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The Effects of an Intervention to Increase Liberal Arts Mathematics and Science Majors' Knowledge Of and Attitudinal Favorability Toward the Teaching Profession

Carolyn Klemballa

Seton Hall University

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THE EFFECTS OF AN INTERVENTION TO INCREASE LIBERAL ARTS
MATHEMATICS AND SCIENCE MAJORS’ KNOWLEDGE OF AND
ATTITUDINAL FAVORABILITY TOWARD THE TEACHING PROFESSION

BY

CAROLYN KLEMBALLA

Dissertation Committee

Martin Finkelstein, Ph.D., Mentor
Rosemary Skeele, Ed.D.
Elaine Walker, Ph.D.

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of the requirements for the Degree
Doctor of Education
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DEDICATION

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CHAPTER I
STATEMENT OF THE PROBLEM

Introduction

This chapter will introduce the reader to the background of the problem that will be explored in this study – the shortage of qualified mathematics and science teachers. The definition of the problem, purpose of the study, research questions, and study summary are presented.

Background of the Problem

For the last 30 years, the United States has experienced a considerable shortage of qualified mathematics and science teachers in middle and secondary schools. According to the National Center of Educational Statistics, the most recent data states that in 1999, there were 2,887,000 public school teachers in grades kindergarten through twelve, of which 1,733,000 were elementary based and 1,154,000 were secondary based (NCES, 2001). Of these nearly three million educators, only five percent were mathematics and science teachers, while the remaining 95% were elementary, special services or other major-based (e.g. history, English) teachers. According to the National Center of Education Statistics, the number of undergraduate mathematics and science education majors added to the number of qualified mathematics and science educators in America’s classrooms did not vary much within the time frame of 1987 through 2001, making the shortage of both mathematics and science education undergraduate majors and
mathematics and science teachers in classrooms persistent throughout more than a decade.

The idea that there are not enough mathematics and science teachers has been an accepted fact for some time. This idea was reinforced in the year 2000 in a report from the National Commission on Mathematics and Science Teaching for the Twenty-first Century, chaired by former senator John Glenn. The report found that two-thirds of mathematics and science teachers would be retiring in the next decade (Saunier, 2002). The nation needs a unified, substantial group to take their place in mathematics and science classrooms. It is imperative to examine this shortage, because the available evidence suggests that the lack of qualified mathematics and science teachers is negatively impacting student performance. Statistics are noted in the literature review that discuss national student performance in mathematics and science over the last decade as well as how U.S. students compare internationally.

The No Child Left Behind Act (NCLB) is a landmark in education reform designed to improve student achievement and change the culture of America's schools (U.S. Department of Education, 2004). President George W. Bush describes this law as the cornerstone of his administration, in which too many needy children are lagging behind their peers (U.S. Department of Education, 2004). With the passage of No Child Left Behind, Congress reauthorized the Elementary and Secondary Education Act (ESEA)—the principal federal law affecting education from kindergarten through high school. In amending ESEA, the new law represents a sweeping overhaul of federal efforts to support elementary and secondary education in the United States. It is built on four common-sense pillars: accountability for results; an emphasis on doing what works based
on scientific research; expanded parental options; and expanded local control and flexibility. The section most appropriate to this study deals with teacher quality. According to NCLB, teachers must hold certification and have the appropriate credentials to be teaching in their fields. If they are not considered highly qualified according to state standards, teachers will lose their jobs at the end of the 2005-2006 school year. Considering the number of emergency teachers already present in mathematics and science positions nationally, this will make the shortage of qualified mathematicians and science teachers even worse.

Definition of the Problem

Due to the teacher shortage, teachers who were not "qualified" were placed in mathematics and science classrooms. According to the Condition of Education (NCES, 2001), in 1995, one-third of teachers with a main assignment in mathematics or science neither majored nor minored in those subjects. The National Center of Educational Statistics found that in the school year 1999-2000, 26% of mathematics students and 16% of science students in K-12 schools were being taught by teachers who had neither a major nor a minor in the subjects that they were teaching. According to the NCES’ (1998) report entitled “Navigating Resources for Schools”, the percent of full-time public school teachers in grades 7-12 who reported having an undergraduate major or minor in their main teaching assignment field in 1998 was 82% for mathematics teachers and 88% for science teachers, as opposed to 89% for social studies, 89% for English and 94% for foreign language. In 1999-2000, the same report cited that 83% of middle school science teachers and 77% of middle school mathematics teachers were teaching without proper certification. According to the Condition of Education (NCES, 2002), in academic
mathematics and science classes, out-of-field teachers generally taught a larger percentage of students in the middle grades than in high school. In the school year 1999-2000, out-of-field mathematics teachers taught 23% of middle school students and 10% of high school students. At the same time, out-of-field science teachers taught 17% of middle school students and 7% of high school students. Overall, out-of-field teachers were more common in physical science than in any other regular subject in both middle schools and high schools. They taught 42% of physical science students in the middle grades and 18% in high school (NCES, 2002). While the statistics above show little variation, they represent a significant dilemma—a high percentage of unqualified teachers in mathematics and science classrooms. After the No Child Left Behind Act causes the dismissal of unqualified teachers in 2006, vacancies will exist for qualified individuals.

Teacher qualifications and student performance in mathematics and science are linked. Researchers have explored the hypothesis that teachers’ knowledge and ability are positively correlated with student learning in the classroom. Several studies in literature have found that students learn more from mathematics and science teachers who majored in those fields (Goldhaber & Fitzsimmons, 1997) and more from mathematics and science teachers who studied teaching methods in those fields (Monk, 1994; Goldhaber & Fitzsimmons, 1997; NCES, 2003). This is primarily because those teachers who are confident in their content area and hands-on learning application can successfully teach the subject to others (Goldhaber & Fitzsimmons, 1997). From the “Nation’s Report Card,” published by the National Center of Education Statistics (2000), a teacher’s undergraduate major seemed to play a significant role in student achievement.
The results showed that eighth-graders whose teachers majored in science education had higher average scores than students whose teachers did not have a major in science education. Compared to other countries, U.S. eighth grade students are more likely to have a science teacher with a major in general education, as opposed to a major in science (NCES, 2000). In the Third International Mathematics and Science Study (TIMSS) Benchmarking Report, research indicated that higher achievement in science is associated with teachers having a bachelor’s and/or master’s degree in science (NCES, 1999). In the Condition of Education Report (NCES, 2002), it was noted that among all secondary teachers, 49% majored in an academic subject (e.g. mathematics, science, history), 38% in a subject area specialization in education (e.g. mathematics education, science education, history education), 7% in general education and 6% other. This reveals another side of the dilemma. The argument thus far has focused on the lack of teacher content knowledge and certification in a mathematics or science subject area. However, it was also reported that teachers in mathematics and science classrooms might be confident in content (as indicated by the 49% majoring in an academic subject), but improperly trained on how to effectively teach it, diminishing the quality of education in America’s mathematics and science classrooms. From these statistics, it seems plausible to conclude that teachers who are not qualified and properly trained both in pedagogy and in content negatively affect students in the classroom and block quality learning.

Across the nation, a decline in national scores in both mathematics and science has been reported in many research publications. In the “Nation’s Report Card,” published by the National Center of Education Statistics (2000), results from the 2000 National Assessment of Educational Progress (NAEP) in Science and Mathematics show
no significant change in scores for grades four and eight, and a decline in performance at grade twelve since 1996. In addition to this steady decline of mathematics and science performance, gender seems to play a significant role in the national mathematics and science scores as well. This study reports that boys seem to outperform girls in the national science assessment in all grades assessed. A report published by the TIMSS International Study at Boston College (NCES, 2000) cites that by twelfth grade, males significantly outperform their female counterparts in both mathematics and science. Gender differences in achievement in both curriculum areas seem to widen at the upper grades (NCES, 2000).

