

**RELATIONSHIP BETWEEN SELF-EFFICACY, ACADEMIC  
ACHIEVEMENT AND GENDER IN ANALYTICAL CHEMISTRY AT  
DEBRE MARKOS COLLEGE OF TEACHER EDUCATION**

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**ABSTRACT**

The aim of this study was to investigate the level of students' self-efficacy, gender difference in self-efficacy and achievement and also relationships between self-efficacy and achievement for second year students in the fall of 2012 in Analytical Chemistry I (ACI) at Debre Markos College of Teacher Education (DMCTE). The self-efficacy survey and the ACI achievement test were completed by 100 students. The self-efficacy survey data were gathered by Likert scale questionnaire. By using inferential statistics (t-test), difference of self-efficacy and achievement in gender is calculated and by using Pearson correlation, the relationships between self-efficacy and achievement were investigated. The analysis of the data indicated that students' level of self-efficacy is medium (50.08), and there is no significant difference in their self-efficacy between sexes ( $t(98) = 0.161, p > 0.1$ ), but there is a statistically significant difference in achievement between sexes ( $t(98) = 0.68, p < 0.1$ ) and also a significant relationship exists between self-efficacy and achievement ( $r=0.385$ , at 0.01 level with 98 degree of freedom). Based on these results, recommendations which will improve the quality of our training specifically in the field of chemistry are forwarded. [AJCE, 3(1), January 2013]

## **INTRODUCTION**

Gender bias in mathematics and science classrooms has been and still continues to be a problem (American Association of University Women) (1). Despite improvements in the past two decades, girls are still less likely than boys to take Chemistry and higher-level Mathematics and science courses in high school (1). As a consequence, fewer female students may study Mathematics and Science at the college level. The types of courses taken in high school and how students perform in these courses can affect acceptance into college, choice of college major, and subsequent career choice (1, 2).

Starting in seventh grade, girls tend to underestimate their abilities in Mathematics and Science despite the fact that their performance remains the same as boys (3). 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” (4, p. 410). Confidence is strongly correlated to which students continue in Mathematics and Science courses and which do not (5). It is thought that self-efficacy may explain course selection patterns in schools that eventually lead to the under representation of women in science (6). Regardless of gender, more career options, including potentially higher career aspirations, are considered by those students who possess a high degree of self-efficacy (7, 8). In essence, “efficacy beliefs partly shape the courses that lives take” (9, p. 239). If a female believes she is unable to succeed in Mathematics or Science, this altered perception may then subsequently manifest itself in lower grades or in avoidance of Mathematics and Science courses altogether.

From my experience as a chemistry instructor for six years at Debre Markos College of Teacher Education (DMCTE), it was noticed that students had varying levels of confidence in their abilities for success in various Chemistry courses, such as General Chemistry I and II,

Organic Chemistry, Inorganic Chemistry and Analytical Chemistry. Female students seemed to express the highest doubts in their capabilities whereas male students frequently seemed overconfident. These variations in confidence will affect their learning of Science. Hence, self-efficacy in science affects science learning, choice of science, amount of effort exerted, and persistence in science (10).

The purpose of this study is to investigate the relationship between Analytical Chemistry I (ACI) course self-efficacy and academic achievement with gender of second year Chemistry and Biology students at DMCTE. ACI is a course that intensively studies the qualitative determination of cations and anions and also the quantitative determination of solubility, acid-base and oxidation-reduction equilibria of solutions and is typically taken by students of Chemistry major and Biology major students. The majority of students enrolled in this course are males completing grade ten and preparatory classes needed for enrollment in diploma teacher in primary schools. It was believed these students would have moderate to high levels of self-efficacy for chemistry; since students self-selected themselves into chemistry and biology. However, I expect that students with higher self-efficacy levels would earn higher grade in ACI than students with lower self-efficacy. Therefore, this expectation of mine needs to be confirmed. Knowing the relationship between students' self-efficacy and achievement with gender will help the college to select students who would be successful in science.

Many studies have been conducted on self-efficacy and academic achievement but adequate research has not yet established a firm connection between self-efficacy and college science performance. As far as my knowledge is concerned no research study was conducted which shows relationship between self-efficacy and academic achievement with gender in analytical chemistry at any level.

## **REVIEW OF RELATED LITERATURE**

### **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 (9). 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 (7, 9). 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 (7, 9, 11). If students master a challenging task with limited assistance, their levels of self-efficacy rise (7).

