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## The power of affective factors (self-efficacy, motivation and gender) to predict chemistry achievement with the benefits of knowledge surveys on metacognition level

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THE POWER OF AFFECTIVE FACTORS (SELF-EFFICACY, MOTIVATION AND  
GENDER) TO PREDICT CHEMISTRY ACHIEVEMENT WITH THE BENEFITS OF  
KNOWLEDGE SURVEYS ON METACOGNITION LEVEL

A Dissertation

Submitted to the Graduate Faculty of the  
Louisiana State University and  
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in partial fulfillment of the  
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Doctor of Philosophy

in

Curriculum & Instruction

by

Xin Wu

B.S., Nankai University, 2008  
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## **ABSTRACT**

Self-efficacy, gender, and motivation are subjective predictors of students' academic achievement. Self-assessment prompted by knowledge surveys involves metacognition, i.e., students' awareness of how they learn. Knowledge surveys can be used to measure changes in students' achievement level and to assist students in content review and inspire reflection on one's ability to learn. In this work, I combined these predictors (self-efficacy, gender, motivation, knowledge survey scores) into a survey to determine whether achievement in general chemistry can be predicted. My proposed research was conducted on 426 students enrolled in General Chemistry I classes (Chemistry for science majors) during a regular 15-week semester at Louisiana State University. The Motivated Strategies for Learning Questionnaire (MSLQ) survey was administered during the last week of classes. Data were analyzed via descriptive statistics, as well as correlation, linear and multiple regression statistical analyses with the correlation of total grades throughout the semester. The analysis results show that self-efficacy, motivation and knowledge survey scores can be used to statistically significantly predict students' future chemistry achievement, and gender turned out to be not a statistically significant predictor in this study.

### **Key Words**

Self-efficacy; metacognition; motivation scale; knowledge survey; chemical education; entry level college chemistry

## CHAPTER I. INTRODUCTION

### 1.1 Background

“Change has already come. We can view this as an opportunity for our community and for the United States, or we can passively react to change and have it imposed on us.”

- Matthew Platz, National Science

Foundation

While students' languages and cultures may differ in different countries, their studies in chemistry are remarkably the same. With few exceptions, undergraduate chemistry majors are expected to take coursework in the four traditional divisions – analytical, organic, inorganic, and physical – as well as a general chemistry course and to complete their bachelor's degrees in three to four years, but some students may spend time longer than four years in order to complete the program. In the United States, chemistry degree programs across the nation generally use the models outlined by the American Chemical Society (ACS) Committee on Professional Training (ACS, 1997). Over 600 colleges and universities nationwide, both public and private, offer ACS approved degrees on Chemistry. In addition, many undergraduate non-chemistry majors, Biology or Environmental Science etc., are also expected to take coursework in at least general chemistry level. As a result, it is an important issue to study the methodologies to improve students' academic achievement in the chemistry discipline.

The philosophy of chemistry, which examine the unique nature of chemical knowledge and chemistry research practice, reveals chemical knowledge and culture (Erduran & Scerri 2002). As such, it can be used to expose the nature of chemistry studies and assist in developing teaching expertise. In 2009, I was a researcher and teaching assistant in the Louisiana State University Chemistry Department, I found that many students are actually struggling to pass the

mandatory chemistry course. Some students, who are doing well in other subjects, may fail the same chemistry course twice, three times or even more. I asked several students who were failing chemistry to discuss why they thought they were unsuccessful. Their feedback can be summarized in three categories: 1) poor quality of instruction; 2) tenuous connections between the textbook content and the exam questions; and 3) too many concepts and equations to effectively memorize the information.

Then I couldn't help but wonder, "Are these the only few reasons why students are failing chemistry? Why do they hate chemistry so much?" With these two questions, I talked to more students and chemistry instructors. Combining their information with my own teaching experiences, I discovered that there are actually eight indicators that appear to impact student performance in chemistry coursework.

First, many students and educators have negative attitudes toward chemistry. Students treat chemistry as "mission impossible" or some course that they have to pass, and are disinterested with no desire to explore the amazing world of chemistry. Some students believe that all they need is to take notes and complete the assignments to get good grades and pass the course. So it is quite common that instructors find that many students have no interest or passion in learning chemistry. However, the majority of instructors are spending the majority of class time in rote learning—memorizing, or calculating answers by using the required equations without thinking deeply about the meanings of what they are learning. On the other hand, educators themselves may also engender a negative attitude towards the affective teaching of chemistry. The students' passive attitudes in class may also negatively influence the educators' approach to the course. For instance, some educators use the same Power Point® slides for years without changing a citation or updating their information. Others consider teaching chemistry as

a temporary job before they locate a position in industry, so they have little incentive to help struggling students. Of course, the low salary for chemistry instructors is also an important factor that cannot be ignored.

The second problem is non-professionalism. As I have explained, some chemistry teachers consider teaching chemistry as temporary until they find a better position with higher pay. The percentage of new chemistry instructors who have not received standardized chemical education is considerably high, and while they are more familiar with the science content, they know little about effective educational methodologies. In addition, chemistry instructors may not have strong backgrounds in chemistry, so they don't have the depth of chemistry knowledge to explain the chemistry concepts and principles. In addition, many chemistry instructors have never been actively involved in a professional chemistry organization or chemical education organization and lack connections to a professional learning community. In the absence of current learning research, they may be unaware of chemical education trends or chemical education teaching methodologies. These factors all result in many chemistry instructors lacking knowledge about chemistry education.

The third problem is one of time constraints. For most undergraduate courses, a class meets only three hours each week. With many complex concepts and mechanisms to cover, the chemistry instructors typically devote time to review the previous class' content, which then reduces the time they have to teach new chemistry content. I once talked to a student who had this to say about his chemistry instructor, "We meet on Monday, Wednesday and Friday. Every time, the class period is too short to address enough new content. And the teacher likes to review so much. I feel like we have been stuck in the same chapter forever." I have noticed that many

instructors do not finish all the chapters listed in their syllabuses by the end of the semesters. One reason for this might be that they spend too much time reviewing the old content.

The fourth and fifth problems are that there are few professional development workshops for college chemical education instructors and little laboratory flexibility. For example, there are very few professional development workshops for the new instructors, and they need more training and workshops to develop advanced science literacy. A common practice in almost every undergraduate laboratory involves students following prescribed steps and content in the manual, rather than creating their own experiments. Safety has been overly considered and students' creativity has been discouraged by the boring lectures and cookbook-style laboratory manuals.

The sixth problem is large class size. For a typical undergraduate chemistry course, one instructor might teach 300 students or more at one time. Since the class size is so large, the interaction between the instructor and each student is reduced and many students may feel ignored or left out by the instructors. In addition, since the class size is too big, it may be hard for the instructor to keep attendance records. Poor attendance in the classroom is one reason that students make poor grades on the exams. From my experience in the past, if a student has more than 30% absences in one semester, it is quite possible that this student will earn less than "C" by the end of the semester.

The seventh problem is poor examination practices. I worked as a teaching assistant in the chemistry department to assist the chemistry instructors as well as teach in the laboratories. From my observations, instructors and teaching assistants often use old tests, and students may have access to the answer keys. In addition, some instructors do not return graded assessments

promptly, which then reduces students' opportunities to examine what they have learned and make adjustments to their preparation for the next class or exam.

The final problem is the choice of career. For chemistry majors, the low quality of chemistry education may influence students' future career plans. If students do not do well in chemistry courses, they may change their career goals and pursue other majors and/or careers after graduation. For non-chemistry majors, the problem is even more severe. For many, chemistry is not a core course within their major, but is a mandatory course that they have to pass. Problems understanding chemistry concepts may mean that they will have difficulty integrating chemistry concepts into their future careers. These eight issues relative to chemistry learning effectively lead me to study the affective characteristics of students in order to determine the factors that can predict students' academic performance in chemistry.

## **1.2 Affective Characteristics**

Since there are many problems in chemical education, we need to pay attention to predictors which may reveal a student's academic success, especially for freshman students. The first year in college is a critical period in which students establish the knowledge foundation that influences their future science study. Therefore, I am interested in studying students' academic achievements in the first-year general chemistry course. In order to discuss factors related to chemistry achievement, I will first examine affective characteristics.

Affective characteristics refer to "human qualities that are primarily emotional in nature: attitudes, interests, values, preferences, self-esteem, focus of control, and anxiety are but a few" (Anderson & Anderson, 1982, p. 524). Affective characteristics are important because they have significant influence on students' determinations of interests, choices, career paths and future

science achievement. Much evidence has been collected on the effects of affective characteristics on school learning, and the positive correlations between the affective characteristics and course grades (Chastain, 2006) have been revealed. When we talk about reasons for a student's success or failure in learning course content, we are actually talking about many factors such as discipline, class engagement, self-regulation, in addition to affective factors. For example, Nolting (2007) points out that performance in mathematics has almost as much to do with students' attitudes and beliefs as it has to do with their mathematical knowledge. Mathematics and many science subjects are often considered as "very challenging" for many students. Affective factors such as attitude, self-efficacy, motivation, and anxiety influence students' learning behaviors and effect their final academic achievement in their coursework. The primary aim of this study is to identify the affective characteristics closely related to academic success of chemistry coursework.

Self-efficacy is the measure of one's own competence to complete tasks and reach goals (Ormrod, 2006). According to social cognitive theory, people learn from one another through observation, imitation, and modeling. Self-efficacy reflects one individual's understanding of the skills he or she can offer in a group setting (Ormrod, 1999). In my teaching experience, I found that students of similar abilities assigned to the same gifted class, have different levels of self-regulating abilities which greatly influences their achievement in class. For example, I had a girl in my environmental gifted class, who could not get along with many of her classmates. She often didn't do her job in the group assignments, was reluctant to do her in-class and after-class assignments, and lacked basic team-work skills. As a result of her inability to self-regulate, she did not earn a good grade at the end of the semester, even though she was a very capable student.

During the past few decades, self-efficacy has emerged as a highly effective predictor of students' motivation and learning. In the late 1970s, a number of researchers began to assess self-beliefs and self-regulations in a more task-specific way. One of the most important of these efforts focused on self-efficacy. In 1977 Bandura proposed a theory stating that "psychological procedures, whatever their form, alter the level and strength of self-efficacy" and he provided guidelines to measure of self-efficacy beliefs ( Bandura, 1977, p. 191). Later other social scientists provided more work indicating the influence of self-efficacy on students' learning. For instance, self-efficacy plays an important role in the socializing process (Kobolla vs. Crawley, 1985). Ahmed and Khatib (2010) also researched predictors of student performance. They found that "intrinsic goal orientation, self-efficacy, test anxiety, and self-regulated learning were significant predictors of student performance" (p. 57). From this aspect, according to Zimmerman (2000), self-efficacy measures focus on students' "performance capabilities" rather than on their personal qualities. Students evaluate their capabilities to conquer certain difficulties and fulfill certain tasks given by the teachers. This is exactly why teachers need to pay attention to self-efficacy levels of students and to foster their development.

There are several instruments to measure the levels of self-efficacy. One such scale is General Self-Efficacy Scale (GSE), which is a simple instrument. The GSE is a 10-item psychometric scale to assess optimistic self-beliefs in order to deal with various difficult demands in life, and it was developed by Matthias Jerusalem and Ralf Schwarzer in 1981. Other researchers developed a different instrument called MSLQ. Pintrich, Smith, Garcia, and McKeachie (1991) developed the Motivated Strategies for Learning Questionnaire (MSLQ). According to Pintrich, the MSLQ is a self-report instrument that can be used as a whole or modules of the whole to measure students' levels of motivation and cognitive learning strategies.

Prior to the MSLQ, much of the research was focused on individual differences in learning styles, and was rarely related to students' study behavior and course academic achievement. Additionally, many of the previous study skills inventories were criticized for having no theoretical basis. Thus, in the early 1980s, Bill McKeachie and Paul Pintrich at the University of Michigan began developing a tool to assess students' motivation and learning strategies in order to promote student learning. The final version of the MSLQ underwent 10 years of development, and the instrument has been used in many varied field studies. This instrument is still being used today to conceptualize and measure college student motivation and self-regulated learning (Duncan & McKeachie, 2005). For this reason, I implemented the MSLQ instrument to assess the chemistry self-efficacy levels of freshman college students.

The second tool used in this study is a knowledge survey. A knowledge survey is a method of evaluating the delivery of a course through the gathering of feedback from the learner on the level of the knowledge they acquired after the completion of the instruction (Wirth & Perkins, 2005). It usually consists of questions that cover the content of the course. The survey evaluates student learning and content mastery at all levels, from basic knowledge and comprehension through higher levels of thinking. Knowledge surveys can serve as both formative and summative assessment tools (Fink, 2003). Students' self-assessment of their understanding prompted by knowledge surveys involves metacognition, or the students' knowledge about their own learning. In addition to standard testing formats, knowledge surveys (KS) have emerged as tools for students to analyze their understanding of specific course content and for faculty to organize their course syllabuses. On this type of survey, students answer questions of varying difficulty and cognitive complexity based on Bloom's taxonomy and they are prompted to assign one of three levels of confidence to each question. Three levels of

confidence, 100%, 50%, and 0%, are used to rate each question on their personal ability to correctly determine the answer to a question. By honestly assigning one of the three levels of response, students are able to quickly determine the areas in which they excel and the areas that will need to be stressed in their review of the material. Another benefit for students is that knowledge surveys clarify the instructors' expectations and important concepts. By studying the questions in knowledge surveys, students are directed to proper skill sets required by the syllabus. Knowledge surveys can also help students review before final exams. Therefore, I have chosen to use a survey to determine if the variation in student Knowledge Survey (KS) scores on the knowledge surveys is relatively consistent across all levels of students' performance throughout the semester.

### **1.3 Research Questions**

#### **Problem Statement**

How are affective characteristics (self-efficacy and motivation) and the use of a Content Knowledge Confidence Survey (CKCS) related to academic achievement in a freshman Chemistry class?

#### **Sub Problems (14)**

1. How are self-efficacy beliefs concerned with the chemistry course in college students?
2. How do self-efficacy scores towards the chemistry course affect the academic achievement?
3. Is there a significant difference in self-efficacy scores towards the chemistry class of college students based on gender?
4. Is there a significant difference in self-efficacy scores towards the chemistry class in freshmen based on according to different majors?

5. What are the motivation levels of college students towards the freshmen chemistry class?
6. How does motivation towards the chemistry course affect the academic achievement?
7. Is there a significant difference in motivation scores towards the chemistry course based on gender?
8. Is there a significant difference in motivation scores towards the chemistry class in college students based on different majors?
9. How do the self-efficacy scores along with the motivation scores towards the chemistry course affect the chemistry achievement?
10. What is the correlation between the motivation scores and self-efficacy scores towards the chemistry course in college students?
11. Are there any other factors that affect academic achievement besides self-efficacy, motivation and gender?
12. Can MSLQ instrument reflect students' self-efficacy and motivation with compassion of their academic achievement?
13. How does CKCS reflect students' confidence levels towards their actual chemistry achievement?
14. What is the correlation between the affective factors and CKCS towards the chemistry achievement in the introductory chemistry course?

#### **1.4 Research Design**

This is a quantitative research design employing two instruments: the MSLQ instrument and a Content Knowledge Confidence Survey (CKCS). MSLQ instrument will be used to measure the three factors indicating students' academic achievement: self-efficacy, motivation, and

gender. The MSLQ instrument used by Pintrich and DeGroot (1990) was employed to measure student motivational beliefs and student strategies for learning. The Pintrich and DeGroot version is a 44-item self-report instrument with five scales. On the other hand, the version used by Duncan and McKeachie (2005) had 81-items and 15 scales. In both versions of the MSLQ students respond to items using a 7-point Likert scale. The scale ranged from 1 = “not at all true of me” to 7 = “very true of me.” This first version was selected to limit student response fatigue because it could be easily completed during a 50-minute class session. Since each question in the MSLQ instrument is corresponding to different scales, three types of questions are selected from the original MSLQ instrument to reflect three scales: self-efficacy, motivation and gender. Three sub-scales provide designations for distinct motivational factors: self-efficacy (10 items), motivation (8 items), and gender (2 items). The scales used in this study were formed from subset questions of the five MSLQ sub-scales. These questions were mapped to the 15-scales of the 44-item MSLQ to create classifications such as the interest scale or the rehearsal strategy scale.

The Content Knowledge Confidence Survey (CKCS) was created by the researcher in consultation with the instructor of the freshman chemistry course during the fall semester of 2012. Twenty questions from a previous final exam were selected to ensure that the most important concepts were covered from the semester. The CKCS required students to assign one of the three levels of confidence to each question:

- a. I have confidence in answering this question
- b. I could answer 50% of this question or know where to get information quickly.
- c. I have no confidence in answering the question.