Worldwide, the problem of declining student performance in mathematics and science is worsening, and the United States shows a larger decline than most other countries, particularly in the older grades. According to the National Center of Educational Statistics (2000-2001), in 1999, out of 26 countries, U.S. 4th graders scored better than 16 countries in mathematics and only three countries outscored them in science. In mathematics, U.S. 8th-grade students outperformed their peers in 17 nations, performed no different than their peers in 6 nations, and performed lower than their peers in 14 nations in 1999. In science, U.S. 8th-grade students outperformed their peers in 18 nations, performed no different than their peers in 5 nations, and performed lower than their peers in 14 nations in 1999. In twelfth grade, U.S. students scored below the international average in both mathematics and science and only outperformed South Africa and Cyprus in both mathematics and science. Out of 21 nations, U.S. students ranked 16th in science scores and 19th in mathematics scores. In the higher grades (middle and secondary schools), it can be suggested that there is a relationship between
improperly trained teachers and the declining quality of learning. This would account for the low scores in international comparisons.

Enrollment in Mathematics and Science Liberal Arts Programs

Some experts suggest that because so many undergraduate students in liberal arts have declared mathematics and science majors, they constitute a target group to fill the gap in mathematics and science classrooms. Although research reveals a slight decline in mathematics and physical science majors, there remains a large number of students obtaining these degrees. Specifically, from 1992 to 2002, the number of mathematics majors declined from about 14,000 to 11,000 and the number of physical science majors declined from about 19,000 to 18,000 (NCES, 2002). In addition, there has been an increase in biological and life science degrees in liberal arts. Specifically, from 1992 to 2002, the number of biology majors grew from about 47,000 to 60,000 nationally (NCES, 2002). These students are potential mathematics and science teachers for middle and secondary schools since they meet the requirements of the No Child Left Behind Act, which could potentially open thousands of jobs for mathematics and science qualified individuals.

Throughout literature, low salary and low comfort level are the two most frequent reasons reported for the lack of mathematics and science majors in undergraduate teacher preparation programs pursuing a career in teaching. According to NCES’ Digest of Education (2002), the number of mathematics degrees declined by 14 percent between 1990-91 and 1995-96 and posted a further 11 percent decline between 1995-96 and 2000-01. In the same report from NCES, physical science degrees were declining as well, but not significantly. On the other hand, the number of biological and life science bachelor
degrees remained steady; in fact, some years, there was an increase in degrees awarded in these fields (NCES, 2002).

Although there is a steady flow of undergraduate biology and life science majors, research has supported the notion that salary is the most common factor keeping them away from teaching. In 1999, NCES reported the average salary for public school teachers to be $40,582 (NCES, 2001). Teachers' salaries are imperative to mention when trying to recruit more educators. The uniform pay scale is under consideration in many districts in the United States as well as countries around the world. Incentives designed to attract undergraduate science majors include abandoning the uniform pay scale and offering higher salaries for positions in demand, such as mathematics and science teachers. Unions usually prevent this from happening. Over 50% of mathematics and science majors report low salary as the number one reason for not selecting education as a career (Saasner, 2002; Ferguson, 2000). Making salaries comparable to non-educational employment opportunities was another reported way to attract and retain qualified mathematics and science teachers (Saasner, 2002; Ferguson, 2000). If prospective or current teachers sense that a mathematics/science degree will qualify them for higher paying jobs in nongovernmental environments, they are likely to either leave the teaching profession or not enter it at all (Saasner, 2002; Ferguson, 2000; Wright & Nassar, 1991; Turner, 1991; Holland, 1990). However, what if they were exposed to the benefits of teaching? Would this possibly attract more mathematics and science teachers?

Literature has discussed several action plans implemented to attract mathematics and science teachers. The most common course of action includes making certification
requirements accessible to graduates who earned a science or mathematics degree in a liberal arts program. Many individuals become teachers today via alternative accreditation programs. They enter the teaching workforce after years in a mathematics or science noneducational job. In rural areas, the lack of mathematics and science teachers is extreme. Institutions of higher education try to recruit teachers in the following ways: encouraging students to visit rural districts, posting job openings, selling the idea of teaching, providing internships, and holding recruiting fairs. Some rural schools ease the transition of new teachers by assigning mentors (Harmon, 2001). The National Science Foundation has been instrumental in recruiting qualified mathematics and science teachers. Their programs will be discussed in the literature review.

Purpose of the Study

The analysis above suggests that a group of potential mathematics and science teachers exists in the schools of liberal arts—mathematics and science majors. As noted above, fear of mathematics and science content prevents many teachers from considering mathematics and science education as a career. Since mathematics and science majors in liberal arts have already declared majors in these fields, they do not fear the content. Therefore, this research will explore a specific problem—the effect of presenting information about teaching to liberal arts mathematics and science majors on their attitude toward teaching and willingness to enter the profession. The author hypothesizes that an intervention which exposes undergraduates to teaching will not only increase their knowledge about the teaching profession, but also increase their favorability toward teaching. Research reveals that with the right information, students are apt to change their major because they are exposed to new ideas. While salary will most likely remain an
issue, the author hypothesizes that an intervention exposing students to the teaching profession will increase undergraduates' knowledge and attitudinal favorability simultaneously.

The National Center of Education Statistics (2002) reports that the number of prospective teachers enrolled in mathematics and science education programs is quite low in comparison to other education majors. In the last fifteen years, the largest proportion of education majors that were mathematics or science education majors was three percent in 1994. Since that year, the National Center of Education Statistics (2002) has shown a slow, but significant decline of mathematics and science education majors. The proportion declined to almost two percent in the year 2001.

The low enrollment in mathematics and science teacher preparation programs is only one factor resulting in the shortage of qualified mathematics and science teachers. To highlight the magnitude of this issue at the national level, in 2001, the U.S. Department of Education allocated $1.174 million dollars for mathematics and science training at colleges for prospective mathematics and science teachers. The goal of this government funding was to increase the quality of mathematics and science education through the pre-service education of future teachers in colleges (Wilson, 2001). In 2000, while still a governor and presidential candidate, George W. Bush called for a national focus on boosting mathematics and science performance by spending an additional $2.3 billion over five years. Within this monetary allegiance to mathematics and science, $345 million was allocated to encourage college graduates to major in mathematics or science education (Wilson, 2001).
There is a persistent decline in the mathematics and science teacher workforce, a decline in enrollments in teacher mathematics and science education programs and an increase in students' mathematics and science interest. A strategy to address this issue might focus on the substantial number of mathematics and science majors in liberal arts schools in colleges and universities across the nation. At many institutions of higher education, research reports that communication lines are weak between schools of liberal arts and schools of education. Consequently, many undergraduate mathematics and science majors are not exposed to teaching as a career choice.

Research also reports that undergraduates are impressionable and likely to change their minds during their college experience. Hoyt and Lester (1995) cite that some career counseling assistance is needed by 60% of currently enrolled undergraduate students at colleges and universities. Literature also reports that when undergraduates are presented with alternative career opportunities, they consider them (Walz, Lambert, & Kirkman, 2002; Finck, Thomas-Clark, Krueger, & Berg-Kelin, 2001; Hoyt & Lester, 1995). This was validated by Lee, Clay, and Presley (2001), who reported that providing college students with a realistic set of expectations for the teaching profession recruits teachers.