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 (7).

Four factors determine self-efficacy: enactive mastery experience, vicarious experience, verbal persuasion, and physiological and emotional states (7, 9). 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 (7, 9). 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's self-efficacy and seeing them fail lowers it. Exposure to multiple successful role models helps increase self-efficacy in observers (7, 9). 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 (7). Emotional state can either positively or negatively affect interpretation of an event's outcome (7, 9). In addition to the four factors that determine general self-efficacy, aptitude, attitudes, and attributions are found to predict science self-efficacy (12).

Efficacy beliefs vary between individuals and will actually fluctuate within an individual for different tasks (9). In many activities, self-efficacy contributes to self-esteem (7). Self-efficacy beliefs affect how people approach new challenges and will contribute to performance since these beliefs influence thought processes, motivation, and behavior (9). Self-efficacy is not static and can change over time resulting from periodic reassessments of how adequate one's performance has been (7). For example, in a college population, Chemistry laboratory self-efficacy increased over the course of a school year whereas Biology self-efficacy decreased over the same duration (13).

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 grade seven, girls tend to underestimate their abilities in Math and Science (3). Several studies (14-17) 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 many cultures intimating that females are not as able as males, especially in such disciplines as math and science (7, 9). 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 (1, 3, 9, 18). Although girls' math and science enrollments increased during the nineties and even exceeded boys in Biology and Chemistry, boys are still enrolled more often in physics and higher-level science courses than girls (1). Confidence is strongly correlated to students continuing in math and science courses (5, 18). In addition, males display more positive attitudes towards careers in science than females (12).

Regardless of gender, more career options, including potentially higher career aspirations, are considered by those possessing a high degree of self-efficacy (7). Self-efficacy can even predict career choice (10). Because of this influence, "efficacy beliefs partly shape the courses that lives take" (9). 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, (19) found that females had lower perceived ability levels in math than males. Low mathematical self-efficacy and inadequate high school math preparation, both being observed give rise to more often in females than in males, lower female aspirations for future study in scientific and technical fields (20). Math self-efficacy is a "critical factor" in career choice (10). Students with higher levels of math confidence earn better grades in college and pursue science majors more often (18). 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 (18). In addition to the studies mentioned here, a significant amount of research has found low mathematical self-efficacy in females. A study conducted in the seventh-graders found higher science self-efficacy in boys and also they intended to take more elective science classes (15,, 17).

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 (13). The study also mentioned that females had lower self-efficacy scores than males for the sciences; however, this finding was not statistically significant. 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 (12). One point to consider is that the researchers only collected information from gifted and talented students and therefore, not all student ability levels were represented.

Perceived ability was the greatest predictor of semester grades for females in high school biology (21). 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 (21). DeBacker and Nelson (21) 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 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 (13) 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.

### **Self-Efficacy and Academic Achievement**

Self-efficacy predicts intellectual performance better than skills alone, and it directly influences academic performance through cognition. Self-efficacy also indirectly affects perseverance (9, 22). 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 (7, 17, 19, 23, 24). Self-efficacy beliefs also contribute to performance since they influence thought processes, motivation, and behavior (9). 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 (9).

Individuals high in self-efficacy attempt challenging tasks more often, persist longer at them, and exert more effort. If there are failures, 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 (7). “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”(7, 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 (7). Numerous studies (9, 15, 23-25) 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 (17). Self-efficacy, self-regulated learning, and test anxiety also were found to be the best performance predictors (17).

In a meta-analysis of 39 studies from 1977 to 1988, positive and statistically significant relationships were found among self-efficacy, academic performance, and persistence for a number of disciplines (22). 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 study (26) 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 (19). 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 (19). 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 (19) perceived ability was the best predictor of achievement for high school math students. According to numerous studies, cognitive skills, modeling, feedback

and goal-setting together affected self-efficacy beliefs that, in turn, affected performance (27). Student-held beliefs affected the amount of effort and perseverance they engaged which subsequently influenced achievement (25).

Many studies support a link between self-efficacy and academic achievement, especially for junior 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. Of the college studies mentioned here, most (19, 22-24, 28) 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 (5). Accordingly, self-efficacy beliefs are “crucial” when applied to the cognitive demands of higher education (9).