Students were not required to solve the problems or answer the twenty questions, but simply to indicate how confident they were in their ability to correctly answer each of the questions. I have two sources of data to compare with the results of MSLQ and CKCS surveys so that we can explore the positive correlations between affective characteristics and academic achievement, and also confirm the benefits brought by CKCS surveys on students' metacognition levels.

### **1.5 Research Limitations**

Limitations of this study were that the study participants were self-selected (they registered for specific sections) of freshman chemistry with the particular instructor. In other words, the study cohorts were not randomly selected. Another study limitation was that the sample sizes were relatively small (426 students). Although it may be better to collect data from multiple semesters in order to reduce data errors and variations, the data for this study were collected during one semester. The Motivated Strategy for Learning Questionnaire (MSLQ) is a self-report instrument and subject to the limitations of a student self-report. The limitation of CKCS is that it increase students' anxiety levels about expectations for content learning and it is also a student self-report instrument. Finally, when students were reporting their high school GPA, this was also a self-report format. As a result, errors exist when some students mistakenly reported the wrong high school GPA.

### **1.6 Summary**

In this study, in order to explore student learning using the three predictors (self-efficacy, motivation and gender), correlation among these factors and the effects of these factors on the chemistry course achievement were investigated. This research examined the different

correlation coefficients of these factors with the comparison of total semester scores in order to identify the power of these predictors (self-efficacy, motivation and gender). In addition, the evidence provided by CKCS adds value to predictions of students' academic achievement.

## **1.7 Glossary**

**Affective characteristics:** human qualities that are primarily emotional in nature: attitudes, interests, values, preferences, self-esteem, focus of control, and anxiety are but a few.

**CKCS:** Content Knowledge Confidence Survey.

**Importance:** Attainment value (Gao & Newton, 2009); importance of doing well in terms of task competence or achievement

**Interest:** Intrinsic value (Gao & Newton, 2009); enjoyment the individual gets from engaging in or performing the task

**Motivation:** a motivating force, stimulus, or influence

**MSLQ:** Motivated Strategies for Learning Questionnaire

**Knowledge Survey:** method of evaluating the delivery of a course through the gathering of feedback from the learner on the level of the knowledge they acquired after the completion of the instructions

**Self-efficacy:** measure of one's own ability to complete tasks and reach goals.

## **CHAPTER II. LITERATURE REVIEW**

### **2.1 Social Cognitive Theory of Motivation**

In general, social cognitive theory is a learning theory based on the idea that people learn by observations in their social environment. It is developed from the area of social learning theory proposed by Neal E. Miller and John Dollard in 1941. Miller and Dollard's theory of psychological functioning emphasizes learning from the social environment. Four important factors have been identified in social cognitive theory in this learning behavior, which are drives, cues, responses, and rewards. If students are motivated to learn a particular behavior, such as a new chemistry concept, that concept could be learned through observations and from the environment. After students give their responses and feedback, their learning behavior would be rewarded with positive reinforcement. Bandura's social cognitive theory (1961) asserts interactions among personal, behavioral, and social/environmental factors. Motivational processes such as setting goals and self-regulation are vital to the learning process. As people set up goals, they regulate and evaluate their learning process. The perception of their process sustains self-efficacy and motivation, which moderates people's learning behaviors. During this procedure, people modify their behavior and act according to their values and goals, and their motivation stimulates them to work hard towards the final outcomes of this learning behavior. From this method we can see that self-efficacy is an especially important factor that influences motivation and learning behaviors. Self-efficacy is also extremely critical for people to deal with difficulties during the learning process. That is why it is important for us to use self-efficacy and motivation to evaluate students' learning and predict their future academic performance.

Motivation helps people bring order into their lives and stimulate their learning behaviors. It is also useful when people want to develop theories to explain their social environment and their observations on certain phenomena. Heider (1958) and Kelley (1967, 1972) were among the first to describe the causal attribution process that people use to explain their observations in their social environment. Bernard Weiner (2000), based on Kelly's work, proposed his theory on motivation from an attributional perspective. According to him, there are two attribution theories of motivation. The first theory, "intrapersonal theory," addresses how people explain their personal events such as successes and failures. The second theory, "interpersonal theory," addresses how people explain personal events of others. He used two metaphors to explain the two theories: person as scientist to explain intrapersonal theory, and person as judge to explain interpersonal theory. Weiner's theory of motivation (2000) explains how people influence each other and the effect of other people's events on learning performance. Educators can use this set of theories of motivation to analyze their interactions with students and work on certain patterns of interactions with students to promote their learning achievement.

In education, students learn through their observations in the social environment, and teachers play an important role in a student's learning acquisition. In light of this research, teachers should be dedicated to promoting students' self-efficacy and motivation levels by recognizing their accomplishments and rewarding their responses. This study is tailored to identify self-efficacy and motivation as possible predictors of future academic achievement.

## **2.2 Self-efficacy, Motivation and Gender**

The central construct in Bandura's (1986, 1997) social cognitive theory is self-efficacy, which he defined as the judgments that people make when identifying their abilities to reach certain levels of performance. According to Bandura's social cognitive theory, if people believe

that they can cope with certain difficulties and accomplish certain outcomes in the task, they are more likely to perform this task; but if they feel less competent or confident, they are less likely to perform this task and deal with the difficulties. As such, people's perceptions of their abilities can serve as motivation to affect their decision-making process and their persistence. In addition, self-efficacy also moderates people's behaviors and connects their prior achievements to their subsequent behaviors. We see many examples of this type in education. For instance, if a student has been doing very well in previous exams, he/she may use similar learning strategies to continue studying and it is possible for this student to obtain high grades on subsequent exams. There are four sources of information from which people form their self-efficacy perception: (a) authentic mastery experiences, (b) vicarious experiences, (c) social persuasions, and (d) physiological indexes (Bandura, 1977). We can conclude that self-efficacy level of students is influenced by their social environment and that this self-efficacy level monitors and moderates their learning behavior in the future.

Self-regulation and self-efficacy are usually used or associated together in many studies. Zimmerman (1989) describes self-regulation as "the degree to which learners are metacognitively, motivationally, and behaviorally active participants in their own learning process" (p. 329), from which we can tell that self-regulation is very similar to self-efficacy and are also researched by a lot of psychologists and educators. In this study, I will use self-efficacy as my predictor to investigate its power to predict students' academic achievement. Usher (2009) explains self-efficacy as follows:

Self-efficacy beliefs develop as the result of emotional, cognitive, or motivational processes; behavioral indicants; or the social environments in which people live and work. In school, for example, students' self-efficacy beliefs can be enhanced when students alter their emotions and thoughts (personal factors), when their teachers use effective classroom structures (environmental factors), and when students improve their self-regulatory practices (behavior). (p. 276)

Undergraduate science majors need to take multiple courses on Chemistry. As I mentioned above, there are many challenges in current chemistry education courses and students may easily get discouraged by these difficulties. Motivation plays an important role during this time and a high motivation level will benefit students who want to become future scientists, especially when they are coping with the difficulties during the learning process. I have observed that students with higher motivation levels tend to score higher in the tests. In addition, motivation benefits all students by promoting their scientific literacy, which is “the capability to understand scientific knowledge, identify important scientific questions, draw evidence-based conclusions, and make decisions about how human activity affects the natural world” (Organization for Economic Cooperation and Development, 2007). The importance of all students becoming scientifically literate is recognized internationally (Feinstein, 2011; Kelly, 2011; Roberts, 2007).

In studying the motivation to learn science, science education researchers have attempted to explain “why students strive to learn science, what emotions they feel as they strive, how intensively they strive, and how long they strive” (p. 2, Bryan, Glynn & Kittleson, 2011). To explain students’ motivation, it is important to examine what contributes to motivation. This knowledge can help science teachers sustain and enhance students’ motivation.

Self-efficacy beliefs have shown validity in influencing motivation. Bandura (1997) states that self-efficacious students work harder and persist longer than the students who doubt their abilities when they encounter difficulties. Zimmerman and Kitsantas (1999) have found that self-efficacy is highly correlated with students’ intrinsic interest regarding certain academic tasks, and this high level of interest can be revealed as high motivation. This influence of self-efficacy on motivation indicates that self-efficacy contributes in motivating persistence and promoting

academic achievement. Schunk (1981) found that self-efficacy increases students' persistence and therefore influences their skill acquisition. In a word, there is a strong, positive relationship between self-efficacy and motivation, and we need to explore the impact of that connection.

One factor to consider is the disproportionate number of females to males in some science fields. The female population is growing in the current chemical education field. Within recent years, females have made remarkable progress in science achievement, science degrees earned, and science careers (National Science Foundation, 2009). Since the late 1990s, women have earned about 57% of all bachelor's degrees and about half of all science and engineering bachelor's degrees (National Science Board, 2012). Most of these degrees are in the life sciences area, however, and females' percentage is still low compared to that of males in degrees earned in the physical sciences. Women currently make up only 25% of the science and engineering workforce (National Science Foundation, 2009). Thus, although we can see the remarkable achievement that women and girls have made in science education, they still remain underrepresented in degrees earned in the physical sciences or engineering field (Ceci & Williams, 2007; Scantlebury & Baker, 2007).

Another factor is the connection to motivation and students' intent to enroll in Advanced Placement Program (AP) science courses. AP courses enable high school students to study science and other subjects at much higher levels than the standard high school course offerings. The training that students received from AP courses may lead them to have higher SAT/ACT scores, better college admission rates, scholarship eligibility, and graduation rates. In discussions with outstanding students in the freshman chemistry laboratory, and students perceive that they received more benefits from his high school AP chemistry course than he would have from a regular chemistry class. The College Board, a nonprofit organization with a 58-year-old AP

program, finds that from 2004 to 2009 the number of students taking AP courses has risen by nearly 50% to 1.6 million students (Kendrick, 2013). This rapid growth shows more students are taking AP courses for high achievement in science learning. Accompanying this growth is the controversial use of AP courses and exams in college admissions, scholarships, and the ranking of “America’s Best High Schools” by Newsweek.

Attention should also be paid to the connection between self-efficacy and gender. Psychologists have found that women and men think differently in many ways, and they develop different efficacy expectations about themselves through the four sources of self-efficacy (Bandura, 1994). Some students have the perception that physical science is a white-male-dominated world, and this perception may possibly discourage female students and decrease their confidence and motivation to become future scientists. For example, if we consider academic achievement as a major source of self-efficacy development, Hackett and Betz (1981) suggest that different background experiences with gender role socialization may lead to gender differences in self-efficacy and confidence in different career domains. Influenced by the traditional early child role models, many boys are exposed to experiences with tasks of a mechanical, scientific, and technical nature, such as fixing a model car or building a robot, earlier and more often than is the case with girls. These early experiences promote the development of stronger self-efficacy expectations among boys toward careers that require those skills.

Why are we concerned about being gender balanced in our academic programs? One answer may be that we need more diverse views in our academic programs and female students can bring new perspectives to that arena. Kenway and Gough (1998) observe that we need to explore the intellectual potentials of females which remain an untapped source for furthering

scientific knowledge. If female students get discouraged in the academic programs and their enrollment decrease sharply, this phenomenon is going to impede the development of science knowledge in the long run. In addition, if we encourage more female students into the physical science fields, the overall populations of students in this area will increase and public interest in this physical science education will increase as well, especially in the case of females since they make up half the population. Lastly, we need to consider the issue of fairness. The pursuit of science is a highly profitable enterprise in our society in terms of money (e.g., employment), status, and influence (e.g., decision-making capabilities). The essence is that job seekers should have equal opportunities to compete within an inclusive environment (Gardner, 1984). Thus, we need to provide a clear path for women who want to study physical science and the current underrepresentation of female science students need to be changed if we want our children to live in a fair society. For example, Urry (2003) reported that women in physics departments throughout the country feel that they are not welcomed within their departments by their male counterparts. I have also experienced the veiled rejection in my own chemistry department, and don't want my female students to have similar experiences. Because of my own experiences, coupled with the research, I wish to study the correlations between self-efficacy and gender, and encourage more female students to enter the world of science.

Regarding the correlation between self-efficacy and gender, Betz and Hackett (1997) suggest that different background experience with gender role socialization may lead to gender difference in self-efficacy and confidence in different career domains. According to their research, total scores of self-efficacy for men and women for the educational requirements and the job duties of 20 occupations showed no significant gender differences. When researchers separated mean scores by traditional and nontraditional occupations, however, they found

significant and consistent gender differences do exist. It is not surprising to find that women demonstrated significantly greater self-efficacy for traditionally female occupations than did men, while men demonstrated significantly greater self-efficacy for traditionally male occupations than did women. Consider the jobs of nurses and mechanical workers for example, the nursing is stereotyped as female occupations, while mechanics is generally associated with males. Specifically, Betz and Hackett's research showed that women demonstrated much lower self-efficacy levels for traditionally male occupations than traditional female occupations, while men demonstrated consistency in self-efficacy levels across the traditional occupations. So we can conclude that gender differences were due to the women's response to the same traditional occupations and also due to the women's perceptions on certain career types. The study also revealed no significant gender differences in scores by the English and mathematics subtests on the ACT. Therefore, the differences in self-efficacy with regard to career choices did not correspond with actual achievement performance. For women, the problem of self-perception exists because of the lack of correspondence between their self-efficacy for nontraditional careers and their measured ability.

Finally, motivation and gender are also strongly associated regarding students' academic achievement. Corpusa & Lepperb (2007) did two studies on how gender and age moderate pupils' motivation levels regarding the stimulus of praise. They found that process praise enhanced motivation for girls, but there were few effects of praise on boy's motivation improvement. So there is a need to include gender into part of my study and try to explore whether there are any significant differences regarding male and female students about their self-efficacy, motivation, confidence and content learning. In my study, I will add gender as an independent variable in my

method design to investigate any statistically significant differences between boys and girls on their chemistry achievement.

### **2.3 MSLQ Instrument**

There are several published instruments to measure the levels of self-efficacy. Some social researchers are using General Self-Efficacy Scale (GSE) as a simple instrument to measure it. The GSE is a 10-item psychometric scale to assess optimistic self-beliefs in life, and it was developed by Matthias Jerusalem and Ralf Schwarzer in 1981. Recently researchers are using a different instrument developed by Pintrich, Smith, Garcia, and McKeachie (1991). It is called Motivated Strategies for Learning Questionnaire (MSLQ). The MSLQ is “a self-report instrument used as a whole or modules of the whole to measure students’ levels of motivation and cognitive learning strategies” (p.3, Pintrich, Smith, Garcia, and McKeachie, 1991). Prior to the MSLQ, much of the research was focused on individual differences in learning styles, and was rarely related to students’ study behavior and course academic achievement. Additionally, many of the study skills inventories were criticized for having no theoretical basis. Thus, in the early 1980s, Bill McKeachie and Paul Pintrich at the University of Michigan began developing a tool to assess students’ motivation and learning strategies in order to promote students’ learning. Starting from 1986, MSLQ was under development formally. After 10 years of development, and then the instrument was used in various field studies. This instrument is still being used today to conceptualize and measure college student motivation and self-regulated learning (Duncan & McKeachie, 2005). In this study I will use the MSLQ instrument to assess students’ self-efficacy levels.

Alfred Bandura described self-regulation as controlling and moderating our behavior through self-observation, judgment, and self-response. Self-regulated learning (SRL) is used to

describe the attributes of successful learner (Schloemer & Brennan, 2006). These learners “use various learning strategies and continually monitor their progress” (Schloemer & Brennan, 2006) and “modify their behavior in an effort to improve their learning process”. According to Schloemer and Brennan, learning is an ongoing, self-regulating, dynamic, an interactive process and learners are making modification as part of the process repeated until they have figured out a formula or a pattern to deal with the problems. Since it is important to measure the levels of self-efficacy, Pintrich, Smith, Garcia, and McKeachie (1991) developed Motivated Strategies for Learning Questionnaire (MSLQ). As I discussed previously, the MSLQ is a self-report instrument to measure students’ levels of motivation and cognitive learning strategies. This is a well-developed instrument that researchers can use to study students’ behavior and course achievement. In this model, students’ motivation is directly linked to their ability to self-regulate their learning activities, where self-regulated learning is defined as “being metacognitively, motivationally, and behaviorally active in one’s own learning processes and in achieving one’s own goal” (Eccles & Wigfield, 2002, p. 124). This framework assumes that motivation and learning strategies are not static traits of the learner, but rather that “motivation is dynamic and contextually bound and that learning strategies can be learned and brought under the control of the student” (Duncan & McKeachie, 2005, p. 117). Based on students’ motivations can change throughout the course, and students’ motivations can also change from course to course, and their learning strategies may be changed as well. For example, if a student’s motivation level is very low for one type of class, he or she may still have a high motivation for other courses they might take.

How do we evaluate students’ academic achievement? The typical method is students’ grades. Past research has revealed that student grade point average (GPA) is the best predictor of

their achievement (Allen et al., 2008; Cameron & McLaughlin, 2008). But students may do well in certain tests, and don't do well in some other tests. So I am going to use students' total scores throughout the semester to indicate their academic levels. The best predictors of academic performance are self-efficacy, test anxiety, and self-regulation (Pintrich & De Groot, 1990). In addition, motivation and knowledge of cognitive strategies are also necessary to promote student achievement (Pintrich & De Groot, 1990). While there are four sources of self-efficacy, Pintrich & De Groot indicate that there are three motivational components linked to student self-regulated learning. They are expectancy, value, and affective. Expectancy "includes students' beliefs about their ability to perform a task" (Pintrich & DeGroot, p. 33). This is measured by the self-efficacy scale in the MSLQ. Students' interest in a task or the belief that the task is important can be measured by the intrinsic value scale of the MSLQ. Affective factors may be the students' feelings or belief towards the learning process or course. If the students like the course that they are taking, or believe firmly they can perform well in this process, it is quite likely that they are actually going to achieve this goal. These affective components are measured with scales of the MSLQ. Pintrich and De Groot developed the MSLQ tool to determine how motivation and self-efficacy influence students' academic achievement together as well as separately. And this study is will determine the relationship to CKCS and academic progress by their course GPA. The subscales of the MSLQ are shown in Table 2.1. (Pintrich et al., 1991, p. 5)

The MSLQ instrument uses Likert Scale to evaluate students' self-efficacy levels for each question. A Likert scale is a psychometric scale commonly used in social science research to collect scaling responses in survey research. This scale is named after its inventor, Rensis Likert. Likert created this format in which responses are scored along a range. The respondent is asked to evaluate their levels according to any kind of criteria. Usually it is lined up in the order from

strongly agree to strongly disagree. Often five ordered response levels are used, although some social scientists prefer the 7-item format. In this study, I am going to use the 7-item Likert format to collect data on respondents' different levels.

Specifically, scores from MSLQ instrument have been used in the following ways: "(a) address the nature of motivation and use of learning strategies in different types of content areas and target populations; (b) help refine our theoretical understanding of motivational constructs, how they are distinct from one another, and what individual differences exist in self-regulated learning; and (c) evaluate the motivational and cognitive effects of different aspects of instruction" (Duncan & McKeachie, 2005, p.117).

For education, scores from the MSLQ can be used to assess students' motivation and self-regulated learning skills. Using the results, instructors are able to identify students who may be having trouble and provide additional study skills assistance. With the advantage of the Internet, many instructors, as well as many advising and counseling centers, have started using online versions of the MSLQ as a form of needs assessment (Duncan & McKeachie, 2005).

## **2.4 Content Knowledge Confidence Survey**

Educators have recognized the value of student self-confidence as a predictor of academic performance for more than 30 years. Self-efficacy, as described by Bandura (1977), is actually a student's confidence in his or her ability to perform a task. Several studies have revealed that higher grades and persistence in the career path are often correlated with students' confidence in their own abilities (Besterfield-Sacre et al., 1998; Lent et al., 1984, 1987; Multon et al., 1991). Nuhfer and Knipp developed an instructional tool they call a knowledge survey (KS), which is based on these self-efficacy concepts (Nuhfer and Knipp, 2003). They report that the results of knowledge surveys can reveal changes in student learning and student confidence levels.

Table 2.1 Components of the MSLQ

Part 1: Motivation Scales		Part 2: Learning Strategies Scales	
Sub-Scale	# of Items	Sub-Scale	# of Items
1. Intrinsic Goal Orientation	4	1. Rehearsal	4
2. Extrinsic Goal Orientation	4	2. Elaboration	5
3. Take Value	6	3. Organization	4
4. Control of Learning Beliefs	4	4. Critical Thinking	5
5. Self-Efficacy for Learning & Performance	8	5. Metacognitive Self-Regulation	12
6. Test Anxiety	5	6. Time/Study Environmental Management	8
		7. Effort Regulation	4
		8. Peer Learning	3
		9. Help Seeking	4
Total Number of Items	31	Total Number of Items	50

It usually includes the important questions which are the key content of the course. These questions range from simple knowledge to evaluation of open-ended questions. For example, Nuhfer (2003) reported an excerpt from a knowledge survey. Six survey questions represent a unit lesson on asbestos, and these six questions are of varying difficulty and cognitive complexity according to Bloom's taxonomy. This type of survey evaluates student learning and

collect data on their content mastery at all levels: from basic knowledge and comprehension through higher levels of thinking. The KS can be used to serve all kinds of needs, such as content review or training in higher level thinking. In addition, a KS can be used as both formative and summative assessment tools. Student's self-assessment of their understanding can be prompted by knowledge surveys involves metacognition, which is a student's knowledge about their own knowledge. In addition to standard testing formats, knowledge surveys (KS) have emerged as self-evaluating tools for students to analyze their understanding of certain instructional content. Content Knowledge Confidence Survey (CKCS, the first time to be used in this paper) is the specific format to be used to evaluate students' confidence of what they have learned. On these surveys, students face questions of varying difficulty and cognitive complexity according to Bloom's taxonomy and they are prompted to assign one of three levels of confidence to each question:

- a. I have confidence in answering this question.
- b. I could answer 50% of the question or know where to get information quickly.
- c. I have no confidence in answering the question.

In the CKCS students don't need to figure out answers to the actual questions. They just need to read the questions and evaluate their confidence level in their ability to figure out each question. By honestly assigning one of the three levels of response, students should be able to determine quickly the areas in which they are familiar and the areas that will need to pay attention to, so that they can focus on their weak area . This KS can also serve as a tool for students so that they understand the faculty expectations for student knowledge and the skill sets required for the entire course, since this set of questions cover the key content of the entire

semester's knowledge. In a word, knowledge surveys can be used in course design, assessment and classroom practice.

## **2.5 Metacognition and Overconfidence**

The Knowledge Survey deals with students' self-evaluation process and is focused on how they have learned. Students' self-assessment of their understanding prompted by KS involves metacognition. Student metacognition of the problem-solving process of chemistry students is one of the ideas that stimulated this study. One of the more comprehensive definitions of metacognition comes from Gourgey, and relates directly to the purposes of the knowledge survey outlined about "awareness of how one learns; awareness of when one does or does not understand; knowledge of how to use available information to achieve a goal; ability to judge the cognitive demands of a particular task; knowledge of what strategies to use for what purposes; and assessment of one's progress both during and after performance" (Gourgey, 2001, p.18).

Often one hears that the most important tasks of education are to teach students how to learn and to help them establish a good habit of continuously learning. But how do we learn how to learn? How do we know what we've learned and whether we have done well in our learning? The concept of metacognition addresses these questions. The simple definition for metacognition is "thinking about one's own thinking. There are two aspects of metacognition: 1) reflection—thinking about what we know; and 2) self-regulation—managing the next action towards learning" (Darling-Hammond et al., 2003, p.158). Taken together, these processes make up an important aspect of learning and development. From the above discussion we can see that it is necessary to develop these metacognitive abilities for all learners.

Metacognition is also closely related to problem-solving skills. Good problem-solvers tend to have highly developed metacognitive skills since they tend to analyze the problems

efficiently. They know how to recognize flaws or gaps in their own thinking, summarize their learning strategies, articulate their thought processes, and revise their efforts (Brown, Bransford, Ferrara, & Campione, 1983). Actually, learners use these skills every day, although we may not realize this. We decide what method to use to solve a problem; we summarize what we have learned or the lessons that we learned from our failures; we use metacognitive skills to develop some patterns to solve new problems. In short, we are the master of our own learning. Students and novice learners often “lack these skills or fail to recognize when to use them” (Flavell & Wellman, 1977, p. 218). As educators, it is important for us to help foster the development of metacognitive skills in students. These are skills that will help students learn how to learn.

John Flavell originally coined the term metacognition in the late 1970s to mean “cognition about cognitive phenomena,” or more simply “thinking about thinking” (Flavell, 1979) as we mentioned in the previous text. Subsequent development and use of the term have remained relatively faithful to this original meaning. For example, researchers working in the field of cognitive psychology have offered the following definitions:

- “The knowledge and control children have over their own thinking and learning activities” (Cross & Paris, 1988, p. 131).
- “Awareness of one’s own thinking, awareness of the content of one’s conceptions, an active monitoring of one’s cognitive processes, an attempt to regulate one’s cognitive processes in relationship to further learning, and application of a set of heuristics as an effective device for helping people organize their methods of attack on problems in general” (Hennessey, 1999, p. 3).
- “Awareness and management of one’s own thought” (Kuhn & Dean, 2004, p. 270)
- “The monitoring and control of thought” (Martinez, 2006, p. 696).

Schraw et al. (2006) see both metacognition and critical thinking as “being subsumed under self-regulated learning,” which they define as “our ability to understand and control our learning environments” (p. 111). Metacognition is also related to self-regulated learning. Self-regulated learning contains metacognition, motivation, and cognition, which includes critical thinking. These skills illustrate critical thinking throughout the process of metacognition, which monitors the level of thinking.

In addition, several researchers have described a link between metacognition and motivation (Ray & Smith, 2010; Schraw et al., 2006; Whitebread et al., 2009). Similar to the affective factors in self-efficacy, Cross and Paris (1988) note that metacognition also includes affective factors such as motivation. Similarly, Martinez (2006) argues that metacognition deals with the management of affective factors; and metacognitive strategies can improve motivation when coping with difficult tasks. Motivation has two primary subcomponents: “(a) self-efficacy, which is confidence in one’s ability to perform a specific task and (b) epistemological beliefs, which are beliefs about the origin and nature of knowledge” (Lai, 2011, p.13). Paris and Winograd (1990) believe that affective factors are inevitable components of metacognition, because as students grow affections and feelings towards the learning process, as they monitor and appraise their own cognition. These studies are indicators of the possible benefits of combining self-regulation factors with knowledge survey which can reflect the level of metacognition.

In addition, there is another interesting factor related to metacognition levels, that of overconfidence. When people make self-assessment errors, they are usually in the direction of overconfidence. For example, people overestimate their reasoning ability, their ability to recognize humor, and their knowledge of grammar (Kruger & Dunning, 1999), and they

underestimate the time they need to complete tasks (Buehler, Griffin, & Ross, 1994). For example, a student may be too optimistic when he/she is estimating his/her final exam scores, and may be disappointed when they find out their actual grades. In the classroom, undergraduate students tend to overestimate their performance on upcoming exams (Hacker, Bol, Horgan, & Rakow, 2000). In Hacker et al. (2000), many students predicted that they would earn scores more than 30% higher than their actual scores. So overconfidence is also a factor that I will explore later.

From the above discussion we can see the promising applications of using combination of characteristics of MSLQ and Content Knowledge Confidence survey to find out which has the highest power to predict students' chemistry achievement in the general chemistry course. In addition, we can also see the influence of student overconfidence revealed by this instrument on their academic achievement in addition to student metacognition level.

## **CHAPTER III. RESEARCH DESIGN AND METHODS**

### **3.1 Introduction**

The researcher is interested in the powers of the three predictors to predict students' chemistry achievement and using a knowledge survey to indicate students' metacognition level. I use a general chemistry course to select the samples. Before carrying out the study, the author received ethical training from NIH and completed the IRB certification. Then the study was proposed to Institutional Review Board in Louisiana State University with consent script, and it was approved in November, 2013.

### **3.2 Population and Samples**

The present study included 610 participants enrolled in two sections of an introductory Chemistry course (CHEM 1201) in the fall semester of 2012 at the Louisiana State University, Baton Rouge, LA. After excluding data for students who did not complete all sections of the first administration of the MSLQ survey, the number of students in the study was reduced to 427. This sample included two sections of students for the same course. Among this sample, 298 students provided their high school GPA, and this 298-person sample was analyzed later.

The first independent variable in this study was student self-efficacy (self-regulated learning) scores. The second independent variable was student's motivation scores. The third independent variable was students' scores on the Content Knowledge Confidence Survey. The fourth independent variable was gender. The last independent variable was students' high school GPA. Of the 427 students who have completed this survey, 299 students submitted their high school GPA. Finally, the dependent variable in this study was students' semester total scores. I will use CTOT to stand for the course total scores.

### 3.3 Procedure

In order to carry out the research, I needed to secure the IRB certification and also apply for IRB protocol approval to Institutional Review Board of Louisiana State University. After receiving the protocol approval from the chair (approval document will be shown in Appendix E), the instructor posted this survey with its consent script on LSU Moodle website, which is used for course management. I constructed the online survey by myself. This survey contains 43 questions in total, and there are three questions on academic background, twenty questions on self-efficacy, motivation and gender (MSLQ), and twenty questions on Content Knowledge Confidence Survey (CKCS). The detailed of what with the consent script will be shown in Appendix D. The instructor explained the meaning and goal of the survey at the second last week of 2012 Fall semester, and the survey was made available to students on 12am that night until the time of their final exam. Students were encouraged to take the survey and they would get five bonus points for completing the survey. The survey was ended when final exam was started, and the results were downloaded in the format of Excel to be analyzed later. The layout of the homepage of the survey is shown in Figure 3.1.

According to the requirements of Institutional Review Board, the consent script was both shown in the homepage description and also at the beginning of CKCS. The students read the descriptions and decided whether they wanted to take part in this survey. If they decided to take part in the research, they logged into the MOODLE website, clicked on the bold name of the survey, and the link directed them to the detailed questions part. The first part is a set of three questions on their academic background and it is shown in Figure 3.2.

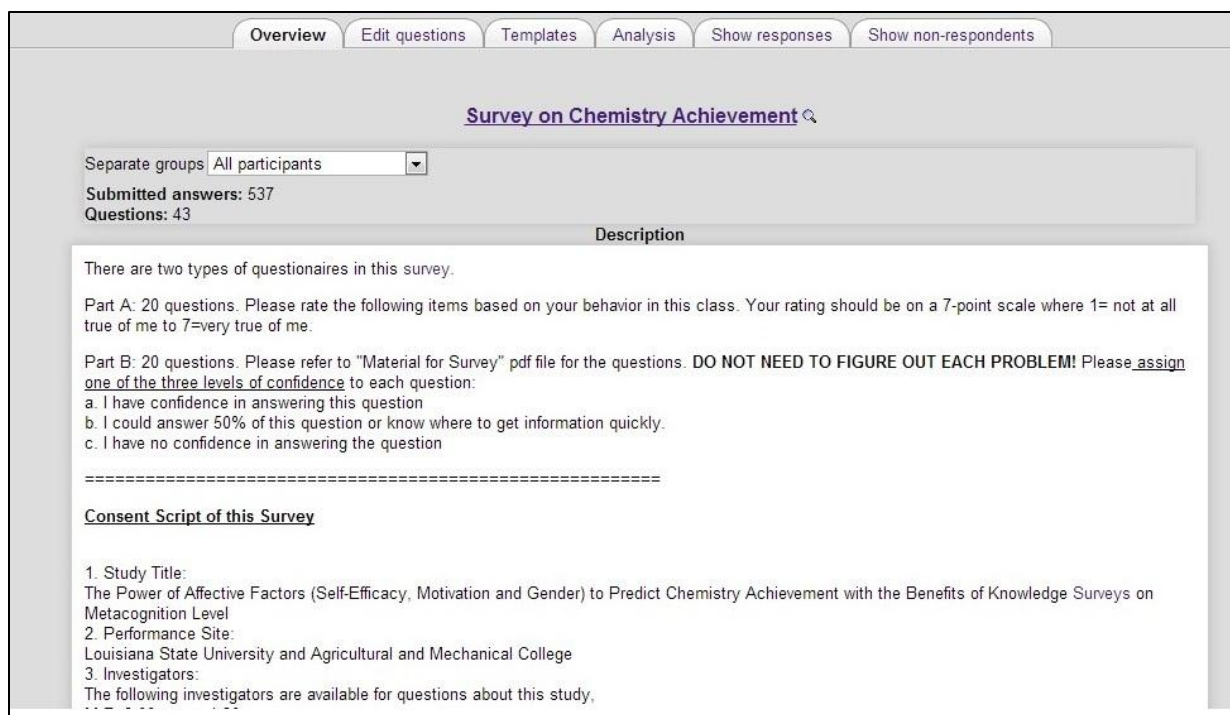







Figure 3.1. The homepage of Moodle Survey






Starting from Question #1, students would see two sets of questions: the first 20 questions are about self-efficacy, motivation and gender, and the second 20 questions are about CKCS. The layout is shown in Figure 3.3.






Students answered the 43 questions in this MOODLE website. When they finished the survey, they clicked on the "Submit" icon and the data was submitted. The survey status was active from the review session of this course to final exam, and all the data was downloaded from this website in the format of Microsoft Excel Worksheet after that. In this study, my assumption is that self-efficacy, motivation, CKCS scores should influence students' chemistry achievement and the power of their predictions can be obtained by multiple regression analysis. My Type I error in this study would be wrongly reject a true hypothesis when it is true. So when my assumption is true and if my results shows no influence, Type I errors occur in this situation.






**Preview**

(\*)Answers are required to starred questions.

(background) What is your high school GPA?\* (Position:1)     

(background) Have you ever taken high school AP Chemistry?\* (Position:2)     

(background) Please select the option according your experience\* (Position:3)     

(1) Compared with other students in this class I expect to do well\* (Position:4)     

☐ (1) 1 not at all true of me

☐ (2) 2

☐ (3) 3






☐ (4) 4

☐ (5) 5

☐ (6) 6

☐ (7) 7 very true of me

Figure 3.2 The background questions of this survey

(2) I'm certain I can understand the ideas taught in this course\* (Position:5)     

☐ (1) 1 not at all true of me

☐ (2) 2






☐ (3) 3

☐ (4) 4

☐ (5) 5

☐ (6) 6

☐ (7) 7 very true of me

(3) I expect to do very well in this class\* (Position:6)     

☐ (1) 1 not at all true of me

☐ (2) 2






☐ (3) 3

☐ (4) 4

☐ (5) 5

☐ (6) 6

☐ (7) 7 very true of me

(4) Compared with others in this class, I think I'm a good student\* (Position:7)     

☐ (1) 1 not at all true of me

☐ (2) 2

☐ (3) 3

☐ (4) 4

☐ (5) 5

☐ (6) 6

☐ (7) 7 very true of me

Figure 3.3 The layout of the survey questions

### **3.4 Data Collection and Instrumentation**

Survey research is probably the best method available to the social researcher who is interested in collecting original data for describing a population too large to observe directly. Careful probability sampling provides a group of respondents whose characteristics may be taken to reflect those of the larger population, and carefully constructed standardized questionnaires provide data in the same form from all respondents. Surveys are also excellent vehicles for measuring attitudes and orientations in a large population. In order to figure out all the aspects and questions related to this study, Table 3.1 outlines each research question and the plan to answer the question.

#### **3.4.1 MSLQ**

The MSLQ instrument used by Pintrich and DeGroot (1990) was employed to measure student motivational beliefs and student strategies for learning. This instrument is a 44-item self-report survey with five sub-scales. On the other hand, the version used by Duncan and McKeachie (2005) had 81-items and 15 scales. In both versions of the MSLQ students respond to items using a 7-point Likert scale. The scale ranged from 1 = “not at all true of me” to 7 = “very true of me.” This study was selected to lessen student response frustration and because it could easily be completed within 30 minutes. Three sub-scales provide designations for distinct motivational factors: self-efficacy (10 items), motivation (9 items), and gender (1 items).

The motivation and strategy use micro-scales used in this study were formed from subset questions of the five MSLQ sub-scales. These questions about self-efficacy were selected from the 81-item MSLQ regarding the interest scale and the rehearsal strategy scale. The motivation questions used in this study were selected from the Global Motivation Scale (GMS) developed by Frédéric Guay, Geneviève A. Mageau and Robert J. Vallerand in 2003.

Table 3.1 Data-Planning Matrix

<b>What do I need to know?</b>	<b>Why do I need to know this?</b>	<b>What kind of data will answer the questions?</b>	<b>How will I initially analyze this data?</b>
How do self-efficacy scores towards the chemistry course affect the academic achievement?	To be able to accurately describe the influence of self-efficacy beliefs on chemistry academic achievement	Self-efficacy scores from the first 10 questions of modified MSLQ instrument, students' semester total grades	Case summary, descriptive statistics of self-efficacy scores, Regression analysis of the self-efficacy scores in order to determine the effects of self-efficacy on semester total grades
Is there a significant difference in self-efficacy scores towards the chemistry class of college students according to the gender?	To describe and understand the difference self-efficacy levels according to different genders	Self-efficacy scores from the first 10 questions of modified MSLQ instrument, gender scores from the 2 questions on gender issues in the instrument, students' genders	Coding, t-test of differences according to gender in self-efficacy scores, case summary of the 2 gender questions

Table 3.1 continued

<b>What do I need to know?</b>	<b>Why do I need to know this?</b>	<b>What kind of data will answer the questions?</b>	<b>How will I initially analyze this data?</b>
Is there a significant difference in self-efficacy scores towards the chemistry class in college students according to different majors?	To describe and understand the difference of self-efficacy levels according to different majors	Self-efficacy scores from the first 10 questions of modified MSLQ instrument, students' majors	Dummy coding, case summary of all different majors, ANOVA test of differences according to different majors in self-efficacy scores
How do motivation scores towards the chemistry course affect the academic achievement?	To be able to accurately describe the influence of attitude on chemistry academic achievement	Motivation scores from the 8 questions of motivation part in the MSLQ instrument, students' semester total grades	Case summary, descriptive statistics regression analysis
Is there a significant difference in motivation scores towards the chemistry course according to	To describe and understand the difference of motivation levels in male and female	Scores from the 8 motivation questions of MSLQ, gender scores from the 2 questions of MSLQ	Coding, t-test of differences according to gender in motivation scores, case summary of the 2

the gender?

students

gender questions

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Table 3.1 continued

<b>What do I need to know?</b>	<b>Why do I need to know this?</b>	<b>What kind of data will answer the questions?</b>	<b>How will I initially analyze this data?</b>
How do the self-efficacy and motivation scores affect the chemistry achievement, and what is the correlation between motivation scores and self-efficacy scores towards the chemistry course?	1) To interpret how the both self-efficacy and the motivation levels affect academic achievement towards this chemistry course 2) To understand the relationship between self-efficacy and motivation towards chemistry achievement	Self-efficacy scores, motivation scores, students' semester total scores	Multiple regression analysis relating to the interpretation of the achievement in accordance with the self-efficacy and the motivation
Are there any other factors that affect academic achievement besides self-	To interpret the influence of students' previous preparation on chemistry achievement towards this chemistry	ACT scores, high school GPA, Chemistry AP course, Mathematics AP	Descriptive statistics of these factors

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efficacy, motivation and gender?	course	course, and other training
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Table 3.1 continued

<b>What do I need to know?</b>	<b>Why do I need to know this?</b>	<b>What kind of data will answer the questions?</b>	<b>How will I initially analyze this data?</b>
How to include these other factors into the analysis to make the prediction of chemistry achievement more accurate?	1) To interpret this influence of previous training factors on students' chemistry achievement; and 2) To make the prediction of self-efficacy and motivation on chemistry achievement more accurate	Self-efficacy scores, motivation scores, students' semester total scores, ACT scores, high school GPA, students' gender	Descriptive statistics of the factors, Multiple Regression analysis (dependent variables: self-efficacy, motivation, total grades; independent variables: ACT, high school GPA, gender), Dummy coding.
Is there a significant difference in motivation scores towards the chemistry class in	To better understand the influence of majors on students' motivation levels to study this chemistry course	Motivation scores from the 8 questions of motivation part in the MSLQ	Dummy coding, case summary of all different majors, ANOVA test of differences according to different majors in

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college students instrument, motivation scores  
 according to students' majors  
 different majors?

Table 3.1 continued

<b>What do I need to know?</b>	<b>Why do I need to know this?</b>	<b>What kind of data will answer the questions?</b>	<b>How will I initially analyze this data?</b>
What is the correlation between the self-regulated factors (self-efficacy, motivation scores) and CKCS towards the chemistry achievement?	To understand the relationships among self-efficacy, motivation and confidence towards chemistry achievement	Self-efficacy scores, motivation scores, CKCS scores, students' semester total scores	Multiple regression analysis relating to the interpretation of the achievement in accordance with the self-efficacy, motivation and confidence scores
How do CKCS scores reflect students' actual chemistry achievement?	To interpret the influence of students' confidence on their chemistry achievement by using	CKCS scores, students' semester total scores	Descriptive statistics of CKCS scores, Regression analysis of confidence level scores on students' total scores, matching of

this CKCS instrument

the 20 questions to the real  
questions in the test in  
order to explore students'  
overconfidence level

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### 3.4.2 Content Knowledge Confidence Survey

The questions from Content Knowledge Confidence Survey (CKCS, Appendix B) were provided to the researcher by the instructor of the chemistry course from a previously administered course exam (final exam) to which students had no access. Twenty content questions were selected by the researcher from this exam that covered the most important chemistry concepts throughout the semesters. Students were given the survey through online website MOODLE and were asked only to assign one of the following three levels of confidence to each question:

- a. I have 100% confidence in answering this question
- b. I could answer 50% of this question or know where to get information quickly.
- c. I have no confidence in answering the question.

Students were not asked to work out the answer to the question, but only to respond with their level of confidence.

### 3.5 Research Timeline and Data Screening

In order to analyze the data that I received from the 427 students who chose to complete the survey, and I used the IBM SPSS software as my statistical tool. According to IBM Software website, IBM SPSS Statistics is an integrated family of products that addresses the entire analytical process, from planning to data collection to analysis, reporting and deployment. The

results were shown in the formats of descriptive statistics, t-test results, Pearson Correlations, multiple regression analysis results. The MOODLE data will be correlated with students' total semester scores provided by the instructor. Multiple regression analysis is about the interpretation of the chemistry achievement in accordance with self-efficacy, motivation and gender. The correlation of CKCS scores and total course scores will also be studied to reveal the benefits brought by knowledge survey. A t-test group statistics study will be done to determine if there is any significant gender difference on academic achievement. These scores can be used to develop a model to determine the power of each predictors.

Delivery of the DOMC (Discrete Option Multiple Choice) question format tests and exams was made possible through use of the MOODLE website. MOODLE enable test and exam delivery, course management, immediate grading, and immediate feedback of the multiple-choice questions in general. The LSU Moodle Website was used to track students' scores on all the assignments and exams, and finally summarized students' total semester scores. As invited by the chemistry course instruction, I got my permission as a guest instructor to track students' scores and compare with their total course scores of this course. Both of the MSLQ and CKCS surveys was preannounced in the class, and administered through Moodle. Students' responses to the survey were collected and summarized by Moodle. The collected data were used in SPSS analysis later. The details of the subjective survey and knowledge survey with consent scripts will be shown in the other attachment. A timeline of my research progress is shown in Table 3.2.

The first step of data analysis was data screening. I used the data screening check list from Chapter 4 of *Using Multivariate Statistics* (Tabachnick & Fidell, 1996).

1. Accuracy of the data file – I need to check if the data has been entered correctly. I completed this step on December 31, 2012.

2. Missing data – It is important to deal with missing data and find out if the data is missing randomly or if there is some pattern to why the data points are missing. I used the “Frequency” function of SPSS to check for missing data or cases. The result of is shown in Table 3.3.

Table 3.2 Timeline of Research Progress

	2012				2013							
	Se pt	No v	No v	Dec	Jan	Ap r	Jun	Jul	Au g	Se pt	Oct	Nov
Obtaining sources for background												
Researching methods												
Writing IPB proposal												
Obtaining IRB Approval												
Administering the survey												
Downloading data												
Writing the first three chapters												
Defending my proposal												
Analysis of												

data	
Writing	
dissertation	
Defense of	
dissertation	

Table 3.3 Checking Missing Data through “Frequency” function

		SE	MOT	CKCS	CTOT	HSGPA
N	Valid	427	427	427	427	298
	Missing	0	0	0	0	130

Note: SE= Self-Efficacy; MOT= Motivation; CKCS= Content Knowledge Confidence Survey

CTOT= Course Total Scores; HSGPA= High School Grade Point Average

### 3. Check for outliers.

#### 3.1 Outliers among dichotomous variables –This is identified by SPSS FREQUENCIES.

Since the only dichotomous variable in this study is gender, so I used SPSS

“Frequency” function to detect outliers. The result is shown in Table 3.4. There is no outlier for the variable of gender, since this dichotomous variable has a relatively even split of about 50% for each gender.

Table 3.4 SPSS Frequency Results on Gender

	Gender	Frequencies	Percent	Valid Percent	Cumulative percent
Valid	Female	151	50.7	50.67	50.67

Male	147	49.3	49.33	100.00
Total	298	100.0	100.00	

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3.2 Outliers among continuous variables –Since I am going to perform regression analysis with ungrouped data, univariate and multivariate outliers are sought among all cases at once.

- For univariate outliers, I used SPSS “Frequency” function to create histograms using SPLIT FILE. The histograms for each variable (SE, MOT, CKCS, HSGPA and CTOT) were plotted and no outliers were found. The example of the histogram for SE is shown in Figure 3.4.

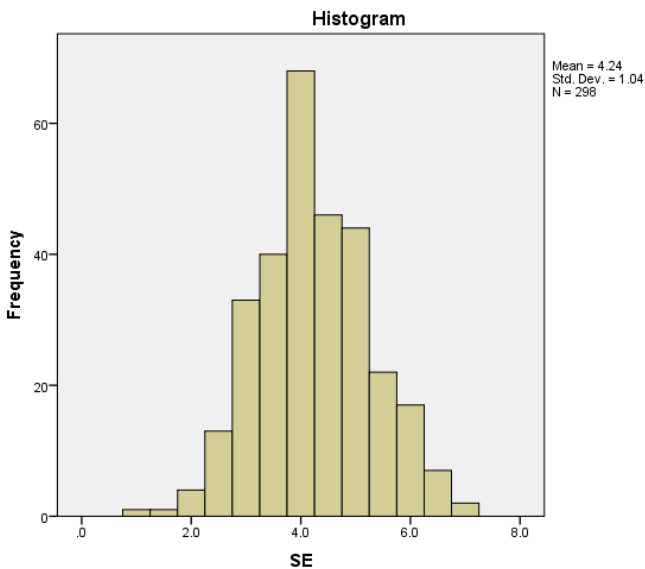


Figure 3.4 SPSS Histogram of SE

- For the multivariate outliers, I computed a Mahalanobis Distance for each case and used these scores to screen for outliers in the same manner that univariate outliers were screened. This analysis and screening was done for all variables. No multivariate outliers were found.

4. Normality – I need to have a normal distribution in order for my analysis to work properly. There are two aspects to normality of a distribution, skewness and kurtosis, and I tested for both of them.

- Skewness test – I used SPSS DESCRIPTIVES/EXPLORE to calculate skewness and the standard error for skewness. Then I divided the skewness value by the standard error for skewness and I got a z score for skewness. No number was found that is greater than 3.3 (Table 3.5). This set of data passed this test for skewness.
- Kurtosis test – I used SPSS DESCRIPTIVES/EXPLORE to calculate kurtosis and the standard error for kurtosis. Then I divided the kurtosis value by the standard error for kurtosis and I got a z score for kurtosis. No number was found that is greater than 3.3 (see Table 3.5 for an example of skewness and kurtosis data for SE). This set of data passed this kurtosis test.

Table 3.5 SPSS SE skewness, kurtosis, and z values

SE	Statistic	Std. Error	z score
skewness	.095	.141	0.674
kurtosis	-.065	.281	-0.231

5. Homoscedasticity, Homogeneity of Variance and Homogeneity of Variance-Covariance Matrices.

- Homoscedasticity – There is no formal test for this feature, but it can be seen graphically. According to the book *Using Multivariate Statistics* (Tabachnick & Fidell, 1996), “The bivariate scatterplots between two variables are roughly the same width

all over with some bulging toward the middle” (page 81). I chose “Graphs—scatterplot” and entered two variables in the X and Y axes, and I didn’t observe any abnormality from the result.

- Homogeneity of Variance – Since I don’t have grouped data, I don’t need to test this feature.
  - Homogeneity of Variance-Covariance Matrices – This multivariate assumption states that an entry in a variance-covariance matrix using one DV should be similar to the same entry in a matrix using another DV. I used Box’s M to check this hypothesis and didn’t observe any abnormality from the result.
6. Multicollinearity and Singularity – I ran bivariate correlations between all of my variables and found that they are neither subscales of another or above .90. The detailed result of this analysis can be found in Section 4.2 later.
  7. Common Data Transformations – Since I had satisfactory normality/ homoscedasticity for my data, I didn’t need to do this common data transformation and the dataset is ready to use for analysis.

### **3.6 Data analysis**

After data screening, the dataset is ready to use. I calculated the average score of self-efficacy based on the 10 questions of the SE in the survey for each of the 427 students. Then I did the same for the nine questions on motivation and calculated the average score of MOT for each student. I repeated this process for the CKCS scores. The high school GPA (HSGPA) was provided by the student.

The scores were used to calculate descriptive statistics, Pearson correlations, t-test results, ANOVA output and the regression analysis results. Finally, a multiple regression analysis

relating to the interpretation of the chemistry achievement in accordance with the self-efficacy, motivation and gender was run using SPSS.

When carrying out the multiple regression analysis, the variables are shown as follows:

Dependent Variable: CTOT (course total scores)

1. Independent Variable 1: SE (self-efficacy scores)
2. Independent Variable 2: MOT (motivation scores)
3. Independent Variable 3: CKCS (content knowledge confidence survey)
4. Independent Variable 4: HSGPA (high school GPA)

### **3.7 Limitations**

Limitations of this study were that the study participants were not randomly selected (they registered themselves into a particular section of chemistry). Another study limitation was that the sample size was small since it was taken from only one course and one semester. Although it may be better to collect data from multiple semesters in order to reduce data errors and variations, the data for this study was collected during only one semester. The Motivated Strategy for Learning Questionnaire (MSLQ) is a self-report instrument and subject to the limitations of a student self-report. The limitation of knowledge survey may increase students' anxiety levels since some content questions in the survey may increase students' anxiety that they haven't grasped the essence of the course before the test, and it is also a student self-report instrument. Finally, when students were self-reporting their high school GPA, which may decrease the reliability of this study.

### **3.8 Summary**

For this study, 427 students responded to the online survey about their self-efficacy and motivation regarding an introductory chemistry course. Variables included self-efficacy, motivation and gender, as well as their Content Knowledge Confidence Survey results and high school GPA. These variables were examined to determine their effects on the chemistry course achievement and their power as predictors of chemistry achievement.

## CHAPTER IV: RESULTS

### 4.1 Descriptive Results

The primary goal of this research is to explore the relationship between self-efficacy (SE), motivation (MOT), content knowledge confidence (CKCS) level and achievement (TOTSCORE). Descriptive statistics for these four parameters were run using SPSS. The results are shown in Table 4.1.

Table 4.1. Descriptive statistics of the survey results

	N	min	max	mean	SD	Skewness		Kurtosis	
						tat	Std error	tat	Td Error
SE	426	1	7.0	4.840	1.253	-.402	.118	-.267	236
MOT	426	1	7.0	3.273	1.049	-.218	.118	-.173	236
CKCS	426	0	2.0	1.393	0.502	-.475	.118	-.475	236
CTOT	426	239	1107	820.967	129.018	-.463	.118	-.505	236

From Table 4.1 we can see that there were 426 students who completed the survey. For the self-efficacy (SE) section, the minimum value is 1.0, which means “not true at all”, and the maximum value is 7.0 which means “very true”. The mean of SE is 4.84, which indicates that these students have a slightly positive level of self-efficacy. The standard deviation is 1.253, which is a little big, indicating that the SE value is different from person to person according to different psychological conditions and personalities.

For the motivation (MOT) section, the minimum value is 1.0 which means “not true at all”, and the maximum value is 7.0 which means “very true”. The mean of MOT is 3.273 which is slightly negative and indicates that these students’ motivation levels are low. The standard

deviation is 1.049, which is also a little big, indicating that the SE value is different from person to person according to different psychological conditions and personalities.

For the CKCS section, the minimum value is 0 which means that students have 0% of confidence to figure out the question, and the maximum value is 2.0 which indicates that students have 100% of confidence to figure out the question. The mean of CKCS is 1.393, which indicates that these students have relatively high confidence in their understanding of the chemistry. The standard deviation is 0.502, and this medium size standard deviation indicates that students are confident in the 20 questions given in the survey or it could indicate the students may be overconfident because of the limited content of this knowledge survey and thought that they have grasped the content very well.

From the kurtosis and skewness data (Table 4.1) we can tell that the distributions of all the four types of scores have slight kurtosis and skewness to the left when compared to a normal distribution. This distribution indicates there is an accumulation towards higher scores.

#### **4.2 Pearson Correlations among All Variables in the Model**

Pearson Correlations were run for the following combinations: SE \* MOT, SE \*CKCS, SE \*CTOT, MOT \*CTOT, MOT \*CKCS, CKCS \*CTOT. I will focus on the magnitude and direction (negative or positive) of the correlations.

From Table 4.2 it is observed that there is a medium positive relationship between self-efficacy and motivation and the strength is 0.283. This result means that students with higher self-efficacy scores tend to have higher motivation scores.

Table 4.2 Correlations Table between SE and MOT

		SE	MOT
SE	Pearson Correlation	1	.283**
	Sig. (2-tailed)		.000
	N	426	426
MOT	Pearson Correlation	.283**	1
	Sig. (2-tailed)	.000	
	N	426	426

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

From Table 4.3 it is observed that there is a medium positive relationship between self-efficacy scores and Content Knowledge Confidence Survey scores and the strength is 0.366. This result means that students with a higher self-efficacy score tend to have higher confidence levels.

From Table 4.4 it is observed that there is a strong positive relationship between self-efficacy scores and total course scores and the strength is 0.588. This result means that students with a higher self-efficacy score tend to have higher total course scores at the end of the semester, indicating that SE is a strong and powerful indicator that can be used to predict students' chemistry achievement.

From Table 4.5 it is observed that there is a weak positive relationship between motivation scores and total course scores and the strength is 0.050. This result means that students with higher self-efficacy score do not tend to have higher total course scores in the end, indicating that MOT is not a good indicator to predict students' chemistry achievement.

Table 4.3 Correlations Table between SE and CKCS

		SE	CKCS
SE	Pearson Correlation	1	.366**
	Sig. (2-tailed)		.000
	N	426	426
CKCS	Pearson Correlation	.366**	1
	Sig. (2-tailed)	.000	
	N	426	426

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

Table 4.4 Correlations Table between SE and CTOT

		SE	CTOT
SE	Pearson Correlation	1	.588**
	Sig. (2-tailed)		.000
	N	426	426
CTOT	Pearson Correlation	.588**	1
	Sig. (2-tailed)	.000	
	N	426	426

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

From Table 4.6 it is observed that there is a weak positive relationship between motivation scores and Content Knowledge Confidence Survey scores and the strength is 0057. This result means that students with higher motivation do not have the confidence to grasp all the content through the course.

Table 4.5 Correlations Table between MOT and CTOT

		MOT	CTOT
MOT	Pearson Correlation	1	.050
	Sig. (2-tailed)		.307
	N	426	426
CTOT	Pearson Correlation	.050	1
	Sig. (2-tailed)	.307	
	N	426	426

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

Table 4.6 Correlations Table between MOT and CKCS

		MOT	CKCS
MOT	Pearson Correlation	1	.057
	Sig. (2-tailed)		.242
	N	426	426
CKCS	Pearson Correlation	.057	1
	Sig. (2-tailed)	.242	
	N	426	426

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

From Table 4.7 it is observed that there is a medium positive relationship between CKCS scores and total course scores, and the strength is 0.295. This result means that students with higher CKCS scores tend to have higher total course scores in the end, indicating that CKCS is a strong and powerful indicator in predicting students' chemistry achievement.

Table 4.7 Correlations Table between CKCS and MOT

		CKCS	CTOT
CKCS	Pearson Correlation	1	.295**
	Sig. (2-tailed)		.000
	N	426	426
CTOT	Pearson Correlation	.295**	1
	Sig. (2-tailed)	.000	
	N	426	426

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

### 4.3 Multiple Regression Results

When running the multiple regressions, I used CTOT as the dependent variable, and SE, MOT and CKCS as the independent variables for Model 1. The summary for Model 1 is shown in Figure 4.8.

Table 4.8 Model 1 Summary

	R	R Square	Adjusted R Square	Std. Error of the Estimate
Model 1	.606	.367	.362	103.02431

NOTE: Predictors: (Constant), CKCS, MOT, SE

The "R" column represents the value of R, the multiple correlation coefficient. R can be considered to be one measure of the quality of the prediction of the dependent variables; in this case, CTOT. A value of 0.606 indicates a good level of prediction. The "R Square" column represents the R<sup>2</sup> value (also called the coefficient of determination), which is the proportion of variance in the dependent variable that can be explained by the independent variables. The R

Square value of 0.367 indicates that the independent variables explain 36.7% of the variability of our dependent variable, CTOT.

The F-ratio in the ANOVA table (Table 4.9) tests whether the overall regression model is a good fit for the data. The independent variables are statistically significant predictors in this model to predict the levels of the dependent variables,  $F(3, 422) = 81.504$ ,  $p < .0005$ .

Table 4.9 ANOVA Table

		Sum of Squares	df	Mean Square	F	Sig.
Model 1	Regression	2,595,247.465	3	865,082.488	81.504	.000
	Residual	4,479,111.452	422	10,614.008		
	Total	7,074,358.918	425			

NOTE: Dependent Variable: CTOT; Predictors: (Constant), CKCS, MOT, SE

#### 4.4 Estimated Model 1 Coefficients

The general form of equation to predict chemistry achievement (CTOT) by using the predictors of SE, MOT and CKCS is:

$$\text{predicted CTOT} = 544.880 + (60.870 * SE) - (15.089 * MOT) + (22.142 * CKCS)$$

This is obtained from the Coefficients table (Table 4.10).

From this equation we can conclude that the most important indicator to predict chemistry achievement is self-efficacy. The negative motivation value indicates that students' average motivation level for this course is low. We can also see that CKCS is also a useful indicator to predict students' academic achievement. We may use this Model 1 equation to predict students' achievement from the beginning of the semester.

Table 4.10 Model 1 Coefficients Results

Model 1	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	544.880	23.907		22.792	.000
SE	60.870	4.468	.591	13.624	.000
MOT	-15.089	4.976	-.123	-3.033	.003
CKCS	22.142	10.723	.086	2.065	.040

Note: Dependent Variable: CTOT

#### 4.5 Multiple Regression Using High School GPA as an Additional Variable

In Section 4.4, I used the three variables of SE, MOT and CKCS to predict students' total scores (CTOT). In Model 1, the SE and CKCS are the most important predictors to forecast students' academic achievement in introductory chemistry and MOT had a negative relationship with students' academic achievement. However, in the online survey given at the end of the semester I also collected additional information about students' high school GPA (HSGPA). When I added the HSGPA into the multiple regression (Model 2), I found that the power of prediction (R square) was weaker (Table 4.11), and I was able to create an estimated model coefficients equation for Model 2.

Table 4.11 Model 2 Multiple Regression Results

	R	R Square	Adjusted R Square	Std. Error of the Estimate
Model 2	.521 <sup>a</sup>	.271	.261	108.438

Predictors: (Constant), HSGPA, SE, CKCS, MOT

The F-ratio in the ANOVA table (Table 4.12) of the overall regression model is a good fit for the data. The table shows that the independent variables statistically significantly predict the dependent variable,  $F(3, 298) = 27.129$ ,  $p < .0005$ . Now the prediction equation changes to:

$$\text{predicted CTOT} = 341.884 + (3.094 * SE) + (39.281 * MOT) + (49.374 * CKCS) + (56.017 * HSGPA)$$

Table 4.12. Model 2 ANOVA Table

		Sum of Squares	df	Mean Square	F	Sig.
Model 2	Regression	1275999.516	3	318999.879	27.129	.000
	Residual	3433573.029	294	11758.812		
	Total	4709572.545	298			

NOTE: Dependent Variable: CTOT; Predictors: (Constant), HSGPA, SE, CKCS, MOT

From this equation we see that now HSGPA is the most important significant predictor, and SE is not as important in predicting students' CTOT (Table 4.13). In addition, MOT now changes from a negative predictor to a powerful positive predictor.

It is important to note that the first multiple regression (Model 1) was done using the sample of 426 students who completed the survey, while the second regression analysis (Model 2) was done using the sample of 298 students in this 426-person group who also provided their high school GPA. So in order to compare the regression prediction results more accurately, I am going to use the first model to run multiple regression analysis on this same 298-person sample (Model 1B). In Table 4.14 we see that the prediction power (R square) is 0.224, which is slightly smaller than that of the analysis based on 426 students.

Table 4.13. Model 2 Coefficient Table

Model 2	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	341.884	53.649		6.373	.000
SE	3.094	7.639	.025	.405	.686
MOT	39.281	8.113	.316	4.842	.000
CKCS	49.374	13.265	.195	3.722	.000
HSGPA	56.017	13.136	.220	4.264	.000

Dependent Variable: CTOT

Table 4.14 Model 1B Multiple Regression Results

	R	R Square	Adjusted R Square	Std. Error of the Estimate
Model 1B	.473	.224	.216	111.528

Predictors: (Constant), SE, CKCS, MOT

The F-ratio in the ANOVA table (Table 4.15) of the overall regression model (Model 1B) is still a good fit for the data. The table shows that the independent variables statistically significantly predict the dependent variable,  $F(3, 298) = 28.232$ ,  $p < .0005$ . Now the prediction equation changes to:

$$\text{predicted CTOT} = 524.020 + (1.732 * SE) + (44.447 * MOT) + (56.861 * CKCS)$$

From this new equation we learn that now CKCS is the most important significant predictor (Table 4.16). In addition, MOT plays an important role as a predictor for both models with or without adding the HSGPA.

Table 4.15. Model 1B ANOVA Table

		Sum of Squares	df	Mean Square	F	Sig.
	Regression	1053467.797	3	351155.932	28.232	.000
Model 1B	Residual	3656901.295	294	12438.440		
	Total	4710369.092	298			

NOTE: Dependent Variable: CTOT; Predictors: (Constant), SE, CKCS, MOT

Table 4.16. Model 1B (modified with HSGPA) Coefficients Table

Model 1B	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	524.020	34.170		15.336	.000
SE	1.732	7.821	.014	.221	.825
MOT	44.447	8.254	.358	5.385	.000
CKCS	56.861	13.490	.225	4.214	.000

NOTE: Dependent Variable: CTOT; Predictors: (Constant), SE, CKCS, MOT

#### 4.6 Does Gender Make a Difference?

I am interested in this question because Chemistry has long been considered a male-dominated field. I used student gender data and ran independent-sample t-tests to see if there were any significant differences between genders on their SE, MOT, CKCS, HSGPA, and CTOT scores (Table 4.17).

In Table 4.17 I used sample of 298 students because this is the sample that everyone in the sample provided detailed background information to be analyzed later. From the group

statistics, no significant differences are observed on genders, but the independent sample test (Table 4.18) does show something interesting.

Table 4.17 t-test group statistics

	GENDER	N	Mean	Std. Deviation	Std. Error Mean
SE	Female	151	4.205	1.0332	.0841
	Male	147	4.276	1.0488	.0865
MOT	Female	151	4.5894	1.04377	.08494
	Male	147	4.4371	.97873	.08072
CKCS	Female	151	1.361	.5169	.0421
	Male	147	1.415	.4768	.0393
HSGPA	Female	151	3.84	.449	.037
	Male	146	3.64	.522	.043
CTOT	Female	151	811.46	136.069	11.073
	Male	147	810.31	115.092	9.493

The Laverne's test of .730 in the SE section (Table 4.18) indicates that we should assume equal variances. The t-test significance of the SE section is .561, so there does not appear to be a difference in means. So we can conclude that the gender difference is not significant for SE scores. Using the same method, we can then conclude that MOT, CKCS and CTOT are the same as SE and there are no significant differences on gender to these variables. However, for the HSGPA section, the gender difference is statistically significant since the t-test significance of

the HSGPA section is .000, which indicates that gender difference exist in students' high school GPA and may influence students' chemistry academic performance in college.

Table 4.18 Independent Samples Test

		Levene's Test <sup>a</sup>		t-test for Equality of Means						
		F	Sig. <sup>b</sup>	t	df	Sig.	Mean Diff	Std. Error Diff	95% Conf. Interval of the Diff	
									Lower	Upper
SE	Equal variances assumed	.119	.730	-.582	296	.561	-.0702	.1206	-.3076	.1671
	Equal variances not assumed			-.582	295.482	.561	-.0702	.1206	-.3076	.1672
MOT	Equal variances assumed	.302	.583	1.299	296	.195	.15233	.11728	-.07848	.38314
	Equal variances not assumed			1.300	295.587	.195	.15233	.11718	-.07829	.38294
CKCS	Equal variances assumed	.940	.333	-.937	296	.349	-.0540	.0576	-.1675	.0594
	Equal variances not assumed			-.938	295.146	.349	-.0540	.0576	-.1674	.0593
HSGPA	Equal variances assumed	29.155	.000	3.497	295	.001	.197	.056	.086	.308
	Equal variances not assumed			3.488	285.399	.001	.197	.057	.086	.309
CTOT	Equal variances assumed	3.671	.056	.079	296	.937	1.151	14.618	-27.617	29.918
	Equal variances not assumed			.079	290.365	.937	1.151	14.585	-27.555	29.857

<sup>a</sup>Levene's Test for Equality of Variances; <sup>b</sup>(2-tailed)

#### 4.7 Metacognition and Overconfidence

In the previous literature review, I've talked about the metacognition and the phenomenon of overconfidence. In order to find out the effect of students' overconfidence on their chemistry learning, I sorted the students' CTOT from the smallest to the highest, and this

sorting was expanded to the corresponding CKCS scores. The sample size is 426, which is the number of students who took the survey. Then I divided the 426 into three groups: lowest third, middle third, and highest third according to their CTOT scores, which indicates three different groups of academic success. Each group has 142 students. Next I calculated the average CTOT and CKCS per each group using Excel. Finally the ratio of CKCS/CTOT were calculated and the results are shown in table 4.19.

Table 4.19 Average CKCS/CTOT scores for the three groups

	CKCS	CTOT	CKCS/CTOT
Lowest Third (1st-143th)	1.225	676.750	0.00181
Middle Third (144th-285th)	1.412	826.635	0.00171
Highest Third (286th-427th)	1.542	959.512	0.00161

A bar graph using the ratio of CKCS/CTOT was created and data labels were added as in Figure 4.1. From Figure 4.1 it is observed that the overestimation on the CKCS scores by weaker students and the more accurate estimation by the strongest students is now quite obvious, since the ratios of CKCS/CTOT for the three groups are decreasing. The relationships shown are nearly identical to those repeatedly displayed in the research of Dunning and Kruger and their colleagues. The relationship, the so-called Dunning – Kruger effect, has been replicated many times under various experimental and real-world conditions. Generally, people with less competence will have a positive bias for rating themselves or their performance as above average. In fact, more than half of them will tend to rate their competence or their performance well “above average”, a notion that does not make obvious sense. The more incompetent the individual, the greater this positive bias becomes. That is, the more incompetent people are, the

greater the difference between their self-assessment and actual ability. Extremely competent people, on the other hand, will have more accurate self-assessment, and may even show negative bias.

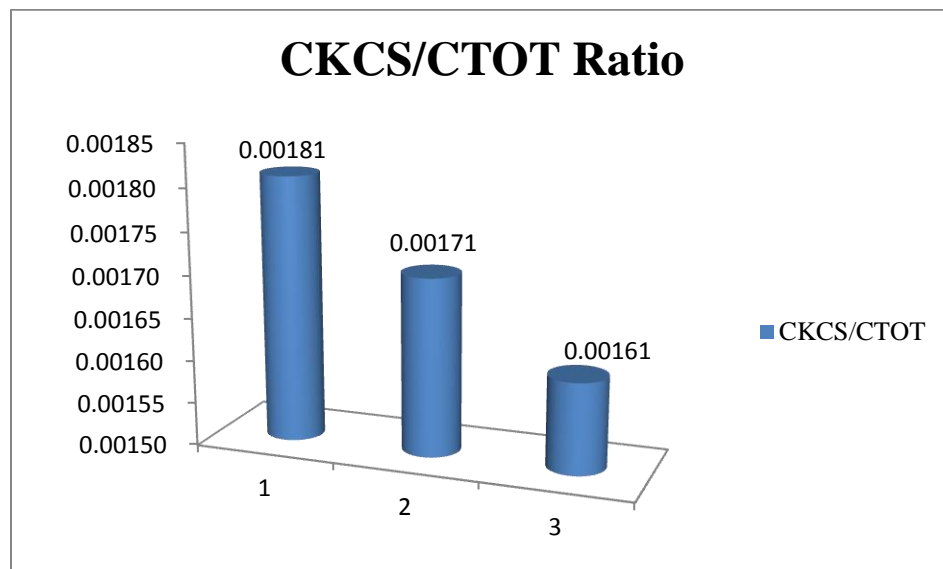


Figure 4.1 CHEM 1202 CKCS/CTOT ratios based on three academic levels (1=lowest third, 2=middle third, 3 = highest third)

#### 4.8 Summary

I used the descriptive statistics and the correlations among the variables to generate an equation to predict students' academic achievement (Model 1, see Section 4.4), which is:

$$CTOT = 544.880 + (60.870 * SE) - (15.089 * MOT) + (22.142 * CKCS)$$

The power of this prediction (R square) is 0.367. This is a medium-strong relationship to predict the CTOT when R equals to 0.606. SE is observed as the strongest predictor, but MOT is shown as a moderately weak negative predictor. Next I added the background information, High School GPA (HSGPA), into the model and generated a different model (Model 2; Section 4.5), which is:

$$CTOT = 341.884 + (3.094 * SE) + (39.281 * MOT) + (49.374 * CKCS) + (56.017 * HSGPA)$$

The power of this prediction (R square) was reduced to 0.271, so the strength of the prediction was reduced. I found that in this prediction equation HSGPA became the most important predictor and MOT changed to a predictor which had strong positive relationship with the CTOT. Next I used the same 298-person sample to run the first regression model and got another prediction equation (Model 1B; Section 4.5):

$$\text{CTOT} = 524.020 + (1.732 * \text{SE}) + (44.447 * \text{MOT}) + (56.861 * \text{CKCS})$$

If we compare the last two equations, we see similar trends for this prediction of academic chemistry achievement. Motivation and CKCS serve as the strongest predictors. So motivation and content confidence can be used to predict students' chemistry academic achievement in this regression model. Among all the three prediction equations, the second equation is the best prediction since it contains all the variables included and has a relatively higher SE power.

## CHAPTER V FINDINGS AND CONCLUSIONS

### 5.1 Findings of This Study

In this study, in order to determine the power of predictors (attitude, self-efficacy and gender) for students' academic achievement in one undergraduate chemistry course and to find the benefits of knowledge survey, correlations and regressions were made for the purpose.

For this purpose, an online survey was designed and 426 non-chemistry major college students who enrolled in one Fall 2012 sections of an introductory Chemistry course (CHEM 1201) at Louisiana State University completed the survey. Statistical analysis was applied to data to answer the sub-questions. Concerning the attitude variable, it was found out that (a) students at Louisiana State University who enrolled in this CHEM 1202 course tend to have a relatively high level of self-efficacy, motivation and confidence towards their academic achievement; that (b) there is no attitude difference or confidence difference according to gender on this chemistry course, but there is statistically significant difference based on gender and the students' previous high school GPA; and that (c) the Kurtosis and Skewness Table of Descriptive Results (as it is seen in Table 4.1) we can tell that the distributions of all the four types of scores (SE, MOT, CKCS and CTOT) have slight kurtosis and skewness to the left when compared to normal distribution. This distribution shows there is an accumulation towards higher scores, which means that students with higher scores tend to have higher levels of self-efficacy, motivation and confidence.

Next the correlations among the four variables were examined using the following combination: SE \* MOT, SE \*CKCS, SE \*CTOT, MOT \*CTOT, MOT \*CKCS, CKCS \*CTOT. Pearson correlations for each combination were run in order to explore the correlations among

these variables, and I focused on the magnitude and direction (negative or positive) of the correlations. So the relationships between the four variables are as following:

- SE \* MOT, medium positive relationship.
- SE \*CKCS, medium positive relationship.
- SE \*CTOT, strong positive relationship.
- MOT \*CTOT, weak positive relationship.
- MOT \*CKCS, weak positive relationship
- CKCS \*CTOT, medium positive relationship.

From the above results we can see that self-efficacy score can be used as powerful predictors to predict students' chemistry achievement.

When running the multiple regressions, I used CTOT as the dependent variable, and SE, MOT and CKCS as the independent variables. The results show that a R square value of 0.367. This means that our independent variables explain 36.7% of the variability of our dependent variable, CTOT. The F-ratio in the ANOVA table tests indicates whether the overall regression model is a good fit for the data. I thus developed the Model 1 equation to predict students' academic achievement, which is:

$$CTOT = 544.880 + (60.870 * SE) - (15.089 * MOT) + (22.142 * CKCS)$$

The power of this prediction (R square) is 0.367. This is a medium-strong relationship to predict the CTOT when R is equal to 0.606. SE is observed as the strongest predictor, but MOT is shown as a moderately weak negative predictor. Then I added the background information, High School GPA, into the model and generated a different model equation (Model 2), which is:

$$CTOT = 341.884 + (3.094 * SE) + (39.281 * MOT) + (49.374 * CKCS) + (56.017 * HSGPA)$$

The power of this prediction (R square) has been reduced to 0.271, so the strength of the prediction has been reduced. I found that in this prediction equation HSGPA became the most important predictor and MOT changes to a predictor that has strong positive relationship with the CTOT. Then I used the same 298-person sample to run the first regression model and got a third model equation (Model 1B):

$$CTOT = 524.020 + (1.732 * SE) + (44.447 * MOT) + (56.861 * CKCS)$$

If we compare the last two equations, we see similar trends for this prediction of academic chemistry achievement (CTOT). Motivation and CKCS serve as the strongest predictors. So motivation and content confidence can be used to predict students' chemistry academic achievement in this regression model.

In addition, the effects of gender and overconfidence were investigated, whose findings were coherent with other researchers' works. There is no statistically significant difference for students' scores on self-efficacy, motivation, and confidence between male and female students. But there is statistically significant difference for students' high school GPA between male and female students, whose reason needs further investigation. For the factor of overconfidence, I divided the students into three groups in increasing order according to their CTOT scores: lowest third, middle third and highest third. The result reveals the overestimation on the CKCS scores by weaker students and the more accurate estimation by the strongest students is now quite obvious, since the ratios of CKCS/CTOT for the three groups are decreasing when their CTOT scores are increasing.

The study revealed that affective characteristics as the self-efficacy beliefs, motivation and confidence levels, are significant predictors of academic achievement in agreement with Levin, Sabar & Libman's (1991), House & Prison's (1998), and Baykul's (1990); presence of a

significant relationship between the affective characteristics scores and students' final scores is in agreement with Morgil & Seçken (2004); and the indication of overconfidence phenomenon corresponds to Kruger – Dunning Effect. This study develops three model equations with the predictors of self-efficacy, motivation, confidence and high school GPA. This model can be used by education researchers and teachers to predict students' future academic achievement in several chemistry courses.

## **5.2 Importance of This Study**

The present study is important since it comes up with multiple models to use self-efficacy, motivation and confidence scores to predict students' future academic achievement in several chemistry courses. It is the first study that researcher has combined the affective characteristics and MSLQ instrument with the increasingly popular instruction tool Content Knowledge Confidence Survey in the chemical education field. It reveals the relationships between affective characteristics and students' academic achievement. It sheds light on the effect of multiple-choice test format and knowledge survey on student performance while this performance is also moderated by motivational beliefs and cognitive strategy use. This study presented three prediction equations by using these factors in order to predict students' chemistry achievement and the prediction power of the two equations are both relatively high, which means that chemistry instructors can use this instrument and modify it on their instructional content to use for their students in order to predict their future academic achievement at the beginning of the semester.

This study is important because many students, especially those attending community college in larger numbers lack the insight that they are underperforming but they can improve their grades if they can have higher levels of self-efficacy, motivation and confidence, since their

positive affective characteristics can promote their future academic success. This study can inspire students and also instructors to work harder to achieve higher levels of learning since the correlations of these variables are promising. In addition, it found that gender is not a statistically importance issue in order to learn chemistry well, which breaks the stereotype that chemistry is a male-dominated field and inspires females students to be more confident on their chemistry studying.

### **5.3 Implications**

Instructors can use the model equations based on the survey data used in this research to predict chemistry students' learning outcomes in introductory chemistry courses at the beginning of the semester to better organize student study groups based. For example, instructors can organize student study groups so that they reflect a wide range of predicted student achievement levels. Study groups organized through this means will have students who are expected to do well in the course and who can peer mentor fellow students who might need additional help. Chemistry instructors can then pay special attention to students who have the lowest scores of this model (which indicates that they are at risk), and students who really need help can be identified and helped by the instructor. In addition, the CKCS survey can be a perfect reference for students to examine their learning levels before the final exam and thus to be more motivated to study for the final exam.

In addition, this study might also be helpful in educational programs such as credit recovery programs, community-based activities or new teachers' training workshops. Educators can use this survey as pre-test and post-test to evaluate students or new teaches' knowledge levels prior to and after the programs. The comparison of the two test results can be used to

analyze the effectiveness of the programs. This survey can be also used in other science course such as Biology, Physics, or Environmental Science.

#### **5.4 Recommendation for Further Research**

Future research might address the use of these models as predictors of achievement for student based on their majors. The students who completed the survey came from different majors and the effects of different majors on chemistry learning can be examined later. From my informal observations, students whose majors are closer to Chemistry, such as Biology, Environmental Science or Food Science, tend to have higher levels of self-efficacy, motivation and confidence in this study, compared with students of other majors.

Another factor that could be researched is the effect of anxiety on student achievement. During my informal talks with the students, I found that students who have too much anxiety often have relatively low motivation and final grades. So it may be an interesting topic to use this build in to this survey a measure of their anxiety level to see if there is a correlation of anxiety with confidence, or with final scores.

My last recommendation for future research is to perform a similar study on students of different college levels (e.g., freshmen, sophomores, juniors and seniors) who are enrolled in introductory chemistry. Usually students who enroll in this introductory chemistry course are freshmen or sophomores, but some are further along in their college course of study when they take the course. So it might be interesting to students of different groups according to their college level or perhaps the number of times that they have failed the course.

## **5.5 Implications for Science Education**

This study examines a possible method to predict students' chemistry academic achievement. In the field of science education, more and more researchers are calling for the need to strengthen self-regulations in students' learning. Schraw, Crippen, & Hartley (2006) drew on several self-regulated learning examples to illustrate effective instructional methods and the needs to develop metacognitive understanding. They also examined the role of personal beliefs such as self-efficacy and worldviews and concluded that science educators should pay attention to these factors and pick up new instructional strategies to promote students' self-regulated learning. My study can be used as an instrument for educators to estimate students' self-regulated learning levels and predict their academic achievement.

In addition to self-efficacy and motivation, my study also explores whether science self-efficacy and motivations differ by gender, which is also a current topic in the science education world. My study can be used to predict college undergraduates' self-efficacy and motivation beliefs, and reveal their current levels of learning. It may be useful for school administrators to evaluate and estimate the current science education situation in universities to determine certain problems related within this process.

## **5.6 Study Limitations**

One limitation of this study was that instead of random selection, the study participants were self-selected in that they registered for specific sections. Another study limitation was that the sample sizes for the treatment and control groups were relatively small. Although it may be better to collect data from multiple semesters in order to reduce data errors and variations, the data for this study were collected during one semester. The Motivated Strategy for Learning Questionnaire (MSLQ) is a self-report instrument and subject to the limitations of a student self-

reports. The limitation of CKCS may increase students' anxiety levels since some content questions in the survey may increase students' anxiety that they haven't grasped the essence of the course before the test, and it is also a student self-report instrument. Finally, when students were reporting their high school GPA, this was a self-report format. So errors exist when some students deliberately reported the wrong high school GPA.

## **5.7 Conclusions**

Self-efficacy, motivation and confidence are subjective predictors of students' academic achievement. My study was conducted on 426 students enrolled in General Chemistry I classes (Chemistry for science majors) during a regular 15-week semester at Louisiana State University. It is a combined instrument of MSLQ and CKCS. The online survey was administered during the last week of classes. Data were analyzed via descriptive statistics, and correlation, linear and multiple regression statistical analyses with the correlation of total semester scores. Finally two prediction equations were proposed and the powers of prediction are relatively strong by using these variables as predictors. The findings indicated that gender did not show a statistical difference on students' self-efficacy, motivation, confidence and final chemistry achievement. However, when adding previous high school GPAs to the data, gender did indicate statistical differences on these factors. This is a promising tool that can be used in many ways of implications.

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## APPENDIX I. IRB CONSENT SCRIPT

1. **Study Title:** The Power of Affective Factors (Self-Efficacy, Motivation and Gender) to Predict Chemistry Achievement with the Benefits of Knowledge Surveys on Metacognition Level
2. **Performance Site:** Louisiana State University and Agricultural and Mechanical College
3. **Investigators:** The following investigators are available for questions about this study, M-F, 8:00 a.m. - 4:30 p.m.  
Xin Wu, 225-933-7888  
Dr. Elzbieta Cook, 225-578-3574
4. **Purpose of the Study:** The purpose of this research project is to determine whether achievement in general chemistry can be foreseen by combining the three factors with knowledge survey.
5. **Subject Inclusion:** Individuals between the ages of 18 and 65 who do not report psychological or neurological conditions
6. **Number of subjects:** About 700 subjects.
7. **Study Procedures:** The study will be conducted in two phases through Moodle. In the first phase, subjects will spend approximately 20 minutes completing the subjective part of survey on self-efficacy, gender and motivation. In the second phase, subjects will spend approximately 30 minutes completing a knowledge survey on Chemistry content to report their metacognition level.
8. **Benefits:** Subjects will gain insights and information when using knowledge survey as their review materials, and their learning motivation level will be enhanced.
9. **Risks:** The only study risk is the inadvertent release of sensitive information found in the first phase of questionnaire. However, every effort will be made to maintain the confidentiality of your study records. Files and all the other information will be kept in secure digital drive with password protection to which only the investigator has access.
10. **Right to Refuse:** Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.
11. **Privacy:** Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

## APPENDIX II. MSLQ QUESTIONNAIRE

Please rate the following items based on your behavior in this class. Your rating should be on a 7-point scale where **1= not at all true of me** to **7=very true of me**.

### Part I: Self-efficacy

- 1) Compared with other students in this class I expect to do well
- 2) I'm certain I can understand the ideas taught in this course
- 3) I expect to do very well in this class
- 4) Compared with others in this class, I think I'm a good student
- 5) I am sure I can do an excellent job on the problems and tasks assigned for this class
- 6) I think I will receive a good grade in this class
- 7) My study skills are excellent compared with others in this class
- 8) Compared with other students in this class I think I know a great deal about the subject
- 9) I know that I will be able to learn the material for this class
- 10) When I am confronted with a problem, I can usually find several solutions.

### Part II: Motivation and gender issues

IN GENERAL, I STUDY FOR THIS COURSE . . .

- 1) because of the pleasure I feel as I become more and more skilled.
- 2) for the pleasure I feel mastering what I am doing.
- 3) because of the satisfaction I feel in trying to excel in what I do.
- 4) because I do not want to disappoint certain people.
- 5) because I want to be viewed more positively by certain people.
- 6) even though my major has little relations to it.
- 7) in order to show others what I am capable of.
- 8) even though I do not think my gender is suitable for this
- 9) even though I am not interested in it
- 10) even though I believe they are not worth the trouble

### APPENDIX III. KNOWLEDGE SURVEY ANSWER SHEET

Please assign one of the three levels of confidence to each question:

- a. I have confidence in answering this question
- b. I could answer 50% of this question or know where to get information quickly.
- c. I have no confidence in answering the question.

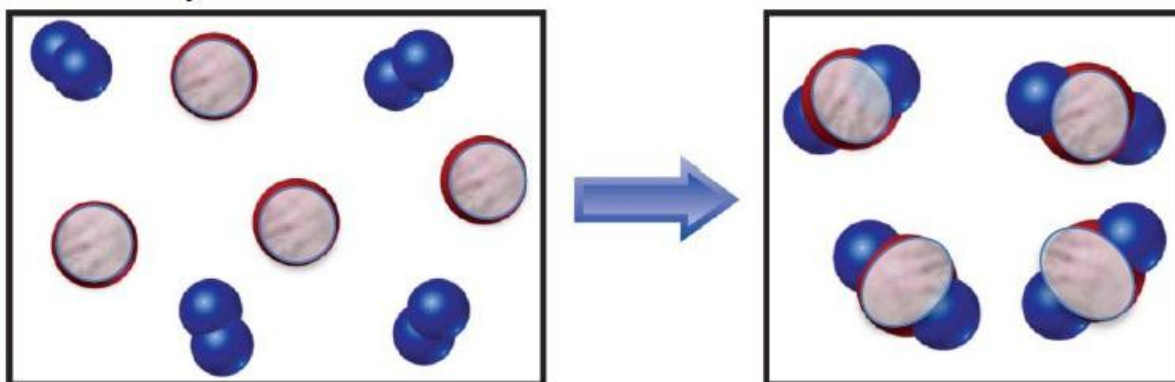
Question 1	a	b	c	Question 11	a	b	c
Question 2	a	b	c	Question 12	a	b	c
Question 3	a	b	c	Question 13	a	b	c
Question 4	a	b	c	Question 14	a	b	c
Question 5	a	b	c	Question 15	a	b	c
Question 6	a	b	c	Question 16	a	b	c
Question 7	a	b	c	Question 17	a	b	c
Question 8	a	b	c	Question 18	a	b	c
Question 9	a	b	c	Question 19	a	b	c
Question 10	a	b	c	Question 20	a	b	c

#### APPENDIX IV. KNOWLEDGE SURVEY CONTENT QUESTIONS

- 1) Which statement below is false?
  - a) Most transition metals have atomic radii of 0.1 to 0.2 nm (or 1 to 2 Å).
  - b) The temperature of boiling water in your kitchen is about 373 K.
  - c) The volume of a small cup of coffee is about 200 ML.
  - d) The distance from Baton Rouge to New Orleans is about 120 km.
  - e) The height of a typical human being is about  $1.7 \times 10^3$  mm.
  
- 2) Which calculation below has an answer expressed with an INCORRECT number of significant figures:
  - a)  $15 \times (444/11.1) = 6.0 \times 10^2$
  - b)  $83.1 + 20.2 = 103.3$
  - c)  $(4.20 \times 10^2) \times (1.003 \times 10^3) = 4.21 \times 10^5$
  - d)  $1103 - 991.2 = 111.8$
  - e)  $1831 \times 6 = 1 \times 10^4$
  
- 3) According to the Bohr's model, what is the energy of photons emitted when electrons in hydrogen atoms return from the 2nd excited state ( $n = 3$ ) to the 1st excited state ( $n = 2$ )?
  - a)  $2.42 \times 10^{-19}$  J
  - b)  $1.94 \times 10^{-18}$  J
  - c)  $1.64 \times 10^{-18}$  J
  - d)  $3.63 \times 10^{-19}$  J
  - e)  $3.03 \times 10^{-19}$  J
  
- 4) The following subatomic particle count is correct for : 28 protons, 31 neutrons, 26 electrons.
  - a)  $^{59}\text{Ni}^{2+}$
  - b)  $^{59}\text{Ga}^{2+}$
  - c)  $^{31}\text{P}^{3-}$
  - d)  $^{54}\text{Xe}$
  - e)  $^{26}\text{Fe}^{2-}$
  
- 5) Which name does not have its correct chemical formula?
  - a)  $\text{ZnCrO}_4$  zinc(II) chromate
  - b)  $\text{SO}_3$  sulfur trioxide
  - c)  $(\text{NH}_4)_2\text{SO}_3$  ammonium sulfate
  - d)  $\text{HPO}_4^{2-}$  hydrogen phosphate ion

e)  $\text{CaI}_2$  calcium iodide

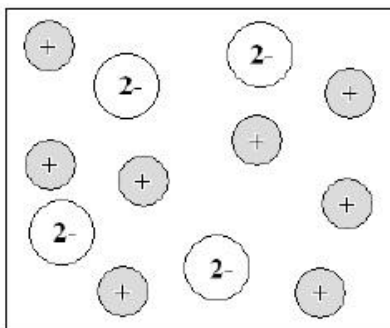
- 6) The reaction between reactant A (dark spheres) and reactant B (light spheres) is best described by which reaction?



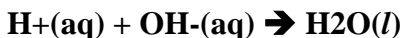
- a)  $\text{A}_2 + \text{B} \rightarrow \text{A}_2\text{B}$   
b)  $2 \text{A} + \text{B}_4 \rightarrow 2 \text{AB}_2$   
c)  $\text{A}_2 + 4 \text{B} \rightarrow 2 \text{AB}_2$   
d)  $\text{A} + \text{B}_2 \rightarrow \text{AB}_2$   
e)  $2 \text{A} + 4 \text{B} \rightarrow \text{A}_2\text{B}_4$
- 7) A molecule is found to contain 47.35% C, 10.60% H and 42.05% O. What is the empirical formula of the compound?

- a)  $\text{C}_2\text{H}_6\text{O}$   
b)  $\text{C}_2\text{H}_6\text{O}_2$   
c)  $\text{C}_3\text{H}_6\text{O}$   
d)  $\text{C}_3\text{H}_8\text{O}_2$   
e)  $\text{C}_4\text{H}_{10}\text{O}$

- 8) The diagram below represents an aqueous solution of one of the following compounds. Which solution does it best represent?

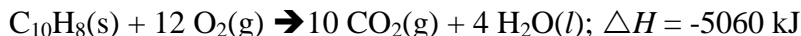


- a)  $\text{K}_2\text{SO}_4$
  - b)  $\text{KCl}$
  - c)  $\text{MgCl}_2$
  - d)  $\text{C}_2\text{H}_5\text{OH}$  (ethanol)
  - e)  $\text{C}_6\text{H}_{12}\text{O}_6$  (glucose)
- 9) Which one of the reactions shown below has the following net ionic equation?



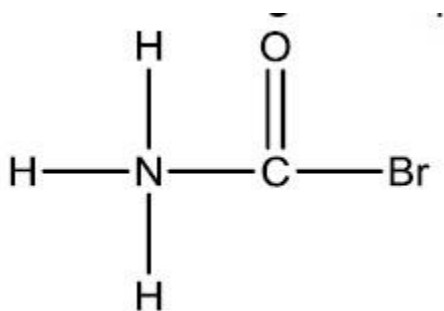
- a)  $\text{Ca}(\text{OH})_2(\text{aq}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$
  - b)  $2 \text{HNO}_2(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \text{Ba}(\text{NO}_2)_2(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$
  - c)  $\text{NH}_4\text{Cl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NH}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) + \text{NaCl}(\text{aq})$
  - d)  $2 \text{HClO}_4(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) + 2 \text{NaClO}_4(\text{aq})$
  - e)  $\text{HClO}(\text{aq}) + \text{NH}_4\text{OH}(\text{aq}) \rightarrow \text{NH}_4\text{ClO}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- 10) A volume of 3.45 mL of 8.95 M aqueous hydrochloric acid is poured onto a large chunk of chalk ( $\text{CaCO}_3$ ), and the reaction is:  $\text{CaCO}_3(\text{s}) + 2 \text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ . What mass of chalk dissolves and what mass of carbon dioxide is formed, assuming 100% yield?
- a) 1.55 g  $\text{CaCO}_3$ ; 0.679 g  $\text{CO}_2$
  - b) 0.773 g  $\text{CaCO}_3$ ; 1.36 g  $\text{CO}_2$
  - c) 1.55 g  $\text{CaCO}_3$ ; 1.36 g  $\text{CO}_2$
  - d) 3.09 g  $\text{CaCO}_3$ ; 0.679 g  $\text{CO}_2$
  - e) 3.09 g  $\text{CaCO}_3$ ; 1.36 g  $\text{CO}_2$

- 11) How many moles of oxygen were used in the combustion of solid naphthalene,  $\text{C}_{10}\text{H}_8$ , if 51 kJ of energy were released to the surroundings?



- a) 0.12 mol
  - b) 0.080 mol
  - c) 9.9 mol
  - d)  $1.0 \times 10^{-2}$  mol
  - e)  $4.0 \times 10^{-2}$  mol
- 12) Select the choice which gives a correct set of values for  $n$ ,  $l$ , and  $m_l$  for an orbital in the subshell given.
- a) An orbital in the 7f subshell is allowed to have the values  $n = 7$ ,  $l = 4$ ,  $m_l = +5$ .
  - b) An orbital in the 6d subshell is allowed to have the values  $n = 7$ ,  $l = 6$ ,  $m_l = +5$ .
  - c) An orbital in the 5p subshell is allowed to have the values  $n = 5$ ,  $l = 2$ ,  $m_l = 0$ .
  - d) An orbital in the 7d subshell is allowed to have the values  $n = 7$ ,  $l = 2$ ,  $m_l = +3$ .
  - e) An orbital in the 3p subshell is allowed to have the values  $n = 3$ ,  $l = 1$ ,  $m_l = -1$ .
- 13) Choose the answer in which the elements S, Ge, and He are listed in order of increasing electron affinity. The element listed last should have the highest tendency to acquire an additional electron.
- a)  $\text{S} < \text{Ge} < \text{He}$
  - b)  $\text{Ge} < \text{S} < \text{He}$
  - c)  $\text{Ge} < \text{He} < \text{S}$
  - d)  $\text{He} < \text{S} < \text{Ge}$
  - e)  $\text{He} < \text{Ge} < \text{S}$

14) Which atom in this molecule has the greatest partial negative charge?



- a) H
- b) N
- c) C
- d) O
- e) Br

15) Which of these molecules or ions is predicted to have the shortest sulfur-oxygen bonds (assuming all atoms obey the octet rule when you draw Lewis structures for these species!)

I.  $\text{SO}_2$

II.  $\text{SO}_3$

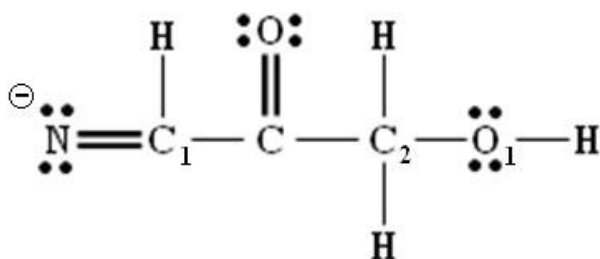
III.  $\text{SO}_3^-$

- a) Molecule I has the shortest sulfur-oxygen bond.
- b) Molecule II and ion III have the shortest sulfur-oxygen bonds.
- c) Ion III has the shortest sulfur-oxygen bond.
- d) The sulfur-oxygen bonds in I, II, and III are all the same length.
- e) Molecule II has the shortest sulfur-oxygen bonds.

16) Which statement is correct about the bond angles in  $\text{NCl}_3$  and  $\text{CCl}_4$ ?

- a) The angles in  $\text{NCl}_3$  are approximately  $120^\circ$
- b) The angles in  $\text{CCl}_4$  are approximately  $109^\circ$
- c) The angles in  $\text{CCl}_4$  are approximately  $90^\circ$
- d) The angles in  $\text{NCl}_3$  are approximately  $180^\circ$
- e) Both a & b are correct

17) In the structure shown below, which is/are the correct hybridizations?



I. The hybridization of  $C_1$  is  $sp^2$ .

II. The hybridization of  $C_2$  is  $sp^3$ .

III. The hybridization of  $O_1$  is  $sp$ .

- a) I and II are correct hybridizations
- b) I and III are correct hybridizations
- c) II and III are correct hybridizations
- d) I, II and III are all correct hybridizations
- e) Only III is correct

18) A gas in a closed, rigid container at  $27^\circ\text{C}$  has a pressure of 312 torr. If the temperature were raised to  $58^\circ\text{C}$ , what would the gas pressure be?

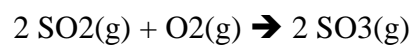
- a) 344 torr
- b) 644 torr
- c) 214 torr
- d) 507 torr
- e) 398 torr

19) Methanol,  $\text{CH}_3\text{OH}$ , would have which of the following intermolecular attractive forces: I

London dispersion II Ion-dipole III Dipole-dipole IV H-bonding

- a) I, III and IV
- b) III and IV
- c) IV
- d) all of them
- e) I, II and III

20) Sulfur dioxide is made from the reaction of sulfur dioxide and oxygen:



What is the maximum volume of  $\text{SO}_3$  produced in a reaction of 1.91 g  $\text{SO}_2$  with 1.29 g  $\text{O}_2$ ?

The  $\text{SO}_3$  gas is collected at STP conditions.

- a) 22.4 L
- b) 0.903 L
- c) 1.34 L
- d) 1.81 L
- e) 0.671 L

## APPENDIX V. IRB APPROVAL LETTER

### ACTION ON PROTOCOL APPROVAL REQUEST



Institutional Review Board  
Dr. Robert Mathews, Chair  
131 David Boyd Hall  
Baton Rouge, LA 70803  
P: 225.578.8692  
F: 225.578.6792  
[irb@lsu.edu](mailto:irb@lsu.edu) | [lsu.edu/irb](http://lsu.edu/irb)

**TO:** Xin Wu  
Human Sciences & Education

**FROM:** Robert C. Mathews  
Chair, Institutional Review Board

**DATE:** November 28, 2012

**RE:** IRB# 3334

**TITLE:** The Power of Affective Factors (Self-Efficacy, Motivation and Gender) to Predict Chemistry Achievement with the Benefits of Knowledge Surveys on Metacognition

**New Protocol/Modification/Continuation:** New Protocol

**Review type:** Full ☐ Expedited ☒ **Review date:** 11/29/2012

**Risk Factor:** Minimal ☒ Uncertain ☐ Greater Than Minimal ☐

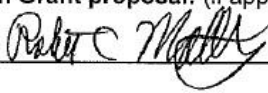
**Approved** ☒ **Disapproved** ☐

**Approval Date:** 11/29/2012 **Approval Expiration Date:** 11/28/2013

**Re-review frequency:** (annual unless otherwise stated)

**Number of subjects approved:** 700

**Protocol Matches Scope of Work in Grant proposal:** (if applicable) ☐

**By:** Robert C. Mathews, Chairman 

**APPENDIX VI. STUDENT DATA**

Student	SE	MOT	CKCS	HSGPA	APChem	CTOT	GENDER
1	3.5	4.75	1.5	3.73	0	916.83	Female
2	3	4	1.5	4	0	923.3	Female
3	4	4	2	3.85	0	804.94	Male
4	4.5	5.25	1	4.52	0	897.69	Female
5	4.5	2.75	2	3.6	0	647.24	Female
6	3.5	3.75	1	3.96	0	724.44	Female
7	3.5	4.25	1.5	3.8	0	954.87	Female
8	2.5	4.25	2	3.8	1	750.8	Female
9	5.5	5.75	1.5	3.8	0	882.05	Female
10	3	5	1	3.1	0	746.36	Female
11	3	4.5	2	3.3	0	808.62	Male
12	4	5	1.5	4.062	0	1000.71	Female
13	5	5.5	1	3.6	0	746.58	Male
14	4	5.5	1	3	0	775.25	Male
15	5.5	5.25	1.5	3.7	0	737.77	Female
16	4	4	0	4	0	693.09	Female
17	5	5	2	3.5	0	856.95	Male
18	5.5	5.25	0.5	3.7	0	975.79	Male
19	3	3.5	1	3	0	746.03	Male
20	5	4.5	2	2.8	0	631.84	Male
21	4.5	3.75	1	3.5	0	777.25	Female
22	4	4	1	3.2	1	654.79	Male
23	4.5	4.25	1	3.8	0	869.08	Male
24	5	3.5	1	3.57	1	955.78	Male
25	4.5	4.75	1.5	3.3	0	828.16	Female
26	4.5	4.25	1.5	4	0	1014.39	Female
27	4	2.5	1.5	3.2	0	788.06	Female
28	5	4.5	1.5	3.65	1	697.43	Male
29	5.5	6.25	0.5	3.5	0	715.1	Female
30	4	5	2	4.1	1	887.04	Female
31	3.5	5.25	2	3.9	1	883.1	Female
32	5.5	5.75	1.5	4.5	0	1049	Female
33	3.5	4.25	2	3.9	0	860.08	Female
34	1	1	0	3	1	624.42	Female
35	5	5	1	3.3	0	808.32	Male
36	4	5	2	3.1	0	858.99	Male
37	5.5	6.25	1.5	4	0	988.86	Male
38	2.5	2.75	1	3.6	0	705.83	Female

**APPENDIX VI. STUDENT DATA (con't)**

Student	SE	MOT	CKCS	HSGPA	APChem	CTOT	GENDER
39	4	3.5	2	2.8	0	782.92	Male
40	5	4.5	1	3.85	0	778.22	Female
41	6.5	5.75	2	3.34	0	934.59	Male
42	4	5	1	3	0	859.52	Female
43	4.5	4.75	1	3.6	1	788.64	Female
44	6	6	1	3.5	0	982	Female
45	2.5	2.75	1	3.2	0	791.06	Male
46	5	5.5	2	4.29	0	1076.28	Female
47	5	3.5	0.5	4.236	0	568.32	Female
48	4	4	2	3.8	1	872.68	Male
49	3.5	4.75	1.5	3.4	0	751.69	Female
50	5	5.5	1.5	3	0	893.71	Female
51	3.5	4.75	1	4.1	0	932.01	Female
52	5	4.5	0.5	3.3	0	533.06	Male
53	4	4	1.5	3.8	1	805.3	Female
54	3	2.5	1.5	3.54	1	886.42	Male
55	3	3.5	1	3.5	0	460.73	Female
56	4	4	2	3.71	0	706.59	Male
57	4	5	0.5	3.7	0	850.32	Female
58	4.5	3.25	1.5	3	0	700.35	Male
59	5.5	4.75	1.5	3.89	0	621.48	Female
60	3.5	3.25	1	3.5	0	705.91	Female
61	3	4	1.5	3.78	0	757.11	Female
62	4.5	4.75	1	3.6	0	1006.41	Female
63	4	5.5	2	4.2	0	1006.41	Male
64	3.5	3.75	2	3.4	0	707.83	Male
65	4	3	1	3.5	0	849.92	Male
66	3.5	5.25	0.5	3.4	0	857.67	Male
67	5	6	1.5	3.9	0	713.1	Female
68	4	3.5	2	3.7	0	789.79	Male
69	5	4.5	1.5	3.75	0	656.65	Male
70	4.5	5.25	2	3.97	0	911.02	Male
71	4	5	1.5	3.6	0	836	Female
72	4.5	5.75	1.5	3.85	0	950.32	Female
73	4	4	1	3.6	0	417.42	Female
74	4	3.5	1	3.8	0	586.54	Male
75	4.5	5.25	1.5	3.2	0	848.76	Female
76	5.5	5.75	2	3	0	760.94	Female
77	4	5	2	3.8	1	827.55	Female

**APPENDIX VI. STUDENT DATA (con't)**

Student	SE	MOT	CKCS	HSGPA	APChem	CTOT	GENDER
78	3.5	5.25	2	3.5	0	780.13	Female
79	3.5	2.75	1.5	3.5	0	724.27	Female
80	4.5	4.75	1	3.7	0	978.75	Male
81	5	4.5	1	4.2	0	790.03	Male
82	4	4.5	1.5	3.48	0	762.83	Male
83	3.5	4.75	1	3.5	0	745.88	Male
84	4	5.5	2	4	0	1006.57	Female
85	3.5	4.75	2	4.6	0	954.41	Female
86	4.5	5.25	2	4.5	0	893.02	Female
87	3	4	2	3.2	0	841.3	Male
88	5	3.5	1.5	3.6	0	928.08	Male
89	6	5.5	1.5	3.8	0	961.5	Male
90	4.5	3.75	0.5	2.8	0	808.47	Female
91	5	5	1	3.5	0	787.57	Male
92	4	4.5	1.5	3	0	799.12	Male
93	3.5	3.75	2	3.5	0	943.79	Male
94	3	4	1.5	3	0	928.43	Male
95	4.5	4.75	1.5	3.75	0	1056.74	Male
96	2.5	4.75	1.5	3.86	0	729.7	Male
97	4	5	1.5	3.93	1	957.33	Female
98	3	3	1	4.1	1	675.98	Male
99	4	5	1	3.5	0	901.93	Female
100	4.5	5.75	1.5	3.8	0	893.58	Female
101	3	3	1	3.9	0	832.33	Male
102	6.5	6.75	1.5	4.3	0	831.22	Female
103	3	3.5	0.5	3.6	0	769.26	Male
104	3.5	5.25	1.5	3.9	1	872.14	Female
105	4.5	2.75	1	4	0	977.55	Male
106	4.5	5.25	0.5	3.4	0	732.31	Female
107	4	5.5	1.5	3.65	0	761.46	Female
108	3	5	1.5	3.4	0	762.38	Male
109	4.5	5.75	1.5	3.4	0	913.98	Male
110	4	5	1.5	3.8	0	906.73	Female
111	6	6	1.5	4	0	899.83	Female
112	4.5	5.25	1	3.7	0	630.7	Male
113	4	5.5	2	3.7	0	1001.23	Female
114	5	5.5	2	3.75	0	897.79	Female
115	4	3	1	3	0	701.35	Male
116	6	6	1.5	3.5	0	763.79	Female

**APPENDIX VI. STUDENT DATA (con't)**

Student	SE	MOT	CKCS	HSGPA	APChem	CTOT	GENDER
117	5.5	4.75	1.5	4.3	0	923.28	Female
118	4.5	4.75	2	3.97	0	889.66	Female
119	4	5	1	3.6	0	784.01	Female
120	3	5	2	3	0	714.22	Female
121	5	5.5	1	3.45	0	714.39	Female
122	3	4.5	2	3.8	1	848.46	Female
123	7	4	2	3.8	0	878.88	Male
124	6	5.5	2	3.7	0	849.28	Male
125	4	4.5	1.5	3.5	1	700.75	Male
126	2.5	3.75	1	97%	0	851.58	Male
127	6	5.5	1.5	3.8	0	712.03	Male
128	4	5.5	1	3.5	0	917.52	Female
129	4	5.5	0.5	3.68	0	1029.88	Male
130	3	3.5	1	3.8	0	654.03	Female
131	4	5	2	4.9	0	922.2	Male
132	4.5	3.75	0.5	3.6	0	620.78	Male
133	5.5	4.75	2	4	0	907.44	Female
134	4.5	4.75	1.5	3.8	0	1051.13	Male
135	4.5	5.75	1	3.8	0	1018.61	Male
136	3.5	4.25	2	3.99	0	812.81	Male
137	4	3	2	4.6	1	813.59	Male
138	3.5	5.25	2	3.7	0	920.28	Male
139	4.5	4.25	0.5	3.8	0	688.69	Female
140	3.5	4.75	1.5	2.8	0	694.7	Male
141	5.5	5.75	0.5	3.4	0	648.7	Female
142	3.5	4.25	2	3.4	0	700.21	Female
143	4.5	4.75	1	3.66	0	770.26	Female
144	5	4.5	1	3.8	0	832.06	Male
145	5	4.5	1	3.17	0	711	Male
146	4.5	5.25	1.5	3.2	0	742.45	Female
147	3	4	1.5	3.4	0	661.8	Male
148	4.5	4.25	1	3.6	1	583.49	Male
149	6.5	6.25	1.5	3.9	0	969.65	Male
150	3	3	0.5	3.4	0	682.72	Male
151	4	5.5	1.5	3.7	0	863.98	Male
152	5	5	1	3.4	0	700.91	Female
153	4	4.5	2	4	0	1071.26	Female
154	4	4	1	3.7	0	820.94	Female
155	4	5.5	1	3.83	1	893.63	Male



**APPENDIX VI. STUDENT DATA (con't)**

Student	SE	MOT	CKCS	HSGPA	APChem	CTOT	GENDER
195	5	6	2	3.57	0	911.74	Male
196	5.5	5.75	1.5	3.75	0	731.87	Male
197	3	4	1.5	3.9	0	729.71	Male
198	5	4.5	1	3.8	0	883.39	Female
199	4	3	1.5	2.9	0	707.12	Male
200	4.5	4.75	2	3.96	0	820.85	Male
201	3.5	4.25	1.5	3.97	0	947.28	Female
202	4	4.5	1.5	3.6	0	928.81	Female
203	5	3.5	1.5	3.8	0	757.59	Female
204	4	4.5	1	3.6	0	866.02	Male
205	4	5.5	1.5	4.25	0	826.89	Female
206	4	3.5	1	4.2	0	636.74	Female
207	3	3.5	1.5	3.654	1	804.37	Male
208	5.5	4.25	1	3.4	0	664.79	Female
209	5	5	2	3.52	0	944.77	Female
210	2.5	3.25	2	4.5	1	850.54	Male
211	4.5	4.75	1.5	3.84	0	896.6	Male
212	3.5	2.25	1	3.12	0	707.04	Male
213	4.5	4.75	1	2.75	0	794.6	Male
214	5.5	5.75	2	3.9	0	897.41	Male
215	5	4.5	0.5	3	0	833.29	Female
216	6	5.5	2	4.89	0	1026.34	Female
217	4	4.5	1.5	3.8	0	443.35	Female
218	3.5	3.75	1	3.81	0	952.24	Male
219	4	5	1.5	4.13	0	772.92	Male
220	4.5	3.75	0.5	4	0	820.74	Male
221	3.5	4.75	2	4	0	942.01	Female
222	6	6.5	1	4.4	0	942.01	Female
223	2.5	1.75	0	3.8	0	797.32	Female
224	4.5	3.25	0	2.5	0	539.37	Male
225	4	4	0.5	3.3	0	692.1	Male
226	4	5	1.5	3.49	0	978.28	Male
227	2.5	2.25	1.5	3.2	1	761.81	Male
228	4.5	5.75	2	3.86	0	922.01	Male
229	3.5	4.75	2	3.46	0	649.84	Male
230	4.5	4.25	0.5	3	0	717.54	Male
231	3.5	4.25	2	3.5	1	902.32	Male
232	4	3	1.5	3.9	0	723.32	Female
233	5	5.5	1.5	3.8	0	932.44	Male

**APPENDIX VI. STUDENT DATA (con't)**

Student	SE	MOT	CKCS	HSGPA	APChem	CTOT	GENDER
234	2.5	3.75	2	3.5	0	644.34	Female
235	3	4.5	1.5	4	0	790.33	Female
236	5	5	1.5	3.78	1	963.87	Male
237	4.5	5.75	1.5	3.98	0	1065.88	Female
238	6	4	1.5	3.9	1	737.57	Male
239	5	3	0.5	3.25	0	469.86	Female
240	6.5	5.25	2	3.86	0	877.4	Male
241	4	5.5	2	3.6	0	931.13	Female
242	2.5	4.25	1.5	3.8	0	696.72	Female
243	6	5	2	4	0	783.04	Male
244	4	5.5	2	3.98	0	955.28	Female
245	4	5	1.5	3.6	0	804.67	Male
246	3.5	4.75	1	4	0	872.03	Male
247	4	4.5	1.5	3.4	0	787.05	Male
248	6	6	1.5	4	0	954.05	Female
249	3.5	4.25	1.5	3	0	810.82	Female
250	5	5.5	1.5	3.96	0	804.76	Female
251	4	4	1.5	3.5	0	725.4	Male
252	5.5	5.75	2	4.4	0	960.91	Female
253	4	4	1.5	3.02	0	766.58	Male
254	3	5	1.5	3.95	0	867.76	Female
255	4	5.5	1.5	4	1	858.48	Male
256	5	4.5	2	4	0	989.04	Male
257	3	4.5	1.5	3.75	0	724.14	Male
258	3.5	3.25	1.5	3.9	0	901.57	Female
259	2.5	1.75	1.5	3.5	0	622.91	Male
260	5	4	1.5	3.3	0	794.38	Male
261	4	4	2	4.4	0	994.23	Female
262	6.5	5.75	1.5	4	0	851.08	Male
263	5	3.5	0.5	2.48	0	715.75	Female
264	5	6	1	4.21	1	828.52	Female
265	5	5	1	3.8	0	706.62	Male
266	4	4	1	3.4	0	789.32	Female
267	3.5	3.75	1.5	4	0	631.34	Female
268	3	3	1	3.1	0	834.95	Male
269	3.5	3.25	0.5	3.95	0	644.6	Female
270	5	4	1	3.1	0	856.14	Male
271	5	4	1	4.22	0	680.66	Female
272	3.5	4.75	1.5	2.8	0	767.34	Male

**APPENDIX VI. STUDENT DATA (con't)**

Student	SE	MOT	CKCS	HSGPA	APChem	CTOT	GENDER
273	3.5	4.75	1.5	3.7	1	841.49	Female
274	6	6	1.5	4	0	819.24	Male
275	4	3	2	3.4	0	668.02	Female
276	3	3	1	3.8	0	740.86	Female
277	2	2.5	1.5	3	0	595.09	Female
278	5	5.5	1.5	3.9	0	896.16	Female
279	6	5.5	1	4	0	784.46	Female
280	3	2.5	1	3.7	0	735.92	Female
281	2.5	2.75	2	3.2	0	618.09	Male
282	4	4	1.5	3.5	0	878.05	Female
283	3.5	3.25	2	3.4	0	753.42	Male
284	4	5.5	0.5	3.6	0	613.84	Female
285	3.5	4.25	1	3.56	0	853.3	Male
286	5.5	5.25	2	4.42	0	944.71	Female
287	6	4.5	1.5	2.8	0	763	Male
288	4.5	5.25	1.5	3.29	0	720.24	Male
289	5	4	1	2.9	0	852.94	Male
290	2	1.5	1	3.8	0	617.15	Female
291	3	3.5	0.5	3.7	0	768.07	Female
292	4	5.5	2	3.6	0	908.88	Male
293	4.5	4.75	1	4	0	1001.72	Female
294	7	6	2	4	0	978.11	Male
295	5	4.5	1.5	3.8	0	724.71	Female
296	4.5	4.75	1	3.2	0	710.32	Male
297	4.5	4.25	1.5	3.3	0	638.73	Male
298	2	4	1.5	3.5	0	460.13	Female

## **VITA**

Xin Wu was born in Xingtai, Hebei Province, China. After finishing her bachelor degree in Chemistry in 2008, she went to study as a PhD student in the Chemistry Department of Louisiana State University. After two years of Analytical Chemistry graduate study and teaching in the general chemistry lab, she recognized her talents and interest in Science Education. So she transferred to the College of Human Sciences & Education in Louisiana State University in the fall of 2010. Then she started taking courses in the doctoral program of Curriculum & Instruction with the specialization of Science Education.