Research Questions

1. What would be the effect of presenting information about teaching careers to mathematics and science majors in schools of liberal arts? Would an intervention increase the knowledge of the teaching profession and all that is associated with it as well as the attitudinal favorability toward teaching as a career for undergraduate students?

2. Does the type of intervention matter with regard to students' knowledge about and attitudinal favorability toward the teaching profession? That is, does a more intensive
intervention, a workshop about the teaching profession, impact undergraduates' knowledge and attitudinal favorability of teaching more so than a less intensive intervention, reading articles about teaching? And, does a less intensive intervention, reading articles about teaching, impact undergraduates' knowledge and attitudinal favorability of teaching more so than no intervention at all?

3. Is there a relationship between knowledge and favorability after an intervention about the teaching profession and associated information? In other words, is higher knowledge of the teaching profession associated with higher attitudinal favorability toward the teaching profession after an intervention?

4. Does an intervention about the teaching profession and associated information impact undergraduate students more at different levels of career uncertainty, as assessed by The Career Decision Scale? That is, after an intervention, do students have a higher attitudinal favorability toward the teaching profession if they are more uncertain in their career choice?

5. Does an intervention about the teaching profession and associated information impact undergraduate students more at different levels of undergraduate education? That is, after an intervention, do students have a higher attitudinal favorability toward the teaching profession if they are a freshman, sophomore, junior or senior?

6. Does an intervention about the teaching profession and associated information impact undergraduate students more depending on their gender? That is, after an intervention, do students have a higher attitudinal favorability toward the teaching profession if they are male or female?
Study Summary

Nationally, the shortage of mathematics and science teachers has been a major problem for several decades and the No Child Left Behind Act could potentially worsen it. Since the No Child Left Behind Act is related to education, many liberal arts mathematics and science majors may not be aware of the ramifications of this act, including the negative impact on mathematics and science education for students and the job openings that will result. Because NCLB does not take effect until the end of the 2005-2006 school year, many researchers are waiting to assess the consequences from its implementation. From projections, it seems evident NCLB will make the shortage of mathematics and science teachers worse. Therefore, it seems imperative to examine if exposing liberal arts mathematics and science majors to the teaching profession is enough to recruit some of these undergraduates into the field of teaching.

If possible interventions are identified that recruit more highly qualified mathematics and science teachers, this study has the potential to increase the quality of mathematics and science education for America's students. Therefore, the research problem - if an intervention exposing undergraduates to teaching increases their knowledge of and attitudinal favorable towards the profession - lies within the broader context of the impending and mounting national shortage of qualified mathematics and science teachers.
CHAPTER II
LITERATURE REVIEW

Introduction

This chapter discusses all of the literature in the field surrounding the shortage of mathematics and science teachers as well as the shortage of mathematics and science education majors. Also included in the literature review is research on the No Child Left Behind Act, the effect of unqualified teachers in classrooms, and a possible recruitment of future mathematics and science educators. The organization of the literature review is included in this chapter, and is quite specific and extensive.

Research has established that the number of teachers who are qualified to teach middle and high school mathematics and science falls short of the nation's need. This shortfall leads to a hypothesis that middle and secondary school instruction leaves students unprepared to study mathematics and science in college (Galney & Weiser, 1995). As early as 1976, there were estimates of a mathematics and science teacher shortage in literature. The aging teacher force in the 1970s, coupled with the estimated upturn of enrollment in the 1980s was reported as a problem in the field of education (Livermore & Hausman, 1976). From 1973-1978, the output of high school teachers in academic subjects dropped 43%. The drop in teacher production coupled with a drop in education majors was projected to lead to a teacher shortage in the 1980s (Livermore & Hausman, 1978). In 1984, a study stated that there was an estimate of 3600 mathematics teachers and 1800 science teachers needed at the secondary level between 1984-1988.
(Reitner, 1984). The 1990s saw an even further decline in mathematics and science teachers. Finding enough qualified mathematics and science teachers was presented as a challenge, especially with current problems in districts regarding the recruitment of individuals in these disciplines (Kantoroom, 1999). This issue was presented to Congress by a Committee on Science Education at the House of Representatives in 1999.

Because of the teacher shortage, unqualified individuals are being placed into mathematics and science classrooms. The National Center for Educational Statistics found that in the school year 1999-2000, 26% of mathematics students and 16% of science students in K-12 were being taught by teachers who had neither a major nor a minor in the subjects they were teaching (Saunser, 2002). In that same year, 77% of urban schools had teacher shortages in the areas of mathematics, science, special education and bilingual education and 68% of districts nationwide had openings for mathematics and science teachers (McCraight, 2000). Consequently, in these schools, unqualified individuals were responsible for educating the students. In literature, this trend can be seen as early as 1981-1982, when 50% of the mathematics and science teachers were emergency teachers hired, not qualified in their main assignment teaching positions (Shynansky & Aldridge, 1982).

In a testimony prepared for delivery to the Committee on Science at the House of Representatives in 1999, it was stated that the nation had to hire as many as two million new teachers in the next decade (Rimbach & Yellis, 2000). This was validated by Laura Bush, in her address at the White House conference on preparing tomorrow's teachers. She enforced the notion future educators need a thorough understanding of teaching
skills, subject content, and an ability to assess students' specific needs to make the greatest academic gains (Bush, 2002).

Unfortunately, future educators cannot all come from traditional teacher preparation programs in mathematics and science education. This is because there has been a catastrophic decline in the number of persons preparing to teach mathematics and science, which results in unqualified teachers in mathematics and science classrooms. Of the 1,169,275 bachelor's degrees awarded in 1993-1994, 107,600 were education degrees, but only 3% of those were mathematics and science education majors. Of the 1,164,792 bachelor's degrees awarded in 1995-1996, 105,509 were education degrees, but only 2.7% percent of those were mathematics and science education majors. Of the 1,172,879 bachelor's degrees awarded in 1996-1997, 105,233 were education degrees, but only 2.5% percent of those were mathematics and science education majors. Of the 1,184,406 bachelor's degrees awarded in 1997-1998, 105,968 were education degrees, but only 2.6% of those degrees were mathematics and science education. Of the 1,209,303 bachelor's degrees awarded in 1998-1999, 107,172 were education degrees, but only 2.4% percent of those were mathematics and science education majors. Of the 1,237,875 bachelor's degrees awarded in 1999-2000, 108,168 were education degrees, but only 2.3% percent of those were mathematics and science education majors. Of the 1,244,171 bachelor's degrees awarded in 2000-2001, 105,566 were education degrees, but only 2.2% percent of those were mathematics and science education majors (NCES, 1997-2002). Therefore, there has been a consistent decline in the output of mathematics and science teachers, as evidenced by the steady decrease in undergraduate bachelor's degrees awarded in mathematics and science education. Table one highlights this.
Table 1

**Bachelor’s Degrees Awarded in Mathematics/Science Education**

<table>
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<tr>
<th>Year</th>
<th>Total B.A Degrees</th>
<th>Education Degrees</th>
<th>Percent that were Mathematics/Science Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993-1994</td>
<td>1,169,275</td>
<td>107,600</td>
<td>3.0%</td>
</tr>
<tr>
<td>1995-1996</td>
<td>1,164,792</td>
<td>105,509</td>
<td>2.7%</td>
</tr>
<tr>
<td>1996-1997</td>
<td>1,172,879</td>
<td>105,233</td>
<td>2.5%</td>
</tr>
<tr>
<td>1997-1998</td>
<td>1,184,406</td>
<td>105,368</td>
<td>2.6%</td>
</tr>
<tr>
<td>1998-1999</td>
<td>1,200,303</td>
<td>107,715</td>
<td>2.4%</td>
</tr>
<tr>
<td>1999-2000</td>
<td>1,237,875</td>
<td>106,168</td>
<td>2.3%</td>
</tr>
<tr>
<td>2000-2001</td>
<td>1,244,171</td>
<td>106,566</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

