STUDENT SELF-EFFICACY IN COLLEGE SCIENCE: AN INVESTIGATION OF GENDER, AGE, AND ACADEMIC ACHIEVEMENT

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ABSTRACT

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This study investigated the relationships between self-efficacy, gender, age, and academic achievement in a two-year college science course, Anatomy and Physiology (A & P). A confidential self-report survey was administered to 216 A & P students to measure student self-efficacy levels. Most students had moderate to high levels of self-efficacy in A & P. A potential relationship between gender and self-efficacy was studied but no significant relationship was found between them. A connection between age and self-efficacy was also examined to determine whether differences existed in self-efficacy between traditional college students (18 to 24 years of age) and nontraditional college students (greater than 24 years of age). No significant findings linked age to self-efficacy. However, there was a significant positive relationship found between self-efficacy and the number of completed college semesters. Finally, the relationship between self-efficacy level and academic achievement in A & P was investigated. Students' midterm and

final A & P grades were used as the measure of academic achievement. Of 216 survey respondents, 158 released their A & P grades for this study. ANOVA results comparing self-efficacy to both midterm and final A & P grades showed highly significant positive relationships between self-efficacy and academic achievement in A & P. Because of the significant link found between self-efficacy and academic achievement, recommendations are presented for educators on how they can address low student self-efficacy levels.

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CHAPTER I.
INTRODUCTION

Background

Gender bias in math and science classrooms has been and still continues to be a problem (American Association of University Women [AAUW], 1999; Sadker & Sadker, 1995). Despite improvements in the past two decades, girls still are less likely than boys to take physics and higher-level math and science courses in high school (AAUW, 1999). As a consequence, fewer female students may study math and science at the college level. The types of courses taken in high school and how students perform in these courses can impact acceptance into college, choice of college major, and subsequent career choice (AAUW, 1999). Students who studied science and math in college tend to work in higher-paying careers, such as those in engineering and biotechnology (AAUW, 1999; "Girls' Math / Science Education," 1998).

Starting in seventh grade, girls tend to underestimate their abilities in math and science despite the fact that their performance remains the same as boys (Sadker & Sadker, 1995). This trend continues on through high school. "…A loss of self-confidence – rather than any differences in abilities – may be what produces the first leak in the female science pipeline" (Alper, 1993, p. 410). Confidence is strongly correlated to which students continue in math and science courses and which do not (Jewett, 1996). It is thought that self-efficacy may explain course selection patterns in high school that eventually lead to the underrepresentation of women in science (Tippins, 1991). Regardless of gender, more career options, including potentially higher career aspirations, are considered by those students who possess a high degree of self-efficacy (Bandura, 1986). In essence, "…efficacy beliefs partly shape the courses that lives take" (Bandura, 1997, p. 239). If a female believes she is unable to succeed in math or science, this altered perception may then subsequently manifest itself in lower grades or in avoidance of math and science courses altogether.

Self-Efficacy

Self-efficacy, also called perceived ability, refers to the confidence people have in their abilities that they can successfully perform a particular task (Bandura, 1997). "…Humans, who engage in considerable self-reflective thought, boost or undermine their efforts by beliefs about their capabilities" (Bandura, 1986, p. 412). Students with low self-efficacy give up more easily in their academic pursuits than students with high self-efficacy. A student's level of self-efficacy is influenced by past successes and failures which can then subsequently impact future successes or failures, such as grades.

Several studies (DeBacker & Nelson, 1999, 2000; Miller, et al., 1996; Pintrich & DeGroot, 1990; Smist, Archambault, & Owen, 1997; Tippins, 1991) have documented that females have lower levels of self-efficacy in math and science courses compared to males. For example, it was found that high school girls, regardless of achievement level, scored lower than boys on perceived ability in biology, chemistry, and physics (DeBacker & Nelson, 2000). In another study, perceived ability was the greatest predictor of semester grades for females in high school biology (DeBacker & Nelson, 1999). Despite many studies at lower levels of education, almost no studies have investigated whether such gender differences exist in student self-efficacy levels in college science.

Numerous studies (Andrew, 1998; Bandura, 1997; Chemers, Hu, & Garcia, 2001; Greene & Miller, 1996; Miller, et al., 1996; Multon, Brown, & Lent, 1991; Pajares, 1996; Pintrich & DeGroot, 1990; Silver, Smith, & Greene, 2001) link self-efficacy to both general academic achievement and science achievement. In a meta-analysis for example, positive and statistically significant relationships were found between self-efficacy, academic performance, and persistence for a number of disciplines (Multon, Brown, & Lent, 1991). Self-efficacy also positively related to achievement in community college students (Silver, Smith, & Greene, 2001).

It is believed that self-efficacy in science may affect science learning, choice of science, amount of effort exerted, and persistence in science (Kennedy, 1996). Many studies (Andrew,

1998; DeBacker & Nelson, 1999, 2000; Pintrich & DeGroot, 1990; Smist, 1993; Wainwright & Gallahan, 1999) have found a connection between self-efficacy and science achievement.

In this researcher's experience as a science instructor at a two-year technical college, it was noticed that students had varying levels of confidence in their abilities for success in various science courses, such as Basic Chemistry Calculations, Basic Biology, and Anatomy and Physiology I. Female students seemed to express the most doubts in their capabilities whereas male students frequently seemed overconfident. Nontraditional college students, defined as those older than 24, seemed to exhibit the most trepidation.

This study investigated the relationships between self-efficacy, academic achievement, gender, and age in Chippewa Valley Technical College (CVTC) Anatomy and Physiology I (A & P) students. A & P is a course that intensively studies the structure and function of the human body's systems and is typically taken by students entering nursing and other allied health professions. The majority of students enrolled in this course are women completing preparatory work needed for future enrollment in nursing or other health programs.

It was believed these students would have moderate to high levels of self-efficacy for science since students self-selected themselves into A & P and health professions. Based on the results of past research, it was also believed that female students would score lower in self-efficacy for A & P than male students would. Another thought was that nontraditional college students, who have larger gaps of time in their education, would score lower on self-efficacy than traditional college students who have no gaps in their education. Nontraditional students also may have attended high school at a time when more gender bias existed in science classes which could have adversely affected their levels of self-efficacy. Finally, it was expected that students with higher self-efficacy levels would earn higher midterm and final A & P grades than students with lower self-efficacy.

Because student self-efficacy and academic achievement are connected, educators should first become aware of student self-efficacy levels and then undertake efforts to raise any low self-efficacy levels they may find. Educators should also become aware of any inadvertently negative influences they may be exerting on student self-efficacy because just as self-efficacy can be raised, it also can be lowered. Strategies to boost self-efficacy could help increase student retention as well as increase academic self-confidence and achievement in science. Increasing student success in science will help ensure that students continue in their healthcare programs, training for occupations where workers are in great demand and salaries are competitive. Students may also possess the confidence to further their education with baccalaureate and advanced degrees.

Statement of the Problem

The purpose of this study was to measure self-efficacy levels in students enrolled in the science course Anatomy and Physiology I (A & P) at Chippewa Valley Technical College (CVTC). This study also documented whether differences in self-efficacy existed based on gender and age. Finally, it determined whether student self-efficacy beliefs related to academic achievement in A & P. Self-efficacy data was collected from 216 students using a confidential self-report survey administered during the Fall 2002 semester. Academic achievement was measured by examining students' midterm and final A & P grades. Of 216 survey respondents, 158 gave permission for their grades to be released for this study.

Research Questions

There were four research questions this study answered. They were:

1. What was the level of self-efficacy for CVTC students enrolled in Anatomy and Physiology?
2. Was there a difference in self-efficacy for students based on gender?
3. Was there a difference in self-efficacy for students based on age?
4. Was there a relationship between self-efficacy and academic achievement in Anatomy and Physiology?

Assumptions and Limitations

It was assumed that students would have accurate perceptions of their self-efficacy levels and would honestly report their self-efficacy. It also was assumed that midterm and final course grades were an accurate assessment of achievement in Anatomy and Physiology.

Limitations to the study include the fact that other variables affecting achievement were not controlled. Grades may not necessarily be the best measure of academic achievement, but if a grade of C- or lower is earned in Anatomy and Physiology, the student needs to retake the course. Results are limited to the answers provided by the respondents and can not be generalized outside of CVTC. Results also may not be the same for different science disciplines, such as chemistry and physics, within the institution. If students did not have accurate perceptions of their self-efficacy levels, then the findings will not be an accurate reflection. Finally, students who take science courses at the college level may have higher self-efficacy levels than students who avoid science at CVTC.

Definition of Terms

Academic achievement – operationally defined as success in a class based on test scores and course grades

Allied health professions – supportive healthcare occupations, including jobs such as medical laboratory technicians, x-ray technicians, and ultrasonographers

Anatomy and Physiology I (A & P) – science course that intensively studies the structure and function of the human body's systems, typically taken by students entering nursing and other allied health professions

Gender – the sex, male or female, of an individual

Nontraditional student – a college student older than 24 years or one who has had a break in education (Hirschorn, 1988), often a single parent or married with children, working full-time (Kinsella, 1998)

Perceived ability – SEE SELF-EFFICACY

Self-efficacy – the confidence individuals have in their abilities that they can successfully perform particular tasks (Bandura, 1997)

Traditional student – a college student under the age of 24, never married, often working part-time (Kinsella, 1998)

CHAPTER II.
LITERATURE REVIEW

Introduction

This chapter will present research about self-efficacy as it relates to cognition beginning with a definition and discussion of the background of self-efficacy. It will emphasize the works of Albert Bandura, the pioneer researcher in this area, who first proposed the theory of self-efficacy. Research studies that relate self-efficacy to gender will then be discussed providing support that quite often females have lower self-efficacy in the disciplines of math and science compared to males. The influence of self-efficacy on academic performance will be covered explaining the connection between self-efficacy and achievement in general. Self-efficacy's effects on college students will also be presented. Finally, self-efficacy and achievement in science courses will be addressed, though research describing the situation for science at two-year colleges has not been conducted.

Definition and Description of Self-Efficacy

Self-efficacy, also called perceived ability, refers to the confidence people have in their abilities for success in a given task (Bandura, 1997). If they possess the ability to successfully perform, then that task will be attempted. The task will be avoided if it is perceived to be too difficult (Bandura, 1986, 1997). Although inefficacious individuals usually avoid challenging tasks, when they do attempt them they give up more easily than individuals with high efficacy. When inefficacious individuals fail, they attribute the unsuccessful result to a lack of ability and tend to lose faith in their capabilities. When they succeed, they are more likely to attribute their success to external factors (Bandura, 1986, 1997). If students master a challenging task with limited assistance, their levels of self-efficacy will rise (Bandura, 1986).

Individuals who possess a high degree of self-efficacy are more likely to attempt challenging tasks, to persist longer at them, and to exert more effort in the process. If highly efficacious individuals fail, they attribute the outcome to a lack of effort or an adverse environment. When they succeed, they credit their achievement to their abilities. It is the perception that their abilities caused the achievement that affects the outcome rather than their actual abilities (Bandura, 1986).

Four factors determine self-efficacy: enactive mastery experience, vicarious experience, verbal persuasion, and physiological and emotional states (Bandura, 1986, 1997). The most influential of these factors is enactive mastery experience, which refers to individuals' experiences with success or failure in past situations. Information gathered from these experiences is then internalized. Past successes raise self-efficacy and repeated failures lower it, which indicates to individuals their levels of capability (Bandura, 1986, 1997).

In a vicarious experience, individuals compare themselves to peers whom they perceive are similar in ability and intelligence to themselves. Watching peers succeed raises observer self-efficacy and seeing them fail lowers it. Exposure to multiple successful role models helps increase self-efficacy in observers (Bandura, 1986, 1997).

Verbal persuasion tries to convince individuals, who may doubt their capabilities, that they possess the skills needed for success at a given task. In education, verbal persuasion delivered by teachers often takes the form of verbal feedback, evaluation, and encouragement. Persuasion must be realistic, sincere, and from a credible source; otherwise it can negatively affect student self-efficacy beliefs (Bandura, 1986, 1997).

Physiological state implies that failure, or some degree of performance impairment, can result if a person fearing failure is in a hyperactive state (Bandura, 1986, 1997). A physiologically hyperactive state includes symptoms experienced during "fight and flight" responses of the autonomic nervous system, such as increases in heart rate, breathing rate, and sweating. Emotional state refers to the mood one is in when performing, such as feeling anxious.

Depending on the mood, emotional state can either positively or negatively affect interpretation of an event's outcome (Bandura, 1986, 1997). In addition to the four factors that determine general self-efficacy, aptitude, attitudes, and attributions are found to predict science self-efficacy (Smist & Owen, 1994).

Efficacy beliefs vary between individuals and will actually fluctuate within an individual for different tasks (Bandura, 1997). In many activities, self-efficacy contributes to self-esteem (Bandura, 1986). Self-efficacy beliefs affect how people approach new challenges and will contribute to performance since these beliefs influence thought processes, motivation, and behavior (Bandura, 1997). Self-efficacy is not static and can change over time resulting from periodic reassessments of how adequate one's performance has been (Bandura, 1986). For example, in a college population, chemistry lab self-efficacy increased over the course of a school year whereas biology self-efficacy decreased over the same duration (Smist, 1993).

To summarize, self-efficacy refers to the confidence people have in their abilities that they will be successful at a given task. It is determined by enactive mastery experience, vicarious experience, verbal persuasion, and physiological and emotional states. Of these factors, enactive mastery experience has the most influence. Self-efficacy beliefs vary between individuals, fluctuate under different circumstances, and can change over time. Self-efficacy also contributes to performance. Connections between self-efficacy and academic performance are especially of interest to educators. In this chapter, numerous studies will show that females possess lower math and science self-efficacy than males and as a result, often earn lower grades in these academic subjects. Consequently, females may be less likely to pursue technical and scientific careers.

Self-Efficacy and Gender

Starting in seventh grade, girls tend to underestimate their abilities in math and science (Sadker & Sadker, 1995). Several studies (DeBacker & Nelson, 1999, 2000; Miller, et al., 1996; Pintrich & DeGroot, 1990; Smist, Archambault, & Owen, 1997; Tippins, 1991) have documented that female students have lower self-efficacy in math and science compared to male students. Girls' capabilities are undermined by sex-role stereotypes in our culture intimating that females are not as able as males, especially in such disciplines as math and science (Bandura, 1986, 1997). Another contributing factor could be the lower level of expectations that parents, teachers, and counselors often hold for girls, which can discourage further study in scientific and technical fields (AAUW, 1999; Astin & Sax, 1996; Bandura, 1997; Sadker & Sadker, 1995). Although girls' math and science enrollments increased during the nineties and even exceeded boys in biology and chemistry, boys still enrolled more often in physics and higher-level science courses than girls (AAUW, 1999). Confidence is strongly correlated to students continuing in math and science courses (Astin & Sax, 1996; Jewett, 1996). In addition, males display more positive attitudes towards careers in science than females (Smist, Archambault, & Owen, 1997). Regardless of gender, more career options, including potentially higher career aspirations, are considered by those possessing a high degree of self-efficacy (Bandura, 1986). Self-efficacy can even predict career choice (Kennedy, 1996). Because of this influence, "…efficacy beliefs partly shape the courses that lives take" (Bandura, 1997, p. 239). If females perceive their abilities to be low in math and science, a whole technological sector of highly-esteemed, high-paying careers may become off-limits to them.

In two separate studies of high school math students, Miller and associates (1996) found that females had lower perceived ability levels in math than males. Low mathematical self-efficacy and inadequate high school math preparation, both present more often in females than in males, lower aspirations for future study in scientific and technical fields (Lapan, Boggs, &

Morrill, 1989). Math self-efficacy is a "critical factor" in career choice (Kennedy, 1996). Students with higher levels of math confidence earn better grades in college and pursue science majors more often (Astin & Sax, 1996). However, mathematics confidence often declines in college and more so for women than men; but for women who pursue math and science majors, mathematics confidence increases (Astin & Sax, 1996). In addition to the studies mentioned here, a significant amount of research has found low mathematical self-efficacy in females. These studies have not all been included, however, since this study addresses self-efficacy in science.

Past research, much of which focuses on the secondary level of education, has shown that lower self-efficacy in females can also be found in science classes. For example, a study of seventh-graders found higher science self-efficacy in boys (Pintrich & DeGroot, 1990). In ninth-grade physical science classes a small but statistically significant difference was found with males scoring higher on science self-efficacy than females (Tippins, 1991). Males also indicated they intended to take more elective science classes (Tippins, 1991).

In a college general chemistry class, a statistically significant finding was reported with males scoring higher than females in science self-efficacy for laboratory skills (Smist, 1993). The study also mentioned that females had lower self-efficacy scores than males for the sciences; however, this finding was not statistically significant. Attrition was an admitted problem in Smist's (1993) study.

High school males were found to have higher self-efficacy in physics, chemistry, and in the laboratory. The same study found females scored higher in self-efficacy than males for biology (Smist, Archambault, & Owen, 1997). One point to consider is the researchers only collected information from gifted and talented students and therefore, not all student ability levels were represented. Females also are more likely to take both biology and chemistry in high school than males (AAUW, 1999). As a result, females may be overrepresented in the study.

Perceived ability was the greatest predictor of semester grades for females in high school biology (DeBacker & Nelson, 1999). Also, females' perceived ability was negatively related to stereotyped beliefs about science. Effort, persistence, and achievement appeared to have a stronger association with perceived ability for females than for males in this population (DeBacker & Nelson, 1999).

DeBacker and Nelson (2000) also found that high school girls scored lower than boys on perceived ability in biology, accelerated chemistry, physics, and advanced placement physics. The researchers expressed concern because regardless of achievement level, girls scored lower.

Most of the research has focused on junior high and high school students and has shown that females have lower levels of self-efficacy in math and science classes. Little is known about whether such differences exist in student self-efficacy levels based on gender in college science, excluding the Smist (1993) study where attrition was a problem. Lower self-efficacy in female students is a concern because low self-efficacy has been linked to lower academic performance. Many studies have been conducted on self-efficacy and academic achievement but adequate research has not established a firm connection between self-efficacy and college science performance. Based on the results of existing research studies, however, there appears to be a relationship between self-efficacy and science achievement.

Self-Efficacy and Academic Achievement

Academic achievement is influenced by a multitude of factors. For example, attitude leads to achievement (Schibeci & Riley, 1986), and aptitude is needed for successful performance (Schunk, 1991). Academic performance is a result of intellectual capability and motivation as well (Bandura, 1997). Based on replicable findings from several studies, Bandura (1997) states that gender and attitude influence academic performance to some extent through their mediating effects on an individual's self-efficacy beliefs. Numerous studies (Andrew, 1998; Bandura, 1997;

Chemers, Hu, & Garcia, 2001; Greene & Miller, 1996; Miller, et al., 1996; Multon, Brown, & Lent, 1991; Pajares, 1996; Pintrich & DeGroot, 1990; Silver, Smith, & Greene, 2001) have found that self-efficacy is one of the influences on both general academic achievement and science achievement.

General Academic Achievement

Many studies (Bandura, 1997; Chemers, Hu, & Garcia, 2001; Greene & Miller, 1996; Miller, et al., 1996; Multon, Brown, & Lent, 1991; Pajares, 1996; Pintrich & DeGroot, 1990; Silver, Smith, & Greene, 2001) link self-efficacy to academic achievement. In fact, Pajares (1996) has criticized several self-efficacy studies that failed to find a connection to academic performance for not being specific enough in the measurement of self-efficacy and for not corresponding with the outcome that best measured performance. Even though a generalized measurement of self-efficacy can nullify its effect, Pajares (1996) also stated that research findings support a general measurement of self-efficacy as a good predictor of grades, choice of academic major, and intent to enroll in a specific course since achievement measures like grades do not correspond well with overly specific self-efficacy measures.

Self-efficacy predicts intellectual performance better than skills alone, and it directly influences academic performance through cognition. Self-efficacy also indirectly affects perseverance (Bandura, 1997; Multon, Brown, & Lent, 1991). Although past achievement raises self-efficacy, it is student interpretation of past successes and failures that may be responsible for subsequent success. Perceived self-efficacy predicts future achievement better than past performance (Bandura, 1986; Chemers, Hu, & Garcia, 2001; Miller, et al., 1996; Pintrich & DeGroot, 1990). Self-efficacy beliefs also contribute to performance since they influence thought processes, motivation, and behavior (Bandura, 1997). Fluctuations in performance may be explained by fluctuations in self-efficacy. For example, varying beliefs in self-efficacy may alter

task outcome, whether it involves two similarly-skilled individuals or the same person in two different situations (Bandura, 1997).

Individuals high in self-efficacy attempt challenging tasks more often, persist longer at them, and exert more effort. If failure results, highly efficacious individuals attribute it to a lack of effort or an adverse environment. When they succeed, they credit their achievement to their abilities. The perception that their abilities caused the achievement affects the outcome rather than their actual abilities (Bandura, 1986).

"…Those who regard themselves as inefficacious shy away from difficult tasks, slacken their efforts and give up readily in the face of difficulties, dwell on their personal deficiencies, …lower their aspirations, and suffer much anxiety and stress. Such self-misgivings undermine performance…" (Bandura, 1986, p. 395). Conversely, individuals with high self-efficacy frequently persevere despite difficult tasks or challenging odds and often succeed because perseverance usually results in a successful outcome (Bandura, 1986).

Numerous studies (Bandura, 1997; Chemers, Hu, & Garcia, 2001; Greene & Miller, 1996; Miller, et al., 1996; Multon, Brown, & Lent, 1991; Pajares, 1996; Pintrich & DeGroot, 1990; Silver, Smith, & Greene, 2001) link self-efficacy to academic achievement. For example, in seventh grade science and English classes, self-efficacy was positively related to cognitive engagement and academic performance (Pintrich & DeGroot, 1990). Self-efficacy, self-regulated learning, and test anxiety also were found to be the best performance predictors (Pintrich & DeGroot, 1990).

In a meta-analysis of 39 studies from 1977 to 1988, positive and statistically significant relationships were found between self-efficacy, academic performance, and persistence for a number of disciplines (Multon, Brown, & Lent, 1991). Out of the studies analyzed, 28.9 % involved higher education. Four factors affected the link between self-efficacy and academic performance. One factor was the time period when the two were assessed. A stronger relationship resulted post-treatment meaning that experimental manipulations to change self-efficacy beliefs

were successful not only in raising self-efficacy but in enhancing academic performance as well. Another factor involved a stronger link between self-efficacy beliefs and performance for low-achieving students. A third aspect involving age found stronger relationships between self-efficacy and performance for high school and college students than for younger students. It is believed that older students can more accurately assess and report their levels of self-efficacy. Finally, stronger effects were found between self-efficacy and basic skills than when self-efficacy was compared to grades or standardized achievement tests (Multon, Brown, & Lent, 1991).

Greene and Miller (1996) found a positive correlation between perceived ability, learning goals, and meaningful cognitive engagement which then influenced academic achievement in college students enrolled in educational psychology. Additional analysis supported this causal model of perceived ability and learning goals leading to meaningful cognitive engagement which then led to academic achievement (Greene & Miller, 1996). They cautioned that the variables of rewards and penalties, strategies, and other self-regulatory activities, not specifically addressed by their study, could have influences on achievement (Greene & Miller, 1996). One criticism of their research is they measured achievement by only using one midterm exam score from the course. Also, they administered their instrument immediately before students took the midterm exam. Test anxiety may have affected the outcome.

In two studies conducted by Miller and colleagues (1996), perceived ability was the best predictor of achievement for high school math students. According to numerous studies conducted by Schunk and colleagues, cognitive skills, modeling, feedback, and goal-setting affected self-efficacy beliefs, which in turn affected performance (Pajares, 1996). Student-held beliefs affected the amount of effort and perseverance they engaged in which subsequently influenced achievement (Pajares, 1996).

Many studies support a link between self-efficacy and academic achievement, especially for junior high and high school students. The connection is less clear in higher education with some studies supporting a connection and others not finding one.

Self-Efficacy in Higher Education

Few studies have investigated the relationship between self-efficacy and academic achievement in higher education. For example, no self-efficacy studies were found that compared traditional (18 to 24 years old) to nontraditional (greater than 24 years old) college students. Of the college studies mentioned here, most (Chemers, Hu, & Garcia, 2001; Greene & Miller, 1996; Multon, Brown, & Lent, 1991; Silver, Smith, & Greene, 2001) support a connection between self-efficacy and academic achievement.

In general, students at the college level need to be self-directed and take greater responsibility for their learning. Students possessing a high degree of self-efficacy are more successful at accomplishing these tasks and as a result, perform better academically (Bandura, 1997). Accordingly, self-efficacy beliefs are "crucial" when applied to the cognitive demands of higher education (Bandura, 1997).

General academic self-efficacy and optimism in first-year college students were strongly related to academic performance and expectations (Chemers, Hu, & Garcia, 2001). These researchers also believe that self-efficacy can predict student academic success. Their results are difficult to generalize though due to a 25 % response rate. Unconventional grading methods utilized by the university studied, such as narrative evaluations instead of letter grades, also make generalization difficult. The researchers created several instruments for the study and no mention was made about whether these instruments possessed adequate validity and reliability.

Stronger relationships were found between self-efficacy and performance for high school and college students when compared to younger students in a meta-analysis of 39 self-efficacy studies (Multon, Brown, & Lent, 1991). Out of the studies included, 28.9 % involved higher education. However, from the list of studies analyzed, it was unclear how many, if any, involved science classes. The previously mentioned Greene and Miller (1996) study found a positive correlation between perceived ability, learning goals, and meaningful cognitive engagement which then influenced college achievement.

Two different studies measured self-efficacy in two-year college students and reported conflicting results. In nontraditional associate degree nursing students, self-efficacy was not found to predict academic achievement (Jeffreys, 1998). Academic variables, such as study hours, study skills, and absenteeism, were the only statistically significant contributors to nursing achievement. Reliability for academic variable measurement in Jeffreys' study, however, was slightly below an acceptable limit (Jeffreys, 1998). In contrast, Silver and colleagues (2001) found self-efficacy positively related to achievement in social science classes for community college students. The main purpose of the study, however, was to refine a self-efficacy instrument.

A study of college students found academic self-efficacy to be significantly more predictive of career choice than academic achievement (Kennedy, 1996). The study also found semester academic performance was positively influenced by perceived goals and previous academic experience, instead of self-efficacy (Kennedy, 1996). The researcher stated her findings do not negate self-efficacy's mediating influence on past achievement and thus, self-efficacy could contribute to academic achievement via this mediatory role. Other studies (Greene & Miller, 1996; Miller, et al., 1996; Pintrich & DeGroot, 1990) support the mediating effects self-efficacy has on academic achievement.

Various research studies across disciplines support the idea that self-efficacy beliefs are an important component of college achievement. Will self-efficacy relate to academic performance in college science? Lack of existing research and contradictory findings in the literature confound the issue. Of three existing studies, two (Andrew, 1998; Smist, 1993) support the link between self-efficacy and academic achievement in college science.

Science Achievement

In science classes, achievement is related to academic preparation, motivation, and the use of learning strategies (Garcia, Yu, & Coppola, 1993). The same study also found gender and ethnicity were not significant predictors of performance in college chemistry. "Self-efficacy is especially important in learning difficult subjects (such as biology and other sciences) given that students enter courses with varying levels of fear and anxiety" (Baldwin, Ebert-May, & Burns, 1999, p. 399). Baldwin and colleagues also stated that self-efficacy becomes more important over the duration of a course as science concepts increase in complexity. Aptitude, attitudes, and attributions were found to predict science self-efficacy in high school students (Smist & Owen, 1994). It is thought that science self-efficacy may affect science learning, choice of science, amount of effort exerted, and persistence in science (Kennedy, 1996).

Many studies (Andrew, 1998; DeBacker & Nelson, 1999, 2000; Pintrich & DeGroot, 1990; Smist, 1993; Wainwright & Gallahan, 1999) have found a connection between self-efficacy and science achievement. For example, in junior high school science classes self-efficacy was positively related to cognitive engagement and achievement (Pintrich & DeGroot, 1990). Self-efficacy had an indirect influence on academic performance by affecting cognitive engagement; cognitive engagement more directly related to academic performance (Pintrich & DeGroot, 1990). A positive and significant relationship was found between confidence and achievement in high school physics students; no difference was found between the sexes (Wainwright & Gallahan, 1999).

A study of high school biology students found perceived ability was the greatest predictor of semester grades for females but not for males (DeBacker & Nelson, 1999). Out of 13 different variables studied, perceived ability most highly correlated with persistence, effort, and achievement (DeBacker & Nelson, 1999). In another study, DeBacker and Nelson (2000) found

that boys and high-achieving students possessed higher perceived ability levels than girls and low-achieving students, respectively.

In a college study, science self-efficacy, mathematics self-efficacy, and self-efficacy for self-regulated learning were found to be distinct entities (Kennedy, 1996). In Kennedy's (1996) study, science self-efficacy did not significantly influence academic achievement. It is thought achievement might be indirectly affected by a combination of self-efficacies for science, math, and self-regulated learning (Kennedy, 1996).

In the aforementioned Smist (1993) study, it was found that males scored higher than females in laboratory self-efficacy in college chemistry. Self-efficacy for science was found to be significantly related to academic performance in two bioscience classes taken by first-year college students (Andrew, 1998). Andrew's study was conducted in Australia and therefore, cultural differences may exist. Also, Andrew developed an instrument for her study, which may not have exhibited adequate validity and reliability.

Little information exists regarding the relationship between self-efficacy and college science performance. Of the studies reviewed here, findings have been contradictory. Could self-efficacy not influence academic performance in college the same way it positively affects performance in lower levels of education? After all, the pursuit of higher education is a choice – a choice more likely made by highly efficacious students who then choose majors based upon their academic strengths. The contradictory results warrant further investigation to clearly determine whether a connection exists between self-efficacy and college science achievement.

Academic achievement is influenced by many factors, such as attitude, motivation, aptitude, and self-efficacy. Numerous studies have demonstrated a connection between self-efficacy and academic achievement. Some studies even have stated that self-efficacy beliefs are a good predictor of academic performance. Many studies correlate self-efficacy with science achievement, but adequate research has not established a firm connection between self-efficacy and performance in science at the college level. Despite the small number of existing studies in

higher education, there appears to be either a direct or indirect relationship between self-efficacy and science achievement.

Summary

Self-efficacy refers to personal confidence in one's abilities for success in a given task. It is determined by four factors: enactive mastery experience, vicarious experience, verbal persuasion, and physiological and emotional states. Of these factors, enactive mastery experience exerts the most influence. Self-efficacy beliefs vary between individuals, fluctuate under different circumstances, change over time, and contribute to academic performance.

Research studies show females have lower self-efficacy in math and science when compared to males. Most research has focused on junior high and high school students with little known about the relationship between gender and self-efficacy in college students. No research studies have been conducted comparing self-efficacy levels in traditional and nontraditional college students.

Academic achievement is affected by a variety of factors, including attitude, motivation, aptitude, and self-efficacy. Numerous studies support a connection between self-efficacy and academic performance. Self-efficacy also is a good predictor of academic achievement. Few studies have investigated a connection between self-efficacy and science achievement in higher education. Of the existing studies conflicting results, which report either a direct relationship or no relationship at all, confound the issue. An indirect connection between self-efficacy and academic performance in college science may exist but has not been investigated yet. This study aimed for a better understanding of the relationships, if any, between gender and self-efficacy, between student age and self-efficacy, and between self-efficacy and academic achievement in college science at a two-year institution.

CHAPTER III.
METHODOLOGY

Introduction

This chapter will describe the subjects of this study and how the sample was selected. It will discuss instrument development for this study and the administration procedures that were followed. Finally, it will describe the statistical analyses performed and mention limitations of the study.

Subjects

Students enrolled in the course Anatomy & Physiology I (A & P) at Chippewa Valley Technical College (CVTC) in Eau Claire, Wisconsin during the Fall 2002 semester were asked to voluntarily complete an in-class survey during October 2002. Approximately 260 students out of 313 enrolled in A & P were chosen using cluster sampling and asked to participate in this study. Out of 260 students, 216 completed surveys, which gave a response rate of 83 %. Subjects included 180 females (83.3 %) and 36 males (16.7 %).

CVTC is one of 16 colleges in the Wisconsin Technical College System (www.cvtc.edu). Of 5,000 credit-seeking students enrolled per year, approximately half are 22 years of age or younger (www.cvtc.edu). CVTC is a commuter college as many of its students live in Eau Claire and the surrounding communities.

A & P is a preparatory course in which students intensively study the structure and function of the human body's systems. The course is typically taken by students entering nursing and other allied health professions. Of the students enrolled in A & P during the Fall 2002 semester, approximately half (55.6 %) were preprogram nursing students. The remaining students were majoring primarily in other health professions, such as radiography, diagnostic medical sonography, dental hygiene, and the medical laboratory technician program. The majority of

students enrolled in A & P were preprogram status. A preprogram student is one who has not been accepted into a particular program or major yet. This status is often seen in first-semester students and in students taking preparatory science classes.

Instrumentation

The purpose of this study was to document CVTC Anatomy and Physiology students' levels of self-efficacy during the Fall 2002 semester. This research also investigated whether there were differences in self-efficacy based on gender and age. Finally, it was determined whether a relationship existed between self-efficacy and academic achievement in A & P.

Since no existing instrument fit the scope of this study, an instrument was constructed to measure student self-efficacy in A & P. An all-purpose measure of self-efficacy is too broad and is not a good method for determining self-efficacy in a discipline or a particular situation (Bandura, 1997). Self-efficacy is domain-specific so more accurate results are obtained when an instrument specific to the discipline is administered (Bandura, 1997). Self-efficacy can be measured by asking subjects to report how confident they are about performing and succeeding in a particular situation (Pajares, 1996). Although task-specific judgments of self-efficacy are preferred, in educational research grades and achievement test results do not correspond well with such specific measurement. To compensate, researchers word items to reflect the course rather than address specific course objectives, which then subsequently results in a broader determination of self-efficacy (Pajares, 1996). Although too broad a measurement of self-efficacy can nullify its effect, Pajares (1996) stated that research findings support general measurement of self-efficacy as a good predictor of grades, choice of academic major, and intent to enroll in a particular course. Taking these factors into account, the instrument developed for this study was tailored to A & P in order to be domain-specific. However, instrument items were also general to some degree so that they more closely corresponded to the achievement measure of grades.

The instrument for this study was a self-report confidential survey that measured student self-efficacy and demographics. Students responded to 15 self-efficacy items on a 5-point Likert scale (*1 = strongly disagree to 5 = strongly agree*) and responded to 6 demographic questions using a multiple-choice format. Survey construction was based on existing research instruments that measured self-efficacy in science, math, or college students (Baldwin, Ebert-May, & Burns, 1999; Ellett, McMullen, Rugutt, & Culross, 1997; Greene & Miller, 1996; Miller, et al., 1996; Pintrich & DeGroot, 1990; Smist, 1993). Statements were phrased both positively and negatively to increase reliability and reduce apathetic answers. The survey was then critiqued by two University of Wisconsin – Stout professors. Based on their feedback, it was determined the instrument had adequate content validity for this study. No other measures of validity or reliability exist for this instrument. The introductory script, consent form, and survey can be found in Appendix A.

Academic achievement levels were determined from students' midterm and final course grades for A & P. This phase of the study was conducted to determine if a positive relationship existed between self-reported levels of self-efficacy and grades earned in A & P.

Procedures

Before the study commenced, permission was sought and granted by three A & P instructors whose students would be surveyed. The other sections of A & P were taught by this researcher. The survey was presented to students during A & P class time in the middle of October 2002. A single examiner verbally informed students about the survey. Because the survey contained an identifier, needed later in the study to match student grades to student responses, signed consent forms were collected from individuals wishing to participate. The survey was then administered to the volunteers and took approximately five minutes to complete. To ensure confidentiality and reduce researcher bias, a separate list was created linking student

survey numbers to either their names or student identification numbers. This list was kept separate from the survey data. No identifying information was given by students on the actual surveys.

Permission to collect and view grades was sought from survey respondents during the week of December 7 to 13, 2002. Students were given a release form to voluntarily sign. Refer to Appendix A for a copy of the release form. Of 216 survey respondents, 158 released their A & P grades for this study resulting in a 73 % response rate. Permission was sought and granted by Sylvia Bare, CVTC Registrar, for access to midterm and final A & P grades for those students signing release forms. Grades were then linked to survey responses so statistical analysis could be performed.

Statistical Analysis

After the data was in spreadsheet form, negatively-worded statements (items 4, 7, 9, and 14) that were included to ensure reliability were recoded to positively-worded ones. Total self-efficacy scores were then calculated by summing the scores for all 15 Likert items. The data was then analyzed using appropriate descriptive and inferential statistics in Microsoft Excel and Statview. Descriptive statistics included computing means and standard deviations and reporting number and percent for each demographic choice. T-tests were run to determine statistical significance, and ANOVA and chi-squared tests were also utilized.

Limitations

The constructed instrument had no existing statistical measures of validity or reliability. Collected data and results are limited to A & P courses at CVTC in the fall of 2002. Results may not accurately reflect self-efficacy in future semesters of A & P, in other science courses, or in

different disciplines at CVTC. Results also may not accurately indicate self-efficacy levels in A & P or other science courses at different institutions.

CHAPTER IV.
RESULTS

Introduction

This chapter will present the results of this study. First, it will describe the sample's demographics and then it will detail the survey responses. The inferential statistical analyses will also be presented. Of these analyses, highly significant positive relationships were found between total self-efficacy and midterm Anatomy and Physiology (A & P) grades and between total self-efficacy and final A & P grades. There also was a significant positive relationship found between self-efficacy and the number of completed college semesters.

Descriptive Statistics

Demographics

Approximately 260 students out of 313 enrolled in Anatomy and Physiology I (A & P) were asked to participate in this study. Out of 260 students, 216 completed surveys, which resulted in a response rate of 83 %. Subjects included 83.3 % females and 16.7 % males.

Demographic items measuring school status, number of completed college semesters, whether the student was retaking the course, gender, age, and ethnicity produced multiple-choice data at the nominal scale of measurement. These items are described by number and percent of students reporting each choice. The sample was predominantly non-Hispanic white (96.3 %) and female (83.3 %). About half (55.6 %) of the sample was traditional college age (ages 18 to 24) and half (44.4 %) was nontraditional college age (greater than age 24). Roughly two thirds of the sample were full-time students (62.0 %). Most students (82.9 %) had never taken A & P before. Students had varying degrees of college experience ranging from no previously completed college semesters (23.1 %) to having completed more than four semesters of college (19.9 %). Table 4.1 reports demographic data.

TABLE 4.1. Description of the Sample (N = 216)

	Frequency (N)	Percent
GENDER:		
Female	180	83.3 %
Male	36	16.7 %
AGE:		
18-24	120	55.6 %
25-30	40	18.5 %
31-35	23	10.6 %
36-40	15	6.9 %
41-45	10	4.6 %
46-50	4	1.9 %
> 50	4	1.9 %
ETHNICITY:		
White, non-Hispanic	208	96.3 %
Asian	1	0.5 %
African American, non-Hispanic	0	0
Hispanic	3	1.4 %
Other	3	1.4 %
Not specified	1	0.5 %
SCHOOL STATUS:		
Full-time	134	62.0 %
Part-time	82	38.0 %
NUMBER OF COMPLETED COLLEGE SEMESTERS:		
0	50	23.1 %
1	22	10.2 %
2	47	21.8 %
3	26	12.0 %
4	28	13.0 %
> 4	43	19.9 %
RETAKING THE COURSE:		
Yes	37	17.1 %
No	179	82.9 %

Self-Efficacy

Survey questions 1 to 15 were Likert items reported on a 5-point scale (*1 = strongly disagree to 5 = strongly agree*). These items measured self-efficacy level and included statements such as: *I am confident I can do well in A & P* and *I don't think I will get a good grade in A & P.* All statements were positively worded except for items 4, 7, 9, and 14, which were negatively worded to increase instrument reliability. Likert items produced numerical data at the ordinal scale of measurement. Students agreed most with items 1, 2, 12, and 13. These item statements included: *I am confident I have the ability to learn the material taught in A & P; I am confident I can do well in A & P; I am confident I can do well in the lab work for A & P;* and *I think I will receive a C or better in A & P.* Students disagreed most with items 4 and 14 which stated: *I don't think I will be successful in A & P* and *I don't think I will get a good grade in A & P.* Means and standard deviations for each self-efficacy item are given in Table 4.2.

TABLE 4.2. Means and Standard Deviations for Self-Efficacy Items

Item Number	Mean	Standard Deviation
1	4.23	0.81
2	4.05	0.86
3	3.67	1.05
4	1.80	0.90
5	3.96	0.81
6	2.83	0.67
7	2.55	1.09
8	3.40	1.00
9	2.05	0.94
10	3.75	1.00
11	3.80	0.97
12	4.15	0.69
13	4.26	0.77
14	1.88	0.97
15	3.90	0.82

1. What was the level of self-efficacy for CVTC students enrolled in Anatomy and Physiology?

After reversing the numerical values for negatively-worded statements (items 4, 7, 9, and 14), total self-efficacy scores were calculated by summing the scores for all Likert items. Scores could range from 15 to 75. Scores greater than or equal to 60 were classified as high self-efficacy, scores from 31 to 59 were classified as moderate self-efficacy, and scores less than or equal to 30 were classified as low self-efficacy. Total self-efficacy scores for students in this study ranged from 28 to 75. The mean total self-efficacy score was 59.2, a score just below a high level of self-efficacy. The mode was 60 and the standard deviation was 10.14.

Inferential Statistics

2. Was there a difference in self-efficacy for students based on gender?

A t-test was used to examine the relationship between total self-efficacy score and gender. The mean self-efficacy score was 58.9 for women and 60.6 for men. Standard deviations were 10.10 and 10.36, respectively. Although the women's collective self-efficacy score was slightly lower than the men's, this difference failed to reach significance ($p = 0.19$).

To determine if there were any gender differences on particular self-efficacy items, chi-squared tests were run on each self-efficacy statement. Some data were binned to keep the expected tables' values greater than 5. No findings were significant (significance level $\alpha = 0.05/15 = 0.003$). The chi-squared test results can be found in Appendix B.

3. Was there a difference in self-efficacy for students based on age?

An ANOVA was used to examine the relationship between total self-efficacy and age. A t-test was used to compare traditional (18 to 24 years of age) and nontraditional students (> 24 years of age) based on mean total self-efficacy scores. The nontraditional students scored slightly

higher on self-efficacy than the traditional students. However, these differences failed to reach significance (ANOVA p = 0.21, t-test p = 0.30). Means and standard deviations for this information are reported in Table 4.3.

Although not one of the original research questions, a significant positive relationship was found between self-efficacy score and the number of previously completed college semesters (p = 0.01). An ANOVA test was used to determine this relationship. Students with more college experience had higher self-efficacy levels compared to students with less or no college experience.

TABLE 4.3. Age, Mean Self-Efficacy Scores, and Standard Deviations

Age	Mean Self-Efficacy Score	Standard Deviation
Traditional (18-24 years)	58.88	9.31
Nontraditional (> 24 years)	59.63	11.13
18-24 years	58.88	9.31
25-30 years	58.00	12.61
31-35 years	59.22	11.20
36-40 years	63.67	7.54
41-45 years	58.80	11.15
46-50 years	63.50	5.69
> 50 years	61.25	11.03

4. Was there a relationship between self-efficacy and academic achievement in Anatomy and Physiology?

Midterm and final A & P grades measuring academic achievement produced numerical data at the interval scale of measurement. Of 216 survey respondents, 158 released their midterm and final A & P grades to this researcher which gave a 73 % response rate for achievement data. Letter grades were first converted to numerical data using the traditional A = 4.00, B = 3.00, C =

2.00, D = 1.00, and F = 0 scale. One-third point was subtracted for minus grades and one-third point was added for plus grades (A+ = 4.00 was an exception). Means and standard deviations describe these items and can be found in Table 4.4. Grades were then linked to survey data. Using an ANOVA test, total self-efficacy was compared to both midterm and final A & P grades. Based on the ANOVA results, highly significant positive relationships were found between total self-efficacy and midterm grades ($p < 0.0001$) and total self-efficacy and final grades ($p < 0.0001$). Therefore, a positive relationship existed between self-efficacy and academic achievement in A & P.

TABLE 4.4. Means and Standard Deviations for Midterm and Final A & P Grades

A & P Grade	Mean	Standard Deviation
Midterm	2.86	1.05
Final	3.04	0.87

The relationships between gender and A & P grades were also examined using ANOVA. A relationship between gender and midterm grades almost reached significance ($p = 0.06$) whereas no significant relationship existed between gender and final grades ($p = 0.09$). ANOVA was used to investigate any connections between age and midterm and final A & P grades; these findings failed to reach significance (midterm $p = 0.25$, final $p = 0.24$). There were no gender-by-age interactions influencing A & P grades either (midterm $p = 0.09$, final $p = 0.08$). Finally, there were no significant gender-by-self-efficacy interactions influencing midterm and final grades in A & P (midterm $p = 0.64$, final $p = 0.50$).

CHAPTER V.
DISCUSSION AND RECOMMENDATIONS

Introduction

This chapter will discuss the results of this study. Significant positive relationships were found between self-efficacy and grades in Anatomy and Physiology. Because of these findings, recommendations are given to educators on how to increase student self-efficacy. There also was a significant positive relationship found between self-efficacy and the number of completed college semesters. Recommendations for further research in college science self-efficacy and how this study could be improved are also presented. The chapter concludes with implications of continued research in self-efficacy.

Discussion

The purpose of this study was to document student self-efficacy, also called perceived ability, in the science course Anatomy and Physiology I (A & P) at Chippewa Valley Technical College (CVTC). This study also documented whether there were differences in self-efficacy based on gender and age and whether self-efficacy related to A & P achievement. Achievement was measured using midterm and final course grades.

1. What was the level of self-efficacy for CVTC students enrolled in Anatomy and Physiology?

Based on this study's results, most students had moderate to high levels of self-efficacy in A & P. Student total self-efficacy scores ranged from 28 to 75. A score of 75 was the highest possible level of self-efficacy. No students received the lowest possible score of 15. The lowest score (28) reported in this study came close to reaching a moderate level of self-efficacy.

Moderate levels of self-efficacy included scores ranging from 31 to 59. The mean total self-efficacy score was 59.2, a score just slightly below a high level of self-efficacy. High levels of self-efficacy included scores greater than or equal to 60.

These results were not surprising considering that college students choose whether to pursue a science-related major. Students deciding to study elective science in college most likely possess high science ability and higher levels of science self-efficacy than students who avoid postsecondary science. These results reflect Bandura's (1986, 1997) self-efficacy theory where individuals attempt tasks in which they believe they will be successful. Students possessing higher self-efficacy will be more successful in college (Bandura, 1997) whereas inefficacious high school students, lacking the belief and abilities for success, may avoid higher education altogether which supports Bandura's (1986, 1997) assertion that individuals will avoid tasks they perceive to be too difficult. Almost every student enrolled in A & P at CVTC is pursuing a career in a health-related field, such as nursing or radiography. Students not majoring in health fields typically do not take A & P. It would be interesting to measure and compare science self-efficacy between science and nonscience majors in higher education.

Observee bias, such as a "please the researcher effect," could offer an alternate explanation for this study's high self-efficacy levels because surveys were not anonymous. Bias may have been a factor since approximately half of the subjects were students in this researcher's classroom.

This study measured self-efficacy about halfway through the semester. Previous research studies differed regarding when to measure self-efficacy with measurements ranging from the beginning to the end of the semester. Other studies did not specify when self-efficacy was measured. No definitive answer could be found in the literature stating when to administer the instrument. Perhaps a measurement of self-efficacy at the beginning of the semester would yield significant differences in the results. After all, self-efficacy can change over time (Bandura, 1986). Also, students in three lab sections knew their midterm course grades before they

participated whereas the other subjects did not. This grade knowledge could have raised self-efficacy in some individuals because past successes increase self-efficacy (Bandura, 1986, 1997).

2. Was there a difference in self-efficacy for students based on gender?

In this study, the women's mean self-efficacy score (58.9) was slightly lower than the men's (60.6). However, this difference failed to reach significance ($p = 0.19$). Chi-squared tests, performed on each self-efficacy item, also showed no significant gender differences. Despite this, it is interesting to note that the lowest mean self-efficacy scores in this study belonged to women.

Most research studies finding gender differences in science self-efficacy have been conducted at the secondary level of education (DeBacker & Nelson, 1999, 2000; Pintrich & DeGroot, 1990; Smist, Archambault, & Owen, 1997; Tippins, 1991). Only one study at the college level was found that addressed science self-efficacy and gender (Smist, 1993). Smist's (1993) study in college chemistry failed to find significant gender differences in self-efficacy except for laboratory skills where males scored higher than females. She did note that attrition was a problem in her study. Based on her results and the results of this study, could there be no connection between science self-efficacy and gender in higher education?

As mentioned before, a plausible explanation for this lack of gender influence could be student avoidance of college science. Students with low science self-efficacy will most likely avoid college-level science. It would be interesting to investigate whether females avoid college science more often than males. Males were greatly underrepresented (only 16.7 % of the sample) in this study. Underrepresentation could have affected the outcome, especially if the males in this study were not representative. Although no direct connection presented itself between gender and self-efficacy in this study, perhaps a more complicated relationship exists. According to Bandura (1997), gender can influence academic performance through its mediating effects on self-efficacy. This study did not control for or investigate any indirect influences that gender could

have on self-efficacy in A & P. Perhaps in researching how gender affects self-efficacy, different results would be found.

3. Was there a difference in self-efficacy for students based on age?

No research studies were found in the literature that compared self-efficacy between traditional (18 to 24 years of age) and nontraditional college students (> 24 years of age). In this study, nontraditional students scored slightly higher on mean total self-efficacy than traditional students but these differences were not significant ($p = 0.30$). This result was unexpected. This researcher thought that nontraditional students, who have larger gaps of time in their education, would score lower on self-efficacy than traditional students who have no gaps in their education. Older nontraditional students may have attended high school at a time when more gender bias existed in science classes which then could have adversely affected their levels of self-efficacy. Since only 8.4 % of the respondents were over 40 years old, past classroom gender bias may explain the lack of older nontraditional students in the sample. Based on this study's results, however, students in the 36-40 years old category and students 46 years and older had the highest self-efficacy scores. These students may not be representative though since they comprised only 10.7 % of the total sample.

One plausible explanation for these results is that nontraditional students have had more life and work experiences than traditional students. Perhaps such experiences contributed to their science self-efficacy. For example, some licensed practical nurses and certified nursing assistants were known to be in the sample. Having already had training and experience in the medical field and some knowledge of human anatomy, disease, and medical terminology, one could expect these students to be more confident and to perform better in a human anatomy and physiology course than students without such experiences.

Previous college experience and previous A & P experience also could have contributed to higher science self-efficacy. In this study, a significant positive relationship was found between self-efficacy level and number of completed college semesters ($p = 0.01$). Students with more college experience had higher self-efficacy levels than students with less or no college experience. It was known that some students in the sample already had earned bachelor's degrees in biology from four-year universities. Not only would these students be more efficacious based on college experience, it is thought these students would also be highly efficacious in the sciences. Some students had already successfully completed college-level A & P and were repeating the course at CVTC only as a refresher. Again, it is believed these students would be highly efficacious.

4. Was there a relationship between self-efficacy and academic achievement in Anatomy and Physiology?

Students' midterm and final A & P grades were used as the measure of academic achievement. ANOVA results comparing total self-efficacy to both midterm and final grades in A & P showed highly significant positive relationships between self-efficacy and academic achievement (midterm $p < 0.0001$, final $p < 0.0001$).

A connection was expected because these results support previously conducted studies (Andrew, 1998; Bandura, 1997; Chemers, Hu, & Garcia, 2001; Greene & Miller, 1996; Miller, et al., 1996; Multon, Brown, & Lent, 1991; Pajares, 1996; Pintrich & DeGroot, 1990; Silver, Smith, & Greene, 2001) that link self-efficacy to academic achievement. This study's results failed to support two college studies (Jeffreys, 1998; Kennedy, 1996) that did not find a connection between self-efficacy and academic performance. Perhaps their lack of significant results may be explained by the use of nonspecific self-efficacy measures that did not correspond well with performance measures – a criticism Pajares (1996) has made of other studies failing to find a

connection between self-efficacy and academic achievement. Since not many studies (Andrew, 1998; Kennedy, 1996; Smist, 1993) have been conducted investigating self-efficacy in college science, the results of the present study contribute information to this emerging branch of the self-efficacy field.

The relationships between gender and A & P grades in this study were also examined. A relationship between gender and midterm grades almost reached significance ($p = 0.06$) but no significant relationship existed between gender and final grades. There were also no connections between age and A & P grades or gender-by-age interactions influencing A & P grades. Finally, there were no gender-by-self-efficacy interactions affecting either midterm or final A & P grades.

This study's results were somewhat surprising considering that existing research (DeBacker & Nelson, 1999, 2000; Pintrich & DeGroot, 1990) supports a connection between gender, self-efficacy, and science achievement. However, these studies were not conducted at the college level. Since the present study can not link gender, self-efficacy, and science achievement together, differences may exist between secondary and postsecondary students in whether gender influences self-efficacy which means gender's influence may be nonexistent in college students.

Recommendations

Recommendations for the Classroom

Because of the significant link between self-efficacy and grades in A & P, it is highly recommended that educators and counselors assess the existing levels of self-efficacy in students. If lower levels of self-efficacy are identified, then appropriate measures should be taken to help raise student self-efficacy levels. Enactive mastery experience, vicarious experience, verbal persuasion, and physiological and emotional states, which are the primary factors that determine self-efficacy (Bandura, 1986, 1997), are prime targets on which educators and counselors should

focus their efforts. Additional areas that can be addressed to help increase student self-efficacy include goal-setting, rewards, and active learning.

When dealing with enactive mastery experience, the most influential factor affecting self-efficacy, the effects of past academic failures need to be minimized. This can be accomplished by changing student interpretations of past failures which then can negate failure's influence in future situations students encounter. Reducing failure's influence is extremely important to raise self-efficacy in low-achieving students (Bandura, 1986, 1997). Students are taught to attribute past failures to external rather than internal factors, an idea grounded in attribution theory. The student is taught that he or she has the power to then alter and control these external factors, like lack of student effort for example. Ideally, students learn that failure does not mean they are "doomed" to repeatedly fail. Once student self-efficacy is at a high level, failures will most likely have less influence on self-efficacy (Bandura, 1986).

Second, exposure to successful role models is commonly performed as a vicarious experience (Bandura, 1986, 1997; Schunk, 1991). These role models can be peers or instructors, but effective, competent models must be used (Bandura, 1997). Most likely, students gain more by watching successful peer role-modeling than instructor role-modeling because students identify more readily with their peers. Watching peers succeed raises observer self-efficacy and seeing them fail lowers it. Instructor role-modeling, however, is more readily available and perhaps, more likely to be consistent. Instructor role models can be used in combination with or in the absence of peer role models.

Verbal persuasion, the third factor, most frequently takes the form of feedback and encouragement given by teachers to students. The less faith students have in their abilities, the more they need frequent, explicit feedback and positive encouragement (Bandura, 1997). Frequently students interpret feedback as proof of their growing capabilities (Bandura, 1997; Schunk, 1991). Verbal persuasion must be realistic, sincere, and credible, or else it can negatively affect student self-efficacy levels (Bandura, 1986, 1997). Verbal persuasion raises self-efficacy

only to the extent that students believe and trust the person issuing it (Bandura, 1997). If persuasion is false, unwarranted, or disingenuous, then it could negatively affect self-efficacy beliefs; factors that lower self-efficacy should obviously be avoided. Feedback should be worded positively and highlight student gains rather than deficiencies (Bandura, 1997). If students are encouraged or motivated, this can lead to mastery of strategies which then subsequently leads to achievement (Pintrich & DeGroot, 1990).

To minimize the potential negative consequences of physiological and emotional states on self-efficacy, techniques that help lower anxiety, reduce stress, teach relaxation, and teach positive self-talk should be taught to students who suffer adverse consequences of hyperactivity and high anxiety (Bandura, 1986, 1997).

When students set short-range goals and meet those goals, self-efficacy is increased (Bandura, 1997; DeBacker & Nelson, 2000; Schunk, 1991). Therefore, goal-setting should be part of any plan to raise self-efficacy. Proximal goal achievement contributes to self-efficacy and higher academic achievement and increases interest in subject matter (Bandura, 1997). Students should set their own educational and classroom goals because personal goal-setting may have more influence on skill development than goals set by a teacher, especially for inefficacious individuals (Bandura, 1997; Schunk, 1991). Teacher-set goals however are better than no goals at all. Goals also should be specific rather than too general like the vague goal statement "do my best" (Schunk, 1991). An additional benefit of goal-setting is that goals increase student motivation (Schunk, 1991).

Rewards could also potentially be used to raise self-efficacy. In his research on children, Schunk (1991) gave students rewards based on performance. These performance-related rewards enhanced self-efficacy, motivation, and skill in the children (Schunk, 1991). Would this work as well with adult students? It is possible. Rewards such as extra credit points, food, leaving class early, or skipping a quiz or exam could be used to reward students who met a certain level of performance.

Finally, the use of active instructional methods in the classroom increases student confidence (Wainwright & Gallahan, 1999) and is strongly encouraged. Active instruction moves from teacher-centered classrooms where lecture is the primary delivery method to learner-centered classrooms where an array of instructional techniques are utilized to actively involve the students. A variety of instructional methods is most likely to reach a diverse audience of learners. Active learning also shifts the student from a passive role to an active one. Active learning is involved in other aspects of learning since it increases students' critical thinking skills, comprehension, information retention, motivation, and success. Perhaps some or all of these factors affect the connection between active learning and student confidence.

By utilizing the different suggestions delineated above when working with students, self-efficacy beliefs can be raised. An increase in student self-efficacy can increase academic achievement through factors like mastery of learning strategies, persistence, and amount of expended effort. Possession of adequate and effective cognitive strategies gives students more control over their learning and increases the repertoire of skills that they can apply when learning difficulties are encountered (Bandura, 1997; DeBacker & Nelson, 2000; Schunk, 1991). More strategies enable them to persist longer at a given task. Self-efficacy influences persistence and amount of expended effort which then subsequently affect achievement (Bandura, 1997; Multon, Brown, & Lent, 1991; Pajares, 1996). Students that persist longer at tasks increase their chances for success (Bandura, 1986). Successes then subsequently raise self-efficacy (Bandura, 1986, 1997).

Recommendations for Further Research

It is recommended that a replication of the present study be conducted. The instrument's wording should be changed slightly since some items (i.e. negatively-worded items) may have confused some respondents (i.e. contradictory answers found on some surveys). Other modifications include pilot-testing the instrument and performing some statistical measures of

instrument validity and reliability. An anonymous survey or survey of students not in the researcher's own classroom may yield different responses if subjects were not entirely honest in this study. Control of extraneous variables is also advised. For example, factors which may influence academic achievement such as aptitude, attitude, motivation, and past academic achievement were not controlled in this study.

It would be beneficial to see if the timing of instrument administration yielded a different outcome (i.e. administer instrument at the beginning of the semester). Measuring different science disciplines and comparing science and nonscience majors also are recommended. A comparison of science self-efficacy between two-year and four-year postsecondary institutions may also reveal interesting information.

Since not many studies currently exist, continued research in college science self-efficacy is recommended. Research can consist of replication of previous studies, the development of new self-efficacy studies in science disciplines, or the continued development of valid and reliable instruments that can be utilized in measuring science and college self-efficacies. Regardless, increasing the volume of research will lead to a thorough understanding of science self-efficacy. Additional studies can continue investigating the relationships, or lack thereof, between gender, age, and science self-efficacy to see if future research replicates the present findings. Other variables, such as ethnicity, that could influence science self-efficacy should also be determined and investigated. Continued research is needed in determining whether science self-efficacy relates to academic achievement with an emphasis on any mediating effects gender has on self-efficacy and self-efficacy has on academic performance.

Conclusion

Although past research studies have shown that females have lower self-efficacy in math and science than males, only one study (Smist, 1993) has investigated gender and self-efficacy in higher education. No researchers have investigated self-efficacy and age of college students. Thus, the present study has ventured into a relatively unexplored domain and has contributed to knowledge about self-efficacy in college science.

Anatomy and Physiology students in this study had moderate to high levels of self-efficacy which supports the assertion that self-efficacy may influence college students' self-selection into or out of science majors. In fact, self-efficacy levels may determine whether students attend college in the first place. In the cognitive demands of higher education, self-efficacy beliefs are "crucial" in determining whether students persist in science and math disciplines which is important because students majoring in science and math are more likely to have future high-paying careers in scientific and technological sectors. The need to address low self-efficacy in science at the junior high and high school levels is also emphasized because of the ramifications low self-efficacy can have on subsequent college major and career choice for students, especially females.

Because student self-efficacy beliefs were found to be significantly and positively related to science achievement in this study, the importance of self-efficacy's influence on academic performance and perseverance in scientific fields can not be understated. After all, "…efficacy beliefs partly shape the courses that lives take" (Bandura, 1997, p. 239). Because student self-efficacy and academic achievement are connected, educators and counselors should identify students with low self-efficacy and then implement methods to raise low student self-efficacy levels.

Through the proper utilization of enactive mastery experience, role-modeling, verbal persuasion, goal-setting, and active learning, educators can effectively help their students increase

low self-efficacy levels and help students successfully achieve their academic goals. In addition to increasing science achievement, these measures could also facilitate an increase in student retention which ensures that students continue in healthcare and science majors where they train for occupations where workers are in great demand and salaries are competitive.

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APPENDIX A
Introductory Script, Consent Forms, and Instrument

I am asking for your cooperation in researching a topic for my master's degree. I am studying what CVTC students' perceptions are of their abilities in anatomy and physiology class. I am collecting information about your confidence level in this course and information about you as a student, to see if that influences your perceptions. The survey will take 10-15 minutes to complete.

Your participation is completely voluntary and is not a requirement of this course. Completing or not completing the survey will not affect your grade in this course. The answers you give will not affect your grade in this course nor will they be part of any records at CVTC. I am asking you to write down your name or student ID (identification) number along with the number on your survey on a list so that I can link additional information about the course to your responses. DO NOT write your name or ID number on the actual survey. Be assured that all information gathered will be kept strictly confidential. This means that any reports of the findings of this research will not contain any identifying information about you.

It is not anticipated that this study will present any significant risks to you. If completing the survey makes you uncomfortable, you can withdraw from the study at any time without negative consequences to you. You may contact me or the University of Wisconsin – Stout if you experience any negative consequences as a result of completing this survey.

If you have any questions about participating in this study, please ask me before completing the survey.

The University of Wisconsin – Stout Institutional Review Board for the Protection of Human Subjects in Research has approved this study. If you have any questions or concerns about this study, please contact me at the address, phone number, or email listed below. Dr. Laura McCullough, my research advisor, is also available for consultation at (715) 232-2536. If you have questions regarding your treatment as a participant in this study, please contact Sue Foxwell, UW-Stout Human Protections Administrator, 11 Harvey Hall, Menomonie, WI, 54751, phone: (715) 232-2477.

If you are interested in receiving a copy of the survey results when the study is complete, you may contact me at the address, phone number, or email listed below.

Thank you,

Diane Witt-Rose, science instructor
Chippewa Valley Technical College
620 W Clairemont Ave
Eau Claire, WI 54702

Phone: (715) 833-6366
Email: dwitt-rose@cvtc.edu

Consent Form

I understand that my participation in this study is strictly voluntary and I may discontinue my participation at any time without fear of negative consequences to me.

I understand that the purpose of this study is to investigate student perceptions of ability / confidence levels in anatomy and physiology class.

I further understand that any information about me that is collected during this study will be held in the strictest confidence and will not be part of my permanent record nor will it affect my grade in this class. I understand that in order for this research to be valuable and effective, certain personal identifiers need to be collected. I also understand that the strictest confidentiality will be maintained throughout this study and that only the researchers will have access to the confidential information. I am aware that I have not and am not waiving any legal or human rights by agreeing to participate in this study.

By signing below, I verify that I am 18 years of age or older, am in good mental and physical condition, and that I agree to and understand the conditions listed above.

Signature_____ **Date**_____

Level of Confidence in Anatomy and Physiology I

Your answers will remain strictly confidential and WILL NOT affect your grade in this course. For each of the following items below, CIRCLE the ONE number that best describes how you feel.

1 = strongly disagree (SD)
2 = disagree (D)
3 = neutral (N)
4 = agree (A)
5 = strongly agree (SA)

		SD	D	N	A	SA
1.	I am confident I have the ability to learn the material taught in anatomy and physiology (A&P).	1	2	3	4	5
2.	I am confident I can do well in A&P.	1	2	3	4	5
3.	I think I will do as well or better than other students in A&P.	1	2	3	4	5
4.	I don't think I will be successful in A&P.	1	2	3	4	5
5.	I am confident that I can understand the topics taught in A&P.	1	2	3	4	5
6.	I believe that if I exert enough effort, I will be successful in A&P.	1	2	3	4	5
7.	I feel like I don't know a lot about A&P compared to other students in this class.	1	2	3	4	5
8.	Compared with other students in this class, I think I have good study skills.	1	2	3	4	5
9.	Compared with other students in this class, I don't feel like I'm a good student.	1	2	3	4	5
10.	I am confident I can do well on the lecture exams in A&P.	1	2	3	4	5
11.	I am confident I can do well on the lab practicals in A&P.	1	2	3	4	5
12.	I am confident I can do well in the lab work for A&P.	1	2	3	4	5
13.	I think I will receive a C or better in A&P.	1	2	3	4	5
14.	I don't think I will get a good grade in A&P.	1	2	3	4	5
15.	I am confident that I could explain something learned in this class to another person.	1	2	3	4	5

OVER →

SURVEY NUMBER _____

For each of the following items below, check the ONE response that best describes you.

16. School status:
_____ Full-time student
_____ Part-time student

17. Number of semesters completed in college (can be at CVTC or another college). **Do NOT count this semester.**
_____ none, this is my first semester in college
_____ 1 semester
_____ 2 semesters
_____ 3 semesters
_____ 4 semesters
_____ > 4 semesters

18. Have you previously taken this course and are now retaking it (for whatever reason)?
_____ Yes
_____ No

19. Gender:
_____ Female
_____ Male

20. Age:
_____ 18 – 24
_____ 25 – 30
_____ 31 – 35
_____ 36 – 40
_____ 41 – 45
_____ 46 – 50
_____ > 50

21. Ethnicity:
_____ White, nonhispanic
_____ Asian
_____ African American, nonhispanic
_____ Hispanic
_____ Other, please specify _____

THANK YOU FOR COMPLETING THIS SURVEY!!

Earlier this semester you filled out a survey about confidence in anatomy and physiology class for Diane Witt-Rose. The second part of the project involves collecting information about the grade you earn in anatomy and physiology to investigate whether there is a relationship between how confident you are and what grade you earn in the course. In order to complete this phase of the study, Diane needs written consent (even if you are in her section) to view your midterm and/or final grades for anatomy and physiology I.

Release Form

I give Diane Witt-Rose, CVTC science instructor, and Dr. Laura McCullough, her UW-Stout research advisor, permission to collect and view my midterm and/or final grade for anatomy and physiology I in the fall of 2002.

I have been informed and understand that my grade will be linked to the responses I made on a confidence survey given earlier in the semester about anatomy and physiology I. The researchers are investigating whether there is a connection between student confidence in a course and the grade earned for the course.

I further understand that my grade will be kept strictly confidential and not shared with anyone other than the above-named researchers. In the final report of the study, information will be summarized and reported as a group. This means that individual students, their survey responses, and their grades will not be able to be identified. When the study is complete, my grade information will be destroyed.

Signature_____ **Date**_____

APPENDIX B

TABLE B1. Chi-Squared Data for Self-Efficacy Items Based on Gender (α = 0.003)

OBSERVED TABLES				EXPECTED TABLES		BINNED OBSERVED DATA			BINNED EXPECTED TABLES		CHI-TEST
Q1	F	M									
1	1	1	2	1.7	0.3	7	1	8	6.7	1.3	**0.706**
2	6	0	6	5.0	1.0	18	3	21	17.5	3.5	
3	18	3	21	17.5	3.5	84	14	98	81.7	16.3	
4	84	14	98	81.7	16.3	71	18	89	74.2	14.8	
5	71	18	89	74.2	14.8	180	36	216			
	180	36	216								
Q2	F	M									
1	2	0	2	1.7	0.3	10	1	11	9.2	1.8	**0.033**
2	8	1	9	7.5	1.5	30	5	35	29.1	5.9	
3	30	5	35	29.1	5.9	89	11	100	83.3	16.7	
4	89	11	100	83.3	16.7	50	19	69	57.4	11.6	
5	50	19	69	57.4	11.6	179	36	215			
	179	36	215								
Q3	F	M									
1	5	1	6	5.0	1.0	24	5	29	24.1	4.9	**0.473**
2	19	4	23	19.1	3.9	52	7	59	49.1	9.9	
3	52	7	59	49.1	9.9	62	12	74	61.6	12.4	
4	62	12	74	61.6	12.4	40	12	52	43.3	8.7	
5	40	12	52	43.3	8.7	178	36	214			
	178	36	214								
Q4	F	M									
1	1	1	2	1.7	0.3	10	2	12	10.0	2.0	**0.868**
2	9	1	10	8.3	1.7	24	3	27	22.5	4.5	
3	24	3	27	22.5	4.5	67	14	81	67.4	13.6	
4	67	14	81	67.4	13.6	78	17	95	79.1	15.9	
5	78	17	95	79.1	15.9	179	36	215			
	179	36	215								
Q5	F	M									
1	3	0	3	2.5	0.5	8	1	9	7.5	1.5	**0.410**
2	5	1	6	5.0	1.0	35	4	39	32.5	6.5	
3	35	4	39	32.5	6.5	96	19	115	95.7	19.3	
4	96	19	115	95.7	19.3	40	12	52	43.3	8.7	
5	40	12	52	43.3	8.7	179	36	215			
	179	36	215								

OBSERVED TABLES				EXPECTED TABLES		BINNED OBSERVED DATA			BINNED EXPECTED TABLES		CHI-TEST
Q6	F	M									
1	0	0	0	0.0	0.0	15	1	16	13.4	2.6	**0.140**
2	2	1	3	2.5	0.5	73	10	83	69.5	13.5	
3	13	0	13	10.9	2.1	92	24	116	97.1	18.9	
4	73	10	83	69.5	13.5	180	35	215			
5	92	24	116	97.1	18.9						
	180	35	215								
Q7	F	M									
1	7	1	8	6.7	1.3						**0.924**
2	35	6	41	34.2	6.8						
3	41	8	49	40.8	8.2						
4	68	13	81	67.5	13.5						
5	29	8	37	30.8	6.2						
	180	36	216								
Q8	F	M									
1	4	3	7	5.8	1.2						**0.438**
2	25	5	30	25.0	5.0						
3	65	13	78	65.0	13.0						
4	60	11	71	59.2	11.8						
5	26	4	30	25.0	5.0						
	180	36	216								
Q9	F	M									
1	3	0	3	2.5	0.5	14	2	16	13.3	2.7	**0.455**
2	11	2	13	10.8	2.2	34	10	44	36.7	7.3	
3	34	10	44	36.7	7.3	76	11	87	72.5	14.5	
4	76	11	87	72.5	14.5	56	13	69	57.5	11.5	
5	56	13	69	57.5	11.5	180	36	216			
	180	36	216								
Q10	F	M									
1	4	0	4	3.3	0.7						**0.200**
2	21	5	26	21.7	4.3						
3	36	4	40	33.3	6.7						
4	83	14	97	80.8	16.2						
5	36	13	49	40.8	8.2						
	180	36	216								

OBSERVED TABLES				EXPECTED TABLES		BINNED OBSERVED DATA			BINNED EXPECTED TABLES		CHI-TEST
Q11	F	M									
1	4	1	5	4.2	0.8	18	6	24	20.0	4.0	**0.330**
2	14	5	19	15.8	3.2	34	6	40	33.3	6.7	
3	34	6	40	33.3	6.7	89	13	102	85.0	17.0	
4	89	13	102	85.0	17.0	39	11	50	41.7	8.3	
5	39	11	50	41.7	8.3	180	36	216			
	180	36	216								
Q12	F	M									
1	1	0	1	0.8	0.2	18	6	24	20.0	4.0	**0.333**
2	3	1	4	3.3	0.7	111	18	129	107.4	21.6	
3	14	5	19	15.8	3.2	50	12	62	51.6	10.4	
4	111	18	129	107.4	21.6	179	36	215			
5	50	12	62	51.6	10.4						
	179	36	215								
Q13	F	M									
1	1	0	1	0.8	0.2	25	5	30	25.0	5.0	**0.387**
2	2	2	4	3.3	0.7	81	12	93	77.5	15.5	
3	22	3	25	20.8	4.2	74	19	93	77.5	15.5	
4	81	12	93	77.5	15.5	180	36	216			
5	74	19	93	77.5	15.5						
	180	36	216								
Q14	F	M									
1	3	0	3	2.5	0.5	15	2	17	14.2	2.8	**0.773**
2	12	2	14	11.7	2.3	27	4	31	25.8	5.2	
3	27	4	31	25.8	5.2	63	12	75	62.5	12.5	
4	63	12	75	62.5	12.5	75	18	93	77.5	15.5	
5	75	18	93	77.5	15.5	180	36	216			
	180	36	216								
Q15	F	M									
1	2	1	3	2.5	0.5	7	3	10	8.3	1.7	**0.449**
2	5	2	7	5.8	1.2	40	6	46	38.3	7.7	
3	40	6	46	38.3	7.7	96	17	113	94.2	18.8	
4	96	17	113	94.2	18.8	37	10	47	39.2	7.8	
5	37	10	47	39.2	7.8	180	36	216			
	180	36	216								