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 (22). 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 study (26) 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 (29). Academic variables, such as study hours, study skills, and absenteeism, were the only statistically significant contributors to students' achievement. Reliability for academic variable measurement in this study, however, was slightly below an acceptable limit (29). In contrast, another study (28) found self-efficacy positively related to achievement in social science classes for community college students.

A study of college students found academic self-efficacy to be significantly more predictive of career choice than academic achievement (30). The study also found semester academic performance was positively influenced by perceived goals and previous academic experience, instead of self-efficacy (30). 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 (17, 22, 26) support the mediating effects self-efficacy has on academic achievement.

### **STATEMENT OF THE PROBLEM**

Analytical Chemistry I (ACI) is one of the main branches among chemistry courses. It is widely used to determine, separate and characterize both organic and inorganic molecules qualitatively as well as quantitatively. 85% of the contents of the course need numerical calculations of computing concentrations of acids, bases and salts. Thus, students are expected to have a skill of solving mathematical problems.

But through my teaching experience of this course at DMCTE, the interest of male and female students towards the course in the class decreased from time to time. Even if the participations of male students in the lecture class were not that much satisfactory, the problem is severe for female students. Actually, their poor participations in the course were similarly

reflected in their final exams. As a result, the number of students (more of females) retaking the course increased from time to time.

As a chemistry instructor, investigating the level of both male and female students' self efficacy in the course and also finding whether academic achievement is influential on self efficacy is very important.

The main purpose of this study was therefore to identify DMCTE second year Chemistry and Biology students' levels of self-efficacy during the fall 2011/12 first semester in ACI. This research also investigated whether there were differences in self-efficacy and academic achievement based on gender. To assist and develop the outlook of students in both sexes towards chemistry, identifying their level of self efficacy is very important.

The outcome of this study is expected to:

- *determine the self-efficacy level of students in ACI course*
- *find whether there is a relationship between academic achievement and self-efficacy based on gender in ACI*

For the purpose of this research, the term "self-efficacy" is operationally defined as DMCTE Chemistry and Biology major students' belief of achieving a good grade in ACI course. Likewise the term "academic achievement" is operationally defined as the letter grade that DMCTE Chemistry and Biology major students have obtained after taking the course ACI.

## **RESEARCH QUESTIONS**

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

- i. What was the self-efficacy level of DMCTE students' who registered for the course Analytical Chemistry I?*

- ii. *Was there a difference in self-efficacy with gender?*
- iii. *Was there a difference of academic achievement with gender?*
- iv. *Was there a relationship between self-efficacy and academic achievement in ACI?*

## **METHODOLOGY**

### **Participants**

The participants of this study were students of DMCTE who originally came from eleven administrative zones of the Amhara region. Students enrolled in the course ACI at DMCTE during the fall 2011/12 first semester were asked to voluntarily respond to the class survey in February 2012. 110 students (50%) out of 222 enrolled in ACI were chosen using systematic random sampling and asked to participate in this study. Out of 110 students, only 100 completed the survey, and took the Analytical Chemistry achievement test which gave a response rate of 90%. Of the students enrolled in ACI during the fall 2011/12 first semester, nearly half (49.6 %) were Chemistry major students and the remaining students were Biology major. Subjects included 45 females (41%) and 55 males (50%). The remaining 9% did not complete the survey and hence did not take the Analytical Chemistry achievement test. Moreover, I took 30 (20 males, 66.67% and 10 females, 33.33%) available students for focus group discussion from the sample students in order to strengthen the values obtained from their self-efficacy surveys and final examination records.

### **Instruments for data collection**

I adapted **self-efficacy scale** developed by Diane L. Witt-Rose (31) and I constructed the surveys by considering the three domains of educational objectives, namely the cognitive, affective and psychomotor. In addition, three psychology instructors critically assessed and

finally modified this instrument that ended up with a total of 15 self-efficacy test items. Student self-efficacy scale made up of five point Likert scale of strongly agree (SA), agree (A), neutral (N), disagree (DA) and strongly disagree (SD) corresponding to 5, 4, 3, 2, and 1 point respectively for positive statements and the reverse for negative statements was applied

Students' **achievement test** made up of 40 objective questions with true-false, multiple choice and short answer items was extracted from Analytical Chemistry I (Chem 122) course and given to them by that particular semester. To make the instrument valid, the achievement test was examined by four DMCTE chemistry instructors. I administered the questionnaire (pilot test) for 30 students that were not part of the study and calculated item total correlations, and finally some items were modified and some were rejected.

Students' **focus group discussion** conducted based on four open ended questions which would help the researcher to investigate the main factors which brought a significant difference between male and female students' self-efficacy and academic achievement in ACI.

### **Procedures**

Before the study commenced, permission was sought and granted by all students to be surveyed, tested and to discuss in group. The survey and the achievement test were presented to students two weeks after they registered for the course and the day after completing their first semester final examination, respectively. These instruments administered to the volunteers and took about two hours to complete the test. To ensure confidentiality and reduce researcher bias, a separate list was created linking student survey numbers to either their names or student identification numbers on the test. This list was kept separate from the survey data. Finally I took 30 (20 male and 10 female available students) from the sample population and invited to reflect freely about their obstacles to develop low self-efficacy and academic achievement in ACI.

### **Statistical Analyses**

After the data were in spreadsheet form, negatively-worded statements that were included to ensure reliability were recorded to positively-worded ones. Total self-efficacy scores were then calculated by summing the scores for all 15 Likert items. The data were then analyzed using appropriate descriptive and inferential statistics using SPSS. 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 difference. In the focus group discussion, the qualitative data was analyzed by percentage.

## **RESULTS**

### **Demographics**

As stated earlier 110 students out of 222 enrolled in ACI were chosen using systematic random sampling and asked to participate in this study. Out of 110 students, only 100 students had completed the self efficacy questionnaires and took the Analytical Chemistry Achievement test. This sample population includes 45 female (40.9 %) and 55 male students (50 %). Since only 100 students responded we will use this size as the sample size in the ensuing pages.

Demographic items include college status, number of completed college semesters, whether the students were retaking the course or not, major fields of study and gender. Roughly two third of the samples were regular students (86.2 %). Most students (99.8 %) had never taken ACI before. Students had nearly the same degrees of college experience, three completed college semesters (84.5 %), as indicated in Table 1 below.

Table 1. Description of the sample (N=100)

Items		Frequency(N)	percent
Gender	Male	55	55%
	Female	45	45%
Field of study	Chemistry	60	54.5%
	Biology	40	36.4%
Retaking the course	yes	6	5%
	No	94	95%
Number of completed college semester	3	89	84.5%
	4	9	16.3%
	>4	2	2.8%

### Self-efficacy

Self-efficacy survey questions (Question 6 to 20) were Likert type items with 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 ACI* and *I don't think I will get a good grade in ACI*. All statements were positively worded except for items 9, 12, 14, and 19, which were negatively worded to increase the instrument's reliability. Likert items produced numerical data at the ordinal scale of measurement.

Students agreed most with items 6, 7, 17, and 18. These item statements included: *I am confident I have the ability to learn the material taught in ACI*; *I am confident I can do well in ACI*; *I am confident I can do well in the lab work for ACI*; and *I think I will receive a better grade in ACI*. Most students disagree with items 9 and 19 which stated: *I don't think I will be successful in ACI* and *I don't think I will get a good grade in ACI*.

***Was there a difference in self-efficacy & achievement of students based on gender?***

Before determining the existence of difference in self-efficacy between male and female students it is essential to compute their level of self-efficacy of the total and the sexes separately. It is known that 5 point Likert scale scores for a 15 items questionnaire range from 15 to 75. According to Diane L. Witt-Rose (31) 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 each student in this study ranged from 31 to 61. The mean total self-efficacy score was 50.08 with standard deviations of 6.09 (Table 2). Therefore, 50.08 is a score just below a high level of self-efficacy.

*Table 2. Means and Standard Deviations for Self-Efficacy Items*

Sex	Number	Mean Self Efficacy	Standard Deviation
Female	45	49.13	5.52
Male	55	50.85	6.48
<b>Total self-efficacy</b>	<b>100</b>	<b>50.08</b>	<b>6.09</b>

Analytical Chemistry I achievement test measuring academic achievement produced numerical data at the interval scale of measurement. After the achievement test and self efficacy questionnaire were administered to the sample population (N=100), the data obtained were organized and means and standard deviations are computed. Mean of females' self efficacy and achievement are 49.13 and 61.84 with standard deviations of 5.52 and 9.88, respectively. Mean of males' self efficacy and achievement are 50.85 and 66.56 with standard deviations of 6.48 and 12.12, respectively. In addition, mean of total respondents' self efficacy and achievement are 50.08 and 64.44 with standard deviations of 6.09 and 11.36, respectively (Table 3).

*Table 3. Summary of Self Efficacy and Achievement by Gender*

Sex	Number	Self Efficacy (Mean)	Std.Deviation	Achievement (Mean)	Std.Deviation
Female	45	49.13	5.52	61.8444	9.88
Male	55	50.85	6.48	66.5636	12.12
<b>Total</b>	<b>100</b>	<b>50.08</b>	<b>6.09</b>	<b>64.204</b>	<b>11.36</b>

A t-test was used to examine the difference in their total self-efficacy score that would exist between the sexes (gender). The mean self-efficacy score was 49.13 for females and 50.85 for males with standard deviations 5.52 and 6.48, respectively. Although the females' collective self-efficacy score was slightly lower than the males', this difference failed to reach significance as can be seen in Table 4.

*Table 4. t-Test for Male and Female (Total Mean Efficacy)*

	Sex	N	Mean	St.deviation	t	df	Sig.
<b>Self- Efficacy</b>	F	45	49.13	5.52	-1.412	98	0.161
	M	55	50.85	6.48			

*\*Equal variances assumed*

A t-test was used to examine the difference in their ACI achievement test results that would exist between the sexes (gender). The mean achievement test result was 61.8444 for females and 66.5636 for males with standard deviations 9.88 and 12.12, respectively. Here, females' mean achievement test result was lower than the males' one. This is statistically significant at 0.1 levels with 95% confidence level between genders with their achievement.

*Table 5. t-test for ACI Achievement Test Results for Both Males and Females*

Achievement	Sex	N	Mean	Standard deviation	df	t	Sig. (2-tailed)
	F	45	61.8444	9.88	98	2.101	0.68
	M	55	66.5636	12.12			

*\*Equal variances assumed*

***Was there a relationship between self-efficacy and academic achievement in Analytical chemistry I (ACI)?***

Relations between students' total self-efficacy and their achievement in ACI were calculated using Pearson correlation coefficient( $r$ ). Therefore, correlation between achievement and self-efficacy for both sexes becomes  $r=0.385$ , which is statistically significant at 0.01 with 98 degree of freedom (2-tailed). Correlation between achievement and self-efficacy for females only becomes  $r=0.377^*$ , which is statistically significant at 0.05 with 45 degree of freedom (2-tailed). Correlation between achievement and self-efficacy for males only becomes  $r=0.362$ , which is statistically significant at 0.01 with 55 degree of freedom (2-tailed).

From qualitative data, the following results are also obtained. At focus group discussions, female students reflect as they are confident enough to solve problems equally with males. This idea of females is also acknowledged by their male peers. However, their achievement result is observed to be lower than that of males. They believe some of the reasons for this disparity are lack of information about the examinations, lower school background, excessive negative test anxieties and inabilities to manipulate calculators.

## **DISCUSSIONS**

***Was There a Difference in Self Efficacy & Achievement for Students Based on Gender?***

From the analysis of the self-efficacy survey data, the following result is obtained. Students' mean total self-efficacy score is 50.08 and their self efficacy scores are found to be in the range from 31 to 61. According to Diane L. Witt-Rose (31) 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. In this

research, a score of 61 is the highest possible level investigated while a score of 31 is the lowest self-efficacy score. Therefore, most students in the sample are in moderate levels of self-efficacy in ACI.

According to Bandura (9) students possessing moderate or higher self-efficacy will be more successful in college, whereas those who lack the belief and abilities for success became inefficient and may avoid higher education altogether. Therefore, according to my analysis students who are enrolled in ACI at DMCTE to learn the subject with their choice have no serious problem in their self efficacy at the beginning. However, self-efficacy can change over time (7). From the analysis of the self-efficacy survey data, there is no significant difference observed between female and male students. That is, females are confident in solving problems equally with males. However, from the focus group discussions it was clear that female students judging male students' as more active participants in the class, they fear that their confidence will not persist with them. Knowing that letter grades in DMCTE is norm referenced, female students expect their result in ACI will be lower than males. Therefore, it is expected that the moderate level self efficacy investigated in this research may decline to lower level due to the effect of norm referenced assessment (when they compare themselves with their classmates in the college) and other possible reasons. This result highly supports the discussion made above. From the total discussion it seems that significant number of students from the sample population probably will develop negative self efficacy in ACI as summative assessments are approaching.

In relation to differences between male and female students in their self-efficacy and academic achievement, research studies conducted at the secondary school level indicate that there exists a gender difference in science self-efficacy (21). However, Smist (13) found opposite

result, in which there is no significant gender difference in their self-efficacy in college chemistry with exception of laboratory skills (males scored higher than females).

According to the analysis in this research, the females' mean self-efficacy score (49.13) was slightly lower than males' (50.85) even though this difference failed to reach significance ( $p=0.19$ ). This research result replicates the results found by the above researcher (13). The slight difference observed between the sexes may be due to the inclusion of chemistry laboratory tasks in the self efficacy survey.

In the analysis, the mean of females' achievement score is 61.84 with standard deviation 9.88, and the mean of males' achievement score is 66.56 with standard deviation 12.12. Here, females' mean achievement test result was lower than the males'. Above all, t-test indicates presence of a statistical difference in achievement between the sexes at 0.1 levels with 95% degree of confidence. The same result was previously found (8, 21).

Therefore, from the above discussions, we can conclude that males and females differ in their ACI despite their initially perceived similar abilities. This may be because of lack of basic study skills, inability to handle materials necessary in the examination which is raised in the focus group discussions.

### ***Was There a Relation Ship between Self-efficacy & Academic Achievement in Analytical Chemistry I (ACI)?***

Female and male students' achievement and self-efficacy are positively correlated, ( $r=0.377$  and  $r=0.362$ ), which are statistically significant at 0.05 and 0.01 with 45 and 55 degree of freedom (2-tailed), respectively. In addition, total students' achievement and self-efficacy are positively correlated ( $r=0.385$ ), which is also statistically significant at 0.01 with 98 degree of

freedom (2-tailed). Some previous studies support this result; there exists positive link between self-efficacy and academic achievement (6, 9).

Therefore, according to the above discussion, students' achievement is highly related to their inbuilt self efficacy. However, only few studies have been conducted investigating the relations between self-efficacy and academic achievement in college science in general and in chemistry in particular.

## **CONCLUSIONS**

This study has investigated the level of students' self-efficacy and their achievement in analytical chemistry I (ACI) and identified the difference in self efficacy and achievement between the males and females and determines relationships between the two variables. The total students' mean self-efficacy level is found to be medium (50.08). The mean score of their achievement in ACI test is 61. Both males and females have no significant difference in self-efficacy. However, female students' self efficacy is slightly lower than that of males. In addition, it was investigated that because of self evaluation in class participations and knowledge of the college's norm referenced evaluation system, female students had developed a fear of not getting better results, which entirely would affect their achievement in analytical chemistry test.

In addition, their self-efficacy and achievement are positively and significantly related. Since student self-efficacy beliefs were found to be significantly and positively related to their achievement in analytical chemistry in this study, the importance of self-efficacy's influence on academic performance in science fields cannot be underestimated. According to Bandura (9) efficacy beliefs partly shape the courses that lives take. Therefore as student self-efficacy and

academic achievement are highly connected, educators and counselors should identify students with low self-efficacy and then implement methods to raise the low student self-efficacy levels.

## **RECOMMENDATIONS**

Because of the significant link between self-efficacy and achievement in ACI, it is highly recommended that educators and counselors assess the existing levels of self-efficacy in students at classroom level. If lower levels of self-efficacy are identified, then appropriate measures should be taken to help raise student self-efficacy levels. The primary factors that determine self-efficacy such as enactive mastery experience, vicarious experience, verbal persuasion, and physiological and emotional states (7, 9) are prime targets on which educators and counselors should focus their efforts. Additional areas that can be addressed to help increase student self-efficacy would be goal-setting, rewards and active learning. Finally, the following recommendations are forwarded:

- Teachers should be responsible to their students to enhance students self efficacy.
- Additional tuition should be provided for female students to increase their achievement.
- Counselors and educators should give continuous advice and develop techniques that help lower anxiety and reduce stress, to increase students self-efficacy

For further research, it is necessary to consider the following issues:

- Control of extraneous variables is advised. For example, factors which may influence academic achievement such as educational background, aptitude, attitude, motivation, and past academic achievement were not controlled in this study.

- Measuring different science disciplines and comparing science and non-science majors are also recommended. A comparison of science self-efficacy between second-year and third-year students may also reveal interesting information.
- Even if there is no significant difference between males and females in self-efficacy in this research, there is significant difference in academic achievement so, further researchers need to focus on identifying those factors that brought this difference.

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