*Note: National Center of Educational Statistics, 2002.*

There are more undergraduates, however, that do possess an interest in mathematics and science. These are the students who have declared a mathematics or science major in liberal arts. Although research reports a slight decline in the number of these majors (specifically, mathematics and physical science), the number of mathematics and science majors is still substantial. This group of mathematics and science majors represents a target group of individuals who could fill the gap in mathematics and science classrooms. Table two and figure one below reports that the number of students who earned a bachelor’s degree in mathematics in higher education in the United States was the following for each year: 11,674 (2000-2001), 12,970 (1999-2000), 12,328 (1997-1998), 12,826 (1996-1997), 13,143 (1995-1996), 14,396 (1993-1994) and finally, 14,812 (1992-1993) (NCES, 2002).
Table 2

Number of Mathematics Liberal Arts Bachelor Degrees

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Mathematics Liberal Arts Bachelor Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-1993</td>
<td>14,812</td>
</tr>
<tr>
<td>1993-1994</td>
<td>14,396</td>
</tr>
<tr>
<td>1995-1996</td>
<td>13,143</td>
</tr>
<tr>
<td>1996-1997</td>
<td>12,820</td>
</tr>
<tr>
<td>1997-1998</td>
<td>12,328</td>
</tr>
<tr>
<td>1999-2000</td>
<td>12,070</td>
</tr>
<tr>
<td>2000-2001</td>
<td>11,674</td>
</tr>
</tbody>
</table>
Figure 1. Number of Mathematics Liberal Arts Bachelor Degrees
Similarly, but to a lesser extent, physical science majors decreased slightly over the years. The number of students who earned a bachelor’s degree in physical science was the following for each year: 17,979 (2000-2001), 18,385 (1999-2000), 19,416 (1997-1998), 19,531 (1996-1997), and 19,647 (1995-1996) (NCES, 2002). This is presented in Table 3 and Figure 2 below.

Table 3

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Physical Science Liberal Arts Bachelor Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995-96</td>
<td>19,647</td>
</tr>
<tr>
<td>1996-97</td>
<td>19,531</td>
</tr>
<tr>
<td>1997-98</td>
<td>19,416</td>
</tr>
<tr>
<td>1999-2000</td>
<td>18,385</td>
</tr>
<tr>
<td>2000-2001</td>
<td>17,979</td>
</tr>
</tbody>
</table>
Figure 2. Number of Physical Science Liberal Arts Bachelor Degrees
In contrast, there has been an increase in biological and life sciences. The number of students who earned a bachelor's degree in biological/life science was the following for each year: 68,553 (2000-2001), 63,582 (1999-2000), 65,808 (1997-1998), 63,975 (1996-1997), 60,994 (1995-1996), 51,383 (1993-1994), and 47,038 (1992-1993) (NCES, 2002). This is presented in Table 4 and Figure three below.

Table 4

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Bio/Life Science Liberal Arts Bachelor Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992-1993</td>
<td>47,038</td>
</tr>
<tr>
<td>1993-1994</td>
<td>51,383</td>
</tr>
<tr>
<td>1995-1996</td>
<td>60,994</td>
</tr>
<tr>
<td>1996-1997</td>
<td>63,975</td>
</tr>
<tr>
<td>1997-1998</td>
<td>65,868</td>
</tr>
<tr>
<td>1999-2000</td>
<td>63,582</td>
</tr>
<tr>
<td>2000-2001</td>
<td>60,553</td>
</tr>
</tbody>
</table>
Figure 3. Number of biological and life science liberal arts bachelor degrees.
There are numerous reasons described in literature for teacher shortages and lack of retention. Prospective teachers either leave or do not enter the field of mathematics and science education for such reasons as low salaries, higher salaries in noneducational career options, lack of preparedness, rigorous certification exams, lack of advancement opportunities, and low emphasis on professional development (McClellan, 2000). Strategies discussed in literature for reducing teacher shortage include: making salaries higher, abolishing the uniform pay scale and making salaries higher for fields in demand (like mathematics and science) as well as making salaries comparable to non-education employment; increasing time spent in training and preliminary content professional development; promoting programs allowing alternate route candidates into fields of mathematics and science; restructuring teacher preparation programs to raise the self-efficacy of prospective teachers; and finally, pre-exposing prospective teachers to both content and pedagogy in preparation to teach mathematics and science.

This literature is imperative to examine, considering the fact that both student population and student interest in mathematics and science is increasing. If this study identifies specific factors which attract mathematics and science liberal arts majors into teaching, the quality of mathematics and science education would increase. Therefore, the following literature review serves to explain overlapping evidence in research which suggests that there are many factors contributing to the lack of mathematics and science education majors, and qualified mathematics and science teachers. The reader should examine the various components of this literature review, as they lay the foundation for a research study investigating the recruitment of mathematics and science majors into the teaching profession.
Organization of the Literature Review

The organization of the literature review is composed of four main sections that are broken down further into subcategories. The first section will discuss The No Child Left Behind Act (NCLB), a government action, which emphasizes the need for qualified teachers in every classroom. NCLB’s focus is on educational improvement and includes four principles: accountability for results, local control and flexibility, expanded parental choice, and effective and successful programs with highly qualified teachers (U.S. Department of Education, 2001). A general overview will include how NCLB will affect the number of qualified mathematics and science teachers in classrooms, how the federal government is planning to assess teacher quality and finally, how specific mathematics and science programs within the act are designed to enhance teacher quality and student learning.

The next section will discuss low salary and its role in the recruitment of mathematics and science teachers. Research suggests making teaching salaries comparable to noneducational employment, infusing a differential pay scale and using monetary incentives, such as grants, loans, and stipends to attract more mathematics and science teachers.

Next, the issue of negative mathematics and science perception will be analyzed. Literature reports that individuals do not enter mathematics and science education because of a poor previous experience with content and low self-efficacy in mathematics and science from that experience. The gender gap in mathematics and science achievement will also be explored. Teachers’ lack of sufficient in-service time, professional development, and resources, will follow.
The consequences of unqualified teachers in mathematics and science classrooms will be discussed and how the quality of student learning is decreasing, especially in international comparisons. The different state requirements for teacher certification will be explored as well as the programs that certify new teachers from other careers.

After these four sections are discussed, the recruitment of mathematics and science teachers will be explored. Due to the fact that there are many students who express an interest in mathematics and science as reported in statistics, it is imperative to analyze if an intervention about teaching would attract them into the profession. This serves as the transition between the literature review and the purpose of this study. Within this section of the literature review, the communication between liberal arts schools and education schools will be discussed as well as alternative programs already established to draw the mathematics and science liberal arts majors into teaching.

Note: Readers might speculate the validity of the few references with "elementary teachers" in the title. While the author's focus is on middle and secondary school mathematics and science education majors, the articles with "elementary" in the title assume student teachers kindergarten through eighth grade; therefore, they are valid resources and are used as part of the review of literature.

The No Child Left Behind Act

Introduction to the No Child Left Behind Act

The section of the literature review will explain the No Child Behind Act (NCLB) and speak specifically about the parts that pertain to enhancing retaining teacher quality in classrooms. First, there will be a brief overview of the No Child Left Behind Act and what it means for a teacher to be considered highly qualified. Since the federal
government has asked states to develop their own means to assess teacher quality. New Jersey was selected by the author to serve as an example of what a state considers a highly qualified teacher. Many states have similar models to New Jersey. Following this is a discussion of the mathematics and science sections of the No Child Left Behind Act, which readily pertain to this study. Included in this section are NCLB’s objectives for improving mathematics and science teaching strategies and teacher quality in mathematics and science classrooms as well as examples of successful programs which indicate gains in teacher quality and student performance.

Overview of the Act Itself

Rod Paige, Secretary of the U.S. Department of Education, describes the No Child Left Behind Act as a directive to improve teacher training in order help students meet higher standards (U.S. Department of Education, 2001). The No Child Left Behind Act was signed into law by President George W. Bush on January 8, 2002 and is the most recent reauthorization of the Elementary and Secondary Education Act of 1965. Teacher quality is a high priority within this government act. NCLB defines the qualifications needed by teachers and paraprofessionals who work in any facet of classroom instruction (Trahan, 2002). The law requires that states develop plans to ascertain that all teachers of core academic subjects are highly qualified by the end of the 2005-06 school year. States must include annual, measurable objectives that each local school district and school must meet in moving toward that goal. Districts must report on their progress in annual report cards to the government. Specifically, the Title II section clause is the portion of NCLB that pertains to teacher quality and will most likely impact the shortage of mathematics and science teachers. It is specifically called “Improving Teacher Quality
State Grants." The overview from the government website states that NCLB will authorize a new State formula grant program that combines the Eisenhower Professional Development State Grants and Class-Size Reduction programs into one program that focuses on preparing, training, and recruiting high-quality teachers (U.S. Department of Education, 2004).

NCLB also gives more resources to schools. The federal and state funding, estimated at $23.7 billion, is the most monies states and local school districts have ever received (U.S. Department of Education, 2004). Specifically, a record-level $2.85 billion in grants were awarded to states to improve the quality of teachers. Under NCLB, these funds will be used directly to increase the number of highly qualified teachers and hold school districts accountable for showing progress. Funding can be used to support a wide array of activities, including teacher professional development (Garcia, 2002). In addition to the state grants programs, Title II of NCLB includes further funding for other teacher quality-related grant programs and $42 million will be awarded to states and school districts to help thousands of outstanding candidates enter teaching through alternative means.

Since education is state mandated, the federal law delegates responsibility for ensuring teacher quality to the state governments. NCLB defines a highly qualified teacher as an educator that has full state certification and passed the state’s licensing examination in that specific field. All current in-field teachers must demonstrate that they are highly qualified by the end of the 2005-2006 school year (U.S. Department of Education, 2004; Richardson, 2002; Garcia, 2002; Edley, 2002; Cicchinielli, Gaddy, Lefkowitz, & Miller, 2003). The Department of Education’s role in orchestrating these
requirements includes the following: to provide districts with the orientation and training needed to support schools in completing the highly qualified teacher identification process; to create a state profile using the highly qualified teacher survey data; and to determine the annual progress goals for increasing the percentage of classes taught by highly qualified teachers. The district's role in orchestrating these requirements is to provide schools and teachers with the orientation, in-service, and support needed to complete the highly qualified teacher identification process.

Presently, states are developing systems to assess the qualifications of practicing teachers. The author has chosen New Jersey to exemplify the process by which states are identifying highly qualified teachers. A highly qualified teacher is one who has a state certification in his/her field, one who passed a rigorous state test in his/her field, or one who completed an academic major, coursework equivalent to a major, or obtained a graduate degree in the appropriate discipline. If one of these is not obtained, they may accumulate a total of 10 or more of the points on the NJ House Standard Matrix in order to obtain the status of highly qualified. Examples of point values include the following: eight years or more of teaching in mathematics or science is worth two points; each course in the specific discipline is worth two points on an undergraduate transcript; enough in-service/professional development is worth two points; and teaching an in-service or graduate course is worth two points. These are only a few examples. The NJ House Matrix is only used to qualify teachers if they do not meet the standard requirements discussed above.

In addition to highly qualified teachers, by the 2005-2006 school year, states must begin testing students in grades 3-8 annually in reading and mathematics. The tests must
be aligned with state academic standards. A sample of students in fourth and eighth grades in each state must also participate in the National Assessment of Educational Progress testing program to ensure the alignment of the state assessment process with national standards (Trahan, 2002; U.S. Department of Education, 2004; Richardson, 2002; Garcia, 2002; Ciochinelli, Gaddy, Lefkowits, & Miller, 2003). This way, the government can identify successful schools, including those that are helping their students make exemplary progress and those schools that need help (U.S. Department of Education, 2001). In the annual progress report to the federal government, each state must submit the number of teachers who are not fully licensed, who are teaching under emergency certification, and who are misplaced in field settings. The federal law requires that states monitor district progress toward meeting state objectives for increasing teacher quality within their district and their schools. If a district fails for two consecutive years to make progress toward meeting the annual objectives, that district must develop an improvement plan. The improvement plan must be designed to help the district meet the state’s annual measurable objectives for increasing the percentage of highly qualified teachers and must address issues that prevented the district from meeting those objectives. Each district must also provide communication to the parents regarding the professional qualifications of the primary teacher of their child. This information includes whether the teacher has met state qualifications for the grade level or subject in which the teacher provides instruction (Trahan, 2002).

Improving Mathematics and Science Education and Teacher Quality

The desire of school districts to fill these vacancies of qualified mathematics and science teachers in schools is intensifying with the passing of NCLB, as states hold
schools accountable for raising school achievement, which is reflected back to qualified teachers (Joffus & Maddox-Dolan, 2002; Edley, 2002). Since there is such a shortage of mathematics and science teachers, the act itself has a special section entitled "Mathematics and Science Activities" with a competitive grant program. Under NCLB, the new state use of funds includes reforming teacher certification/licensing requirements, alternative routes to state certification, teacher recruitment and retention initiatives, reforming tenure systems, teacher testing, and merit pay.

Part B of Title II includes a section on Mathematics and Science Partnerships (MSP). The MSP program brings together efforts of the National Science Foundation and the Department of Education to improve mathematics and science education in grades kindergarten through twelve. MSP authorized $450 million to improve the academic achievement of students in the areas of mathematics and science. The use of the funds are aimed to improve quality instruction through the training and professional development of teachers in conjunction with the redesign of many curricula, stronger teaching skills, technology based teaching methods, and mentoring programs with content experts. Grants made through the National Science Foundation will provide funding for up to five years to support partnerships among institutions of higher education and school districts. The objective of part B of Title II also brings mathematics and science teachers into contact with working scientists, mathematicians, and engineers, and develops programs to encourage young women and other underrepresented groups to pursue careers in mathematics, science, engineering, and technology (U.S. Department of Education, 2004; Richardson, 2002).
The Alliance for Excellent Education is a national policy, advocacy and research organization linked to NCLB created to help middle and high school students receive an excellent education. Although their main focus is on the most at-risk low income students, their objectives based on NCLB will most likely benefit mathematics and science students and teachers. Many teachers are currently leaving the profession because of low pay, difficult working conditions, and a lack of training and support. With the focus on increased testing, some veteran teachers have begun to feel that they are suddenly held much more accountable for student progress while, at the same time, their individual creativity as teachers is no longer valued. With their departure, districts must sometimes hire large numbers of underqualified or beginning teachers to fill the vacancies, and they often do so without putting necessary support systems in place. With this Alliance, more than $40 million will be invested in schools of education. The monies will be used to implement induction programs that provide faculty mentors and coaches to new teachers (Jofus & Maddox-Dolan, 2002). There are several benefits to mathematics and science teachers from such a program: new and veteran teachers stay longer in their teaching positions, saving districts money in turnover costs; new teachers are more effective in the classroom and use teaching practices that improve student achievement; veteran teachers become happier in their jobs and learn new ideas to implement in their curriculum; and mentoring teachers go on to have additional leadership and extra income in their districts (Jofus & Maddox-Dolan, 2002).

There are many states that have teacher support, induction, and assessment programs. Most of these induction programs provide effective transitions into the teaching career, improve the educational performance of students through additional
training for new teachers, ensure the professional success and retention of new teachers, improve the rigor and consistency of individual teacher performance assessments, establish an effective, coherent system of performance assessments, and ensure continuous program improvement (Joftus & Maddox-Dolan, 2002). California, Texas, Ohio, Georgia, New York, and Louisiana are all states that presently have a teacher induction program and so far, the results have been positive. To ensure that they meet NCLB's requirements for qualified teachers in every classroom, schools work with their districts and states to develop and implement comprehensive, well-financed induction programs for new teachers. Such programs in the states listed above proved effective in recruiting qualified teachers and keeping them in place, frequently saving districts significant amounts of money (Joftus & Maddox-Dolan, 2002). This training is necessary for all teachers who, under NCLB, must demonstrate a highly-qualified state in order to keep their jobs.

Summary of the No Child Left Behind Act

The No Child Left Behind Act is imperative to discuss, as it has implications for a worsening shortage of qualified mathematics and science teachers. If this act maintains its standards of quality, there will be many teachers without a job at the end of the 2005-2006 school year and a wide-open job pool for appropriately qualified candidates to enter teaching.

Salary

Introduction to Salary

The objective of this section of the literature review is to discuss the primary reason undergraduates do not choose mathematics and science education -- salary. In
addition to the overall low salary, qualified teachers are leaving or not even entering the field after graduation, due to competitive salaries in noneducational career options. The author also describes findings which suggest that abolishing a uniform pay scale may attract more mathematics and science teachers, not only from teacher education programs, but from liberal arts mathematics and science programs as well. Lastly, research will also be discussed that includes loans, stipends, and other forms of incentives to attract more mathematics and science teachers.

Teachers Leave for Low Salaries and Salaries in Other Fields

The average salary for public school teachers grew slowly during the 1990s, reaching $40,582 in 1998-99. After adjustment for inflation, teachers' salaries rose one percent between 1988-99 (NCES, 2001). It seems imperative to mention the role that teachers' salaries play. Many studies show that contrary to conventional wisdom, the problem schools have adequately staffing classrooms with qualified teachers is not due to increases in student enrollment or teacher retirement. In fact, many teachers are leaving to pursue mathematics and science careers in arenas other than education, simply to make more money (Ingersoll, 1999; Rumberger, 1987; Flowers, 1982; Madfis, 1991; Hudson, 1996; Ferguson, 2000). In the early 1980s, Yeotis and Nickel (1983) and Flowers (1982), reported that five times more science and mathematics teachers left to take non-teacher jobs than teachers in other disciplines. In order to retain teachers, salaries had to be increased or else unqualified teacher would be placed in those classrooms, negatively impacting student performance in mathematics and science (Flowers, 1982; Yeotis & Nickel, 1983). This is not much different today. Low salary is the primary factor keeping good, qualified teachers out of classrooms, coupled with a ballooning student population.
and the steady retirement of the experienced teaching population (Ingersoll, 1999; Flowers, 1982; Malfles, 1991; Saxner, 2002; Haxison, 1996; Wright and Nassar, 1991; Gonzalez, 1999). In a statement made before the Committee on Science Presentation at the House of Representatives in 1999, it was noted that since teacher salaries hardly make the profession attractive, it is difficult to hire teachers in fields where their expertise equips them for many other higher-paying jobs (Fanstonroom, 1999). In one example research study, when asked to list their top three reasons for leaving the field, 66% of mathematics and science teachers reported low salary as the number one reason. The remaining third had low salary at least in their top three factors (Sausner, 2002). Another example study in Illinois, conducted by the Illinois Board of Education (1983), stated that one-fifth of all mathematics and science teachers are leaving due to higher salaries in different careers.

As the United States competes in a world increasingly driven by mathematics and science, potential teachers in these fields of science and mathematics graduates are lured away by other career opportunities. This is mostly attributed to competition with business and industry, where salaries are much higher and attractive to mathematics and science oriented people (Hudson, 1996; Terner, 1991; Ferguson, 2000). Specific data was reported in Ferguson's study (2000), as he noted that each year a higher proportion of younger teachers think about abandoning their chosen career as science teachers to enter the high-tech industry. This includes 32% of science teachers with one to three years experience, 37% of those with four to six years on the job, 33% of those working between seven and nine years and 37% with ten to fifteen years of experience (Ferguson, 2000). The average salary for teachers in 1991 was $21,542 and those entering careers
related to mathematics earned $29,244. Those entering fields of chemistry earned $29,700 and professions related to computer science were making $30,924. As a result, many who were qualified to teach mathematics and science did not. Instead they entered the business world and industry related professions (NEA Today, 1993). The students with an aptitude for mathematics and science who would have become teachers thirty years ago are now becoming computer programmers, scientists, or engineers (Saunner, 2002). Staffing shortages arise not just from lack of mathematics and science teachers, but also from the way in which teachers are deployed in schools. There is frequently a conflict between whole school responsibilities and the demands of science teaching.

Good teachers tend to be promoted out of the science team to careers other than education, such as writing state curriculums, texts, etc., or in careers that allow them to work with information technology more, if they have computer experience (Turner, 1991).

It seems evident from these studies in literature that more prospective teachers would choose mathematics and science if there were perhaps a higher paying salary and better monetary rewards or incentives. Connecticut is a prime example. Connecticut pays its teachers very well, an average of $61,918 as compared to the national average of $48,728 (Saunner, 2002). As a result, Connecticut does not have as extreme a shortage of mathematics and science teachers as other states. The fact remains that the teaching profession cannot compete salary-wise with business opportunities for mathematics, science, and technology qualified individuals (Gonzalez, 1999). Due to this, America is losing qualified teachers in mathematics and science classrooms, which leads to a
decrease in quality learning for students (Ingersoll, 1999; Rumberger, 1987; Flowers, 1982; Madies, 1991; Hudson, 1996; Ferguson, 2000; Yeotis & Nickel, 1983).

Certified Undergraduates Do Not Enter Classrooms

In addition to these decreasing number of mathematics and science teachers, recent graduates from higher education with majors in mathematics and science education accept job opportunities in noneducational employment opportunities as well (Rumberger, 1985). These graduates are seeing the same noneducational opportunities that are higher-paying (Ingersoll, 2003, Rumberger, 1985, Rumberger, 1987). A landmark longitudinal study was conducted at Iowa State from 1985-1989, which included 842 graduates. The study compared career paths of mathematics and science education majors with those majors in other educational disciplines. The data showed that the percentage of science and mathematics teachers teaching after graduation the first year was over 60%. That number dropped to 51% five years after graduation. Comparatively, 42% of secondary graduates and 58% of elementary education majors taught the first year following graduation and their numbers remained constant. Thirty seven percent of mathematics and science education majors stated that they would most likely be teaching mathematics and science in ten years, compared to over 75% of other education majors. The most frequent response for the drop out was reported as better salaries and career opportunities in nonteaching jobs (Holland, 1990). Furthermore, this study suggested that unless mathematics and science teachers are retained, the shortage of mathematics and science teachers will become more severe (Holland, 1990).
A Differential Payscale

As early as 1983, some state policies suggested differential salary scales to attract mathematics and science prospective teachers (Palaich & Burnes, 1983). Several strategies to attract and retain mathematics and science teachers include one-time signing bonuses or higher salaries than teachers in other disciplines (Palaich & Burnes, 1983; Yeotis & Nickel, 1983). In addition to these bonuses, one study even suggested that teachers in any field or discipline should be encouraged to pursue training in mathematics and science with the reward of stipends, sabbaticals, tax credits or other incentives to ascertain appropriate certification (Flowers, 1982).

Aborting the uniform pay scale is under consideration in many districts in the United States, as well as other countries. Possible incentives to attract high school science teachers for example would be to do away with the uniform pay scale, and offer higher salaries for a physics high school position in comparison to an elementary teaching position. Basic economics argues that teachers in subjects in short supply (i.e. mathematics and science) should be paid more than those in fields that are amply supplied. In a study conducted by Carl (1984), it was reported that in 1983, only 4.7% of the entering freshmen aspired to careers in teaching and less than one percent of them expressed interest in mathematics or science education. Consequently, school districts are in fierce competition with one another to attract and hold qualified teachers. In 1984, the Houston Independent School District was a pilot district that implemented a new salary structure called the Houston Second Mile Plan (Carl, 1984). Summed up, the plan called for an additional two thousand dollar annual stipend for mathematics and science teachers. Also, a compressed salary guide was put into effect. The raises per year for
Mathematics and science teachers were close to 14%. In addition, several incentives were enticing to these mathematics and science teachers such as high priority location, professional growth, outstanding education progress rewards, and unique campus assignment (Carl, 1984). Considering the positive growth of Houston’s teachers to the present day, it seems apparent that the plan did yield positive effects. Although Houston found immediate success from this plan, research did not denote any other valid studies with such a success rate. Actually, many states feel anxiety about this quick fix, as mathematics and science are then given a more prestigious status and this could potentially lead to unwanted tension within academic communities.

Monetary Incentives

Some reports have alluded to several programs that offer reimbursement for training in mathematics and science pedagogy and content. There is no concrete evidence of any of these programs having an adverse effect on the decline of mathematics and science teachers (Fox, 1983). However, one solution proposed by a survey of mathematics and science teachers includes making teaching positions more attractive by offering general college scholarships and loans to ease entry into teaching (Carr, 1988). Reports of a study of incentive programs in the fifty states and District of Columbia state: Fifty percent of states have some form of incentive program as a response to the shortage of mathematics and science teachers (Besl, 1986). The states that are presently offering such incentives are: Alabama, Georgia, Kentucky, Maryland, North Carolina, Oklahoma, South Carolina, Tennessee, and Virginia (Cormet, 1986). Programs, as evidenced by the King Foundation Forgivable Loan Program in Texas, describe low loans and scholarships are designed to attract teachers into mathematics and science fields as well.
as supply funding for certification. The financial incentive already has proven to be moderately successful, with a higher enrollment in mathematics and science education programs in these states (Cornett 1986; Beal, 1986; Casey, 1988; Baker, 2000).

Summary of Salary

The findings in this portion of the literature review suggest that educational policy initiatives will not solve school staffing problems if they do not address the problem of teacher retention (Ingersoll, 2003). And, in order to retain and/or attract teachers, salary must be negotiated. It seems clear that many teachers are leaving the profession or choosing not to enter the profession of mathematics and science teaching due to salary alone as well as competitive salaries in other employment options that call for their mathematics and science background and expertise. Likewise, recent graduates who are newly certified to teach never even enter mathematics and science classrooms for the very same reason. Administering loans, grants, stipends and reimbursement for being trained in mathematics and science did prove to be a positive indicator of obtaining more mathematics and science teachers. Although a differential pay scale has positive intentions, it may lead to adversity and uneasiness in teacher unions. The key factor that kept resurfacing throughout all of the literature cited was salary. If the mathematics and science teacher salary was increased, the author proposes two ripple effects: Not only would the applicant pool of teachers increase due to a monetary incentive, but fewer teachers would leave due to the fact that the higher salaries would be comparable to non-educational employment opportunities.
Negative Perceptions of Mathematics and Science

Introduction to Negative Perceptions of Mathematics and Science

The objective of this section of the literature review is to provide the reader with data on the negative perceptions of mathematics and science and how low self-efficacy linked with previous experience, poor initial training, and a lack of professional development and resources lead to fewer mathematics and science prospective teachers. “It is necessary for colleges and universities to train those who wish to be teachers more in depth into mathematics and science content. This would give those teachers more confidence when teaching” (Blosser, 1984, p.2).

Low Self Efficacy Linked With Past Experience

To be effective, teachers must be masters of what they teach and must find their subjects intensely intriguing. Unfortunately, this is not often the case with prospective mathematics and science teachers. A common maxim in the educational profession is that one teaches the way one is taught. Indications are that preservice teachers’ beliefs, attitudes, and practices may be linked to previous experiences (Thomas & Pedersen, 2003). In literature, preservice teachers report being “turned off” to mathematics and science education in the beginning because of their own experiences with those subjects in their previous schooling (Merseth, 1983; Totsun, 2000). Many educators reported that a low comfort level with science led to a low comfort with the same subject at a later age (Sharp, 1984). Thomas & Pedersen (2003) assert that students will recall their own experiences in mathematics and science, and if they did not feel comfortable with the content, they will be less likely to want to teach it themselves. Because mathematics and science now take a more constructivist approach (Morrell & Carroll, 2003), whereby
students are actively learning in cooperative learning groups, prospective teachers are having a hard time feeling excited about this approach, because they themselves did not learn this way.

Previous experience with mathematics and science in elementary, middle, and high school leads many students to feel nervous about the content, which in turn, leads to a lower self-efficacy. Self-efficacy is broadly defined as a situation-specific expectation that teachers can help students learn (Ashton & Webb, 1986; Bandura, 1997). Efficacy expectations influence a teachers’ thoughts and feelings, their choice of classroom learning activities and the amount of effort and persistence in spite of obstacles they may face (Cantrell, 2003). As early as eighth grade, students report a low comfort level with science content. A survey of eighth graders was taken to rate possible careers out of a total of 45 choices. The survey revealed that eighth grade students do not rate science education as a desirable career at all, considering it was in the bottom 20%. The study concluded that the shortage of science teachers would not likely diminish unless science teaching is made to be a more attractive career choice (Anderson, 1984). Research from Delisi (2000), stated that forty percent of United States eighth graders learned science from teachers who reported a low level of confidence. Downing, Filer, & Chamberlain (1997) examined whether there was a connection between prospective teachers’ confidence in teaching mathematics and science with their ability in mathematics and science. Using TIPS II (science content skills test with 36 questions), and Science Attitudes Scales (SAS) to assess subjects’ attitude towards science, data analysis showed that there was a statistically significant correlation between the two variables and that indeed, with higher confidence in their ability to teach science, prospective teachers will
be more likely to express a desire to teach science (Downing, Filir, & Chamberlain, 1997). Students who feel respected, encouraged, challenged, and those that were provided with opportunities to apply learning to real life situations view their elementary and middle school experiences in mathematics and science classes more favorably (Ellsworth & Buss, 2000). Instructional strategies that led to facilitating student success were those that fostered student understanding of concepts rather than coverage of material, included less lecture and more hands-on experiences, included problem solving and demonstrated a valuing of class time for discussion of ideas (Ellsworth & Buss, 2000). Unfortunately, many students do not have these memories in their middle and secondary mathematics and science classrooms. Mathematics and science methods courses need to include personal vignettes, teaching episodes at a practicum site, and other activities that allow preservice teachers to be active learners themselves (Carnes, Shull, Brown, Munn, 1998; Tosun, 2000). In fact, many researchers often propose that, especially with science teaching, instructors of methods courses need to use school-based experiences as the basis for preparing student teachers and only use scholarly material to supplement and make meaning of those experiences (Carnes, Shull, Brown, Munn, 1998; Morrell & Carroll, 2003). Often, these two components of the student teaching experience are in reverse order, stressing the scholarly material as the primary basis to form lesson plans and school-based experiences as supplementary episodes.

**Gender Differences**

Gender plays a significant role in the shortage of mathematics and science teachers. The proportion of incoming females in the fields of mathematics and science is
low due to the low self-efficacy and attitude they have about these subjects. In addition, to this, many experts agree that women seem uncomfortable in a profession dominated by men (Zewotir, 1999; Jacobi, Rogers, & Brownlow, 2000). In one study (Jacobi, Rogers, & Brownlow, 2000), students who rated themselves higher with science anxiety took fewer science courses in college and reported that their science teachers in high school were not helpful. Those with science anxiety were more perfectionistic, suggesting that science anxiety may stem from a desire to avoid tasks that do not ensure success. More women than men scored themselves with higher anxiety from previous experience. According to Jacobi, Rogers, & Brownlow (2000), the difference in cognitive ability between the sexes might not necessarily contribute to the gender differences in science achievement. Most gender differences, including higher SAT Verbal scores for men (Hyde & Lynn, 1988) and a slight IQ advantage of men (Furnham & Rawles, 1995) are meaningless on a practical level. However, mathematics ability is typically needed to learn science concepts, including spatial ability and mental rotation and those who excel in mathematics and spatial skills are usually male (Feingold, 1988; Voyer, Voyer, & Bryden, 1995). Belenky’s research (1986) discusses why women are underrepresented in science classes and teaching. She suggests that women’s learning needs are not met and because science is characterized as value-free and objective, women feel out of place because they value a more connected way of knowing.

As girls get older and move into high school, their self-efficacy negatively changes with regard to mathematics and science. However, boys’ self-efficacy changes in a positive manner, with increasing confidence (Kimball, 1989; Trankina, 1993). The link between self-perceptions and ability is strong. Chipman, Krantz, & Silver (1992)
suggest that high performance in mathematics and science does not necessarily predict pursuit of mathematics and science careers as strongly as perception of the subjects, suggesting that beliefs about abilities and self-efficacy with regard to a subject are more important indicators that performance of whether or not a woman will engage in any kind of scientific career.

Gender differences in mathematics and science interest can also stem from other factors, such as gender stereotyped professions. Parents may encourage children differently to enter certain fields. Science, computer science, and mathematics are often viewed as masculine professions while the arts, literature, and education are more often viewed as feminine professions (Acker & Oatley, 1993; Potts & Martinez, 1994; Taylor, 1997). While education is deemed as more of a feminine profession, the lack of interest in science and mathematics for women stems from their experience with the subjects in the earlier grades. If women do not feel comfortable with the subject, they are less likely to want to teach it. Proportionally, few women are scientists or science teachers; thus, there are few women scientists and teachers to serve as role models for students (Trunkina, 1993; Acker & Oatley, 1993).

**Inadequate Training/Lack of Professional Development**

In addition to these factors, inadequate initial training and little in-service help were two reasons frequently cited for the lack of mathematics and science teachers. Science was noted as the subject with the least pre-exposure to before teaching the subject matter. Though many teachers attend conferences and meetings, the amount of time devoted to in-service education is typically less than six hours per year, according to a national survey of one thousand science and mathematics teachers in four hundred
twenty-five schools in the United States (Weiss, 1978). The National Survey of Science and Mathematics Education (1993) validated this statistic with a much wider pool of mathematics and science teachers. Among high school mathematics and science teachers nationwide - many of whom are specialists in their field - only one-half spent six or more hours on in-service education during the school year 1992-1993 (The National Survey of Science and Mathematics Education, 1995). Overall, there is a low priority given to professional development through in-service training by school districts (Lewis, 1998; Weiss, 1978; Graham & Fennell, 2001). Professional development regularly and often is the key to implementing and sustaining change in mathematics and science programs. It must be valued by districts and opportunities for teachers' growth must be supported (Graham & Fennell, 2001). The role of professional development is critical in the support and retention of mathematics and science teachers, including student teachers, at every level. The student teacher and beginning teacher is essentially an apprentice -- one who needs time, support and additional training to learn more and more (Graham & Fennell, 2001). Professional development and in-service training are the links between preservice preparation and daily work as practicing teachers. The need for professional development is great, given the large number of mathematics and science teachers who enter the teaching profession with emergency certification and the number of mathematics and science teachers who teach out of field (Huffman, Thomas, & Lawrenz, 2003). The accountability movement in the United States has also placed increased pressure on schools and districts to provide targeted professional development that will clearly help improve student achievement, as evidenced previously by the No Child Left Behind Act (Huffman, Thomas & Lawrenz, 2003). Crushing teacher loads also make it
impossible for them to perform well, no matter how well their preparation might have been (TEKS, 1989).

The National Science Foundation is instrumental in helping the in-service crisis. Part of the reason why so many candidates are leaving or not entering the profession of mathematics and science education is lack of training time once they enter the field of teaching (Lewis, 1998). Now, through National Science Foundation grants, states are choosing to focus on professional development because of the inadequate preparation of middle school and high school teachers in science and mathematics as well as the No Child Left Behind Act (Lewis, 1998; Richardson, 2002; Garcia, 2002; Edley, 2002).

A second reason that there is a newfound focus on in-service and professional training is teachers' uncertainty about teaching with technology. Considering many mathematics and science curriculums stress the use of technology, another variable has entered the equation of a declining pool of mathematics and science teachers. Preservice teachers must be exposed not only to technology apparatus and skills, but must be presented with how to effectively incorporate technology into mathematics and science lessons without losing valuable curriculum time. This is not prevalent in many colleges and universities. Too often, undergraduates in mathematics/science education programs are required to take a technology course, outside of the school of education; therefore, the educational pedagogy of how to infuse technology is absent (Nieves, 2001).

There is valid research suggesting an increase in professional development. Between 1986 and 1993, the percentage of teachers participating in in-service and professional development increased substantially. While only 65% of tenth through twelfth grade mathematics teachers had some type of in-service training or professional
development in 1986, more than 80% did in 1993. The in-service training percentage is still growing. However, despite the increase over this six-year period, in 1993 many teachers, as evidenced by the remaining 20%, still did not spend any time in professional development opportunities, much less substantial time (The National Survey of Science and Mathematics Education, 1993). States are realizing the need for professional development opportunities, not only in mathematics and science, but in all subjects. In fact, some states require it, as exemplified by New Jersey. It is state mandated that teachers acquire 100 hours of professional development within five years. New Jersey is a pioneer in this arena and an example of a state that not only has an excellent academic reputation, but one that appreciates and devotes time to teacher preparation and professional development (New Jersey Department of Education, 2004).

**Insufficient Resources**

Insufficient resources and support are included in this section of literature reviewed. Resources and support include supplemental materials, texts, and laboratory manuals. The present science textbooks and methods of instruction impede progress toward science literacy (TