of the learning environment and their alignment with one another interact to produce notable differences in self-efficacy and achievement? | Randomly assigned to a norm or self-referenced feedback group | SEC (pre/post)/self-efficacy<br><br>Final course grades/ achievement<br><br>PALS (median split) / Learning Environment Perceptions | Factorial ANOVA over the 2 (perception) X 2 (feedback) matrix<br><br>Follow up t-tests |

Table 6. Items from the AGQ to gauge goal orientation (Elliot & McGregor, 2001).

| Mastery Approach (3 items) |
|---|
| I want to learn as much as possible from this class. |
| It is important for me to understand the content of this course as thoroughly as possible. |
| I desire to completely master the material presented in this course. |
| **Mastery Avoid (3 items)** |
| I worry that I may not learn all that I possibly could in this class. |
| Sometimes I'm afraid that I may not understand the content of this class as thoroughly as I'd like. |
| I am often concerned that I may not learn all that there is to learn in this class. |
| **Performance Approach (3 items)** |
| It is important for me to do better than other students. |
| It is important for me to do well compared to others in this class. |
| My goal in this class is to get a better grade than most of the other students. |
| **Performance Avoid (3 items)** |
| I just want to avoid doing poorly in this class. |
| My goal in this class is to avoid performing poorly. |
| My fear of performing poorly in this class is often what motivates me. |

Table 7. Items adopted from the PALS to gauge learning environment perceptions (Midgley et al., 1995).

| Class Task Goal Structure (6 items) | Class Ability Goal Structure (5 items) |
|---|---|
| In this class, the instructor believes that all students can learn. | In this class, the instructor treats students who get good grades better than other students. |
| In this class, understanding the work is more important than getting the right answers. | In this class, only a few students get praised for their work. |
| In this class, mistakes are okay as long as we are learning. | In this class, the instructor only cares about the smart students. |
| In this class, the instructor thinks how much you learn is more important than test scores or grades. | The instructor has given up on some of the students. |
| The instructor for this class wants students to really understand their work, not just memorize it. | In this class, special privileges are given to students who get the highest grades. |
| Trying hard counts for a lot in this class. | |

Table 8. Self-efficacy chemistry items (Crippen & Earl, 2004).

1. Balancing a chemical equation.
2. Determining protons, neutrons and electrons from the symbol of an isotope.
3. Performing empirical formula calculations from percent composition data.
4. Interpreting a balanced chemical equation using simple stoichiometry.
5. Converting between number of molecules, the mass of a sample and the number of moles of a sample.
6. Writing the name of a chemical compound from its formula.
7. Writing a chemical formula from its chemical name.
8. Calculating the amount of heat required to raise a substance's temperature a required number of degrees.
9. Determining the oxidation number of an element in a compound.
10. Identifying when the mixing of two known solutions will result in the formation of a precipitate.
11. Identifying the oxidizing and reducing agents in a known re-dox reaction.
12. Predicting the insoluble product and spectator ions of a precipitation reaction.
13. Calculating the concentration of a solution from titration data.
14. Determining molecular geometry from a given Lewis structure.
15. Determining molecular geometry from a chemical formula.
16. Drawing a Lewis structure for a molecule from a chemical formula.
17. Arranging a set of elements in order based upon the size of their atomic radius.
18. Arranging a set of elements in order based upon the amount of energy required to remove their first electron (first ionization energy).
19. Writing and interpreting electron configurations for atoms and ions.
20. Applying the combined gas law to solve for an unknown pressure, volume, or temperature of a known gas sample.
21. Applying the ideal gas law to solve for an unknown pressure, volume, temperature, or amount of a known gas sample.
22. Applying Dalton's law of partial pressures to solve for an unknown pressure, volume, or amount of a known gas sample collected over water.
23. Calculating the average mass of an element from isotopic masses.
24. Calculating the wavelength of electromagnetic radiation from its frequency (or vice versa).
25. Determining the polarity of a compound from its Lewis Structure (or formula).
26. Determining molecular formulas from percent composition data (and molecular masses).
27. Determining the limiting reactant in a reaction.
28. Determine the percent yield of a reaction.
29. Calculating specific heat.
30. Determining the types of intermolecular forces that exist in a pure substance.
31. Calculating the amount of heat needed to melt or boil a substance.
32. Calculate the amount of energy released by a given reaction.
33. Using the ideal gas law to calculate molar mass of a gas or the density of a gas.
34. Calculating the molarity of a diluted solution.

Table 9. Subject group assignments

| | | Feedback group | | Total |
|---|---|---|---|---|
| | | Self-referenced | Norm-referenced | |
| Learning environment perception | Class-ability | 43 | 47 | 90 |
| | Class-task | 39 | 45 | 84 |
| | Not assigned | 6 | 4 | 10 |
| Total | | 88 | 96 | 184 |

Table 10. Descriptive statistics for dependent measures (N=184).

| | Min. | Max. | Mean | Std. Deviation | Skewness Statistic | Kurtosis Statistic |
|---|---|---|---|---|---|---|
| Self-efficacy item total – Pre-test | 34.00 | 204.00 | 120.30 | 33.89 | -.396 | -.399 |
| Self-efficacy item total – Post-test | 64.00 | 204.00 | 165.64 | 27.07 | -1.201 | 2.036 |
| Mastery approach item total – Pre-test | 4.00 | 21.00 | 18.88 | 2.77 | -1.963 | 5.270 |
| Mastery approach item total – Post-test | 3.00 | 21.00 | 18.11 | 3.33 | -1.478 | 2.515 |
| Performance approach item total – Pre-test | 3.00 | 21.00 | 15.37 | 4.92 | -.622 | -.578 |
| Performance approach item total – Post-test | 3.00 | 21.00 | 14.14 | 5.19 | -.495 | -.597 |
| Mastery avoid item total – Pre-test | 3.00 | 21.00 | 12.25 | 4.84 | .012 | -.723 |
| Mastery avoidance item total – Post-test | 3.00 | 21.00 | 12.71 | 4.72 | -.199 | -.639 |
| Performance avoid item – Pre-test | 3.00 | 21.00 | 16.20 | 4.10 | -.924 | .712 |
| Performance avoidance item total – Post-test | 3.00 | 21.00 | 15.75 | 4.25 | -.717 | .086 |
| PALS item total – Class-task | 12.00 | 42.00 | 33.89 | 5.52 | -.790 | .971 |
| PALS item total – Class-ability | 5.00 | 35.00 | 8.57 | 5.44 | 2.468 | 6.920 |
| Self-regulation (cumulative number of clicks) | 0 | 324 | 89.68 | 65.68 | .991 | .751 |
| Overall course grade | 319.25 | 736.70 | 602.61 | 80.69 | -.652 | .153 |

Table 11. Homogeneity tests for dependent variables with subjects assigned by feedback group.

| Multivariate | | | |
|---|---|---|---|
| Variable | Box's M | F | p |
| Goal Orientation (pre-test) | 9.70 | .95 | .488 |
| Goal Orientation (post-test) | 5.92 | .58 | .834 |

| Univariate | | |
|---|---|---|
| Variable | Levene's Test (F value) | p |
| Mastery Approach (pre-test) | .003 | .959 |
| Mastery Approach (post-test) | 1.172 | .281 |
| Mastery Avoid (pre-test) | .444 | .506 |
| Mastery Avoid (post -test) | .017 | .896 |
| Performance Approach (pre-test) | .183 | .669 |
| Performance Approach (post -test) | 2.213 | .139 |
| Performance Avoid (pre-test) | .524 | .470 |
| Performance Avoid (post -test) | .010 | .920 |
| SEC (pre-test) | 2.231 | .137 |
| SEC (post-test) | .068 | .795 |
| Self-Regulation | 3.632 | .058 |
| Course Grade (total points) | .048 | .826 |

Table 12. Homogeneity tests for dependent variables with subjects assigned by feedback group and learning environment perception group.

| Multivariate | | | |
|---|---|---|---|
| Variable | Box's M | F | p |
| Goal Orientation (pre-test) | 62.86 | 2.00 | .001 |
| Goal Orientation (post-test) | 52.38 | 1.15 | .243 |

| Univariate | | |
|---|---|---|
| Variable | Levene's Test (F value) | p |
| Mastery Approach (pre-test) | 2.413 | .038 |
| Mastery Approach (post-test) | 1.063 | .382 |
| Mastery Avoid (pre-test) | .706 | .619 |
| Mastery Avoid (post -test) | 1.937 | .090 |
| Performance Approach (pre-test) | 1.543 | .179 |
| Performance Approach (post -test) | 2.907 | .015 |
| Performance Avoid (pre-test) | 2.738 | .021 |
| Performance Avoid (post -test) | 2.702 | .022 |
| SEC (pre-test) | 2.201 | .056 |
| SEC (post-test) | .182 | .969 |
| Self-Regulation | 3.642 | .004 |
| Course Grade (total points) | .927 | .465 |

Table 13. Reliability estimates using Cronbach's alpha values.

| Variable | Cronbach's Alpha |
|---|---|
| PALS (overall) | .63 |
| PALS (class-task) | .73 |
| PALS (class-ability) | .83 |
| AGQ (pre-test) | .80 |
| AGQ (post-test) | .81 |
| Mastery Approach (pre-test) | .82 |
| Mastery Approach (post-test) | .86 |
| Mastery Avoid (pre-test) | .83 |
| Mastery Avoid (post -test) | .81 |
| Performance Approach (pre-test) | .89 |
| Performance Approach (post -test) | .92 |
| Performance Avoid (pre-test) | .76 |
| Performance Avoid (post -test) | .81 |
| SEC (pre-test) | .97 |
| SEC (post-test) | .97 |

Table 14. Descriptive statistics for each of the four AGQ subscales by feedback group.

| AGQ Subscale | Feedback Group | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Mastery approach- pre-test | Self-referenced | 19.10 | 2.44 | 87 |
| | Norm-referenced | 18.91 | 2.40 | 94 |
| | Total | 19.01 | 2.42 | 181 |
| Mastery approach - post-test | Self-referenced | 18.35 | 2.79 | 87 |
| | Norm-referenced | 17.00 | 3.47 | 94 |
| | Total | 18.17 | 3.16 | 181 |
| Mastery avoidance - pre-test | Self-referenced | 12.29 | 4.86 | 87 |
| | Norm-referenced | 12.32 | 4.67 | 94 |
| | Total | 12.31 | 4.75 | 181 |
| Mastery avoidance - post-test | Self-referenced | 12.82 | 4.77 | 87 |
| | Norm-referenced | 12.73 | 4.56 | 94 |
| | Total | 12.78 | 4.65 | 181 |
| Performance approach- pre-test | Self-referenced | 15.03 | 4.85 | 87 |
| | Norm-referenced | 15.67 | 4.98 | 94 |
| | Total | 15.36 | 4.91 | 181 |
| Performance approach - post-test | Self-referenced | 14.12 | 4.83 | 87 |
| | Norm-referenced | 14.31 | 5.36 | 94 |
| | Total | 14.22 | 5.10 | 181 |
| Performance avoid - pre-test | Self-referenced | 16.21 | 4.15 | 87 |
| | Norm-referenced | 16.43 | 3.82 | 94 |
| | Total | 16.33 | 3.98 | 181 |
| Performance Avoidance - post-test | Self-referenced | 15.66 | 4.19 | 87 |
| | Norm-referenced | 16.05 | 4.12 | 94 |
| | Total | 15.86 | 4.15 | 181 |

Table 15. Self-regulation as a function of feedback group and perception of the learning environment.

| | | Feedback group | | |
|---|---|---|---|---|
| | | Self-referenced | Norm-referenced | Marginal means (perception) |
| Learning environment perception | Class-task | M=89.72<br>SD=53.46 | M=72.96<br>SD=52.25 | M=80.74<br>SD=53.17 |
| | Class-ability | M=93.84<br>SD=63.92 | M=98.96<br>SD=84.37 | M=96.51<br>SD=74.93 |
| | Marginal means (feedback) | M=92.65<br>SD=59.69 | M=86.97<br>SD=70.93 | |

Table 16. Group self-efficacy means along the 2 x 2 factorial (feedback by perception).

| Feedback group | Learning environment perception group | Self-efficacy | Mean | Std. Error |
|---|---|---|---|---|
| Self-referenced | Class-ability | Pre | 117.20 | 5.120 |
| | | Post | 164.09 | 3.955 |
| | Class-task | Pre | 132.18 | 5.376 |
| | | Post | 175.94 | 4.153 |
| Norm-referenced | Class-ability | Pre | 115.93 | 4.897 |
| | | Post | 155.91 | 3.783 |
| | Class-task | Pre | 114.94 | 5.005 |
| | | Post | 170.63 | 3.866 |

Table 17. Tests of within-subjects contrasts for self-efficacy.

| Effect | Mean Square | F | P | Power ($\alpha$=.05) |
|---|---|---|---|---|
| Time x Feedback Group | 1,493.34 | 2.307 | .131 | .327 |
| Time x Learning Environment Perception Group | 1,306.70 | 2.018 | .136 | .413 |
| Time x Feedback Group x Learning Environment Perception Group | 1,535.79 | 2.372 | .096 | .475 |

Table 18. Course achievement means along the 2 x 2 factorial (feedback by perception).

| Feedback Group (randomly assigned) | Learning environment perception group (class task vs. class ability) | Mean | Std. Deviation | N |
|---|---|---|---|---|
| 1 Self-referenced | Class-ability | 598.35 | 82.99 | 43 |
| | Class-task | 635.56 | 67.12 | 39 |
| | Not assigned | 555.61 | 79.56 | 6 |
| | Total | 611.93 | 78.85 | 88 |
| 2 Norm-referenced | Class-ability | 577.29 | 88.01 | 47 |
| | Class-task | 607.82 | 73.88 | 45 |
| | Not assigned | 636.41 | 59.13 | 4 |
| | Total | 594.06 | 81.82 | 96 |
| Total | Class-ability | 587.35 | 85.82 | 90 |
| | Class-task | 620.7 | 71.76 | 84 |
| | Not assigned | 587.93 | 80.14 | 10 |
| | Total | 602.61 | 80.69 | 184 |

# APPENDIX B

# FIGURES

Figure 1. A representative example of a worked example/self-explanation condition (Crippen & Earl, 2004).

**A Suggestion**

After studying the example below, explain to yourself how the terms oxidized, reduced, oxidizing agent, and reducing agent are used. Consider both their relation to each other as words and phrases, as well as to chemical compounds in a balanced chemical equation.

**Worked Example**

Iron is oxidized and nickel is reduced in the example reaction below.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Balanced Chemical Equation** | $Fe_{(s)}$ | + | $Ni(NO_3)_{2\,(aq)}$ | ---> | $Fe(NO_3)_{2\,(aq)}$ | + | $Ni_{(s)}$ |
| **Oxidation States** | (0) | | (+2)[(+5)(-2)3]2 | | (+2)[(+5)(-2)3]2 | | (0) |
| **Action** | Oxidized | | Reduced | | | | |
| **Function** | Reducing Agent | | Oxidizing Agent | | | | |

Close Window

Figure 2. Norm-referenced feedback protocol

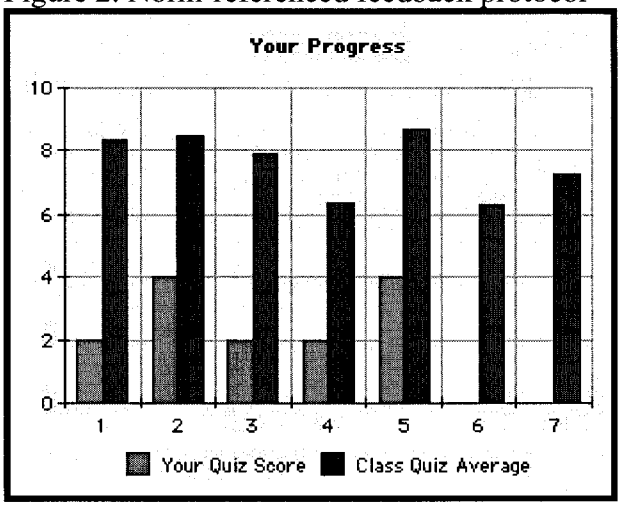


Figure 3. Self-referenced feedback protocol.

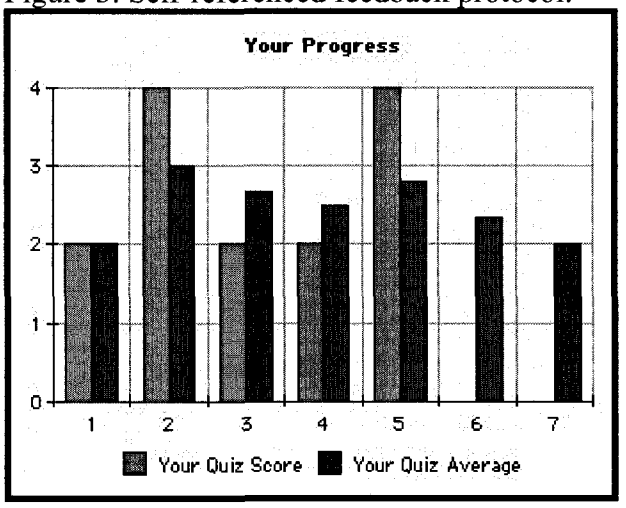


Figure 4. Research design logic model.

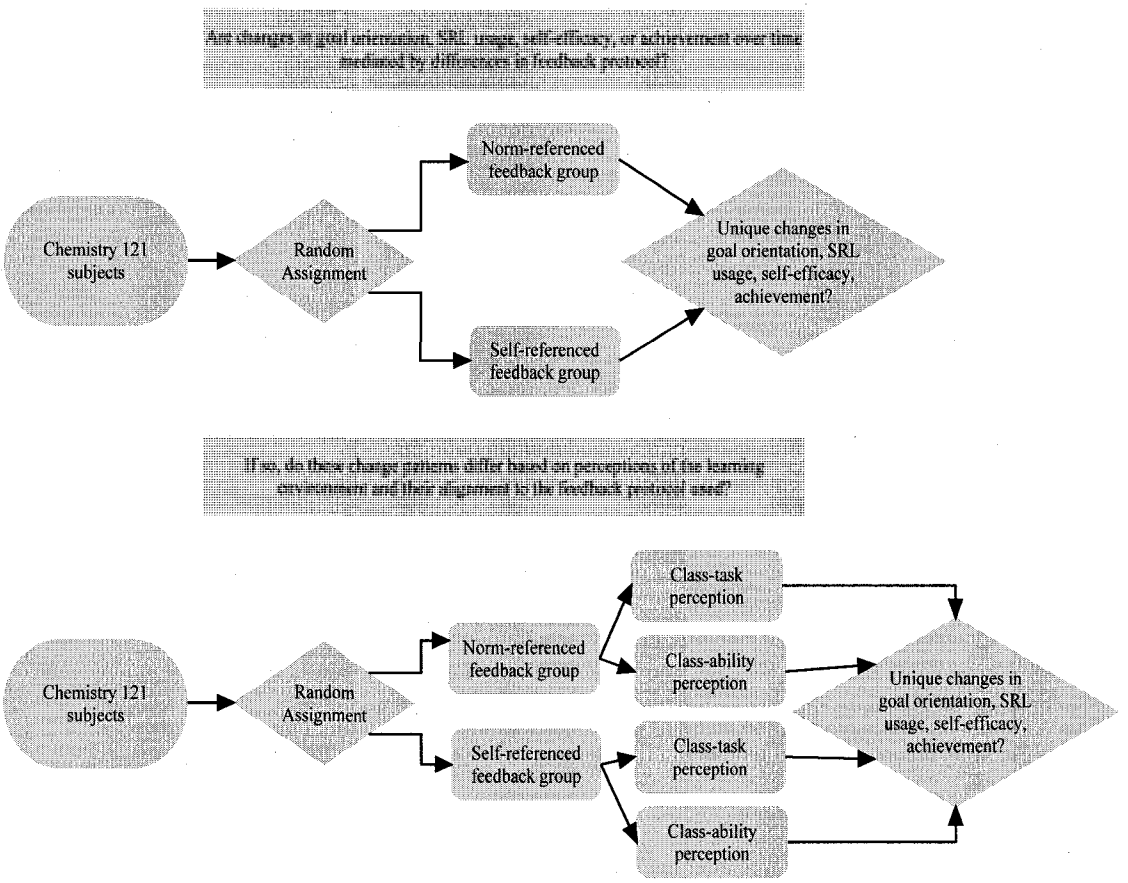
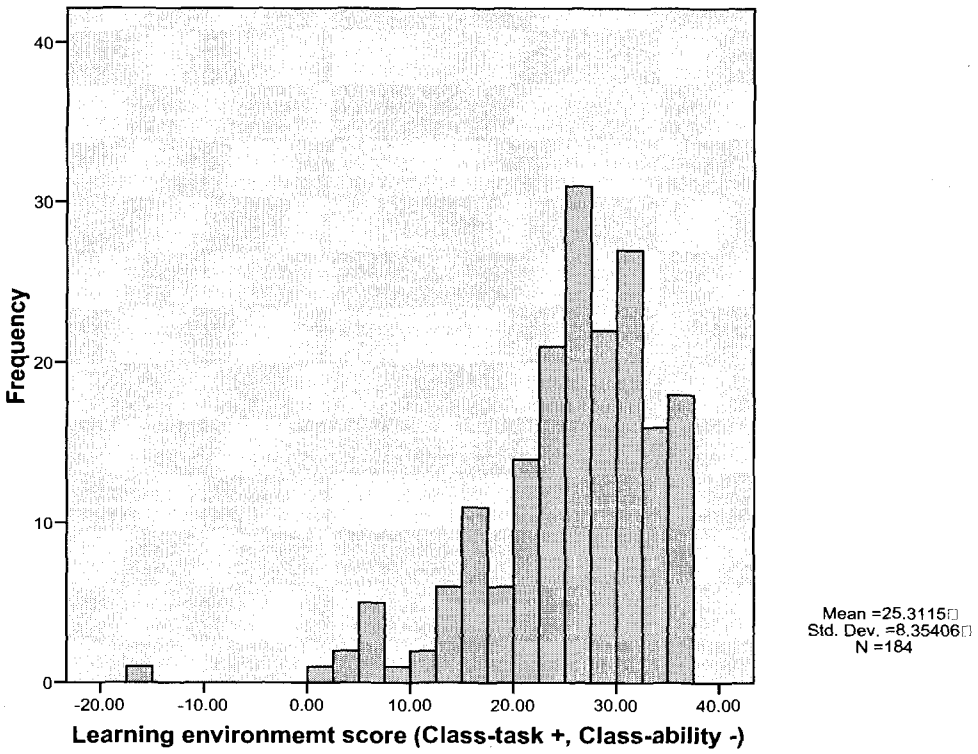


Figure 5. Histogram distribution of PALS scores.



# APPENDIX C

# INFORMED CONSENT

## Student Use of Web-based Materials in Undergraduate Chemistry

Informed Consent Form

**OPRS#-0505-1589**

Purpose of the Research

We are interested in the effect of motivation on student use of Web-based course materials and its impact on performance.

Procedures

Your instructor will be using *WebCT* to provide additional learning materials as part of this course (e.g., lecture notes, additional readings, examination answers, on-line assessments/worked examples). You have the option of using these materials to improve your performance in the course. We seek permission to track your use of the Web-based materials and to use your exam scores. In addition, we request that you complete a few surveys.

Data collection will involve use of the Web through integration with *WebCT*. Accepting participation in this study allows us to use your data in our study. Declining participation means we cannot use your data in our study, but **does not** affect your access to materials. Your participation is strictly voluntary.

Pressing the 'Accept' button constitutes informed consent and includes your data in the study. Selecting 'Decline' allows access to the materials but does not include your data in our study.

Data from this study will be stored on a Web server located in a secure location on the campus at the University of Nevada Las Vegas (UNLV). Records will be removed from the server for analysis at the end of the current academic term. Records will be destroyed following analysis.

**Student identity is anonymous.** Your L-number and login will solely identify you during data collection. At the completion of data collection, the results of the assessments will be removed and compiled. A random anonymous coding system will be applied before data analysis.

Risks

Risk to participants is minimal. Access to the site is password restricted and the data is stored securely on campus. Complete security of any computer system can never be guaranteed, but every reasonable effort will be made in this regard.

Benefits

Participants who use the Web-based course materials to learn chemistry may gain a deeper understanding and improve their performance.

## Confidentiality

The privacy of participants will be maintained throughout the study. We cannot guarantee the confidentiality of this information because it is gathered using the Web and Web-access to the database by surreptitious means unknown to us may be possible now or may become possible in the future, however.

## Compensation

There is no compensation for participating in this research.

## Opportunity to Ask Questions

Persons interested in discussing the research can contact the principal investigator, Dr. Kent J. Crippen, kcrippen@unlv.Nevada.edu, (702) 895-2517.

## Freedom to Withdraw

You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigators, the University of Nevada-Las Vegas, or the participating agent. Your decision will not result in any loss of benefits to which you are otherwise entitled.

## Consent, Right to Receive a Copy

You are voluntarily making a decision whether or not to participate in this research study. 'Accepting participation' certifies that you are **at least 18 years of age** and have decided to participate. By "clicking" on the 'Accept' button, you are acknowledging you meet the minimum age requirement and agree to participate. **We encourage you to print a copy of this form for your records.**

## Investigators

Dr. Kent J. Crippen, kcrippen@unlv.Nevada.edu, (702) 895-2517.
Dr. MaryKay Orgill, MaryKay.Orgill@ccmail.nevada.edu, (702) 895-3580.

## IRB Contact

For questions regarding the rights of research subjects, please call the UNLV Office for the Protection of Research Subjects, (702) 895-2794.

# APPENDIX D

# INSTITUTIONAL REVIEW BOARD APPROVAL

# Social/Behavioral IRB – Expedited Review
# Modification Approved

***NOTICE TO ALL RESEARCHERS:***

*Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.*

**DATE:** July 3, 2007

**TO:** **Dr. Kent Crippen**, Curriculum and Instruction

**FROM:** Office for the Protection of Research Subjects

**RE:** Notification of IRB Action by Dr. J. Michael Stitt, Chair
Protocol Title: **Student Use of Web-Based Materials in Undergraduate Chemistry**
Protocol #: 0505-1589

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The modification of the protocol named above has been reviewed and approved.

Modifications reviewed for this action include:

- The removal of Dr. Boyd Earl from the research team.
- The addition of Kevin Biesinger and Kevin Kirk to the research team.
- The addition of the PALS questionnaire as a research instrument.

This IRB action will not reset your expiration date for this protocol. The current expiration date for this protocol is March 21, 2008.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through OPRS. No changes may be made to the existing protocol until modifications have been approved by the IRB.

Should the use of human subjects described in this protocol continue beyond March 21, 2008, it would be necessary to submit a **Continuing Review Request Form** *60 days* before the expiration date.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@unlv.edu or call 895-2794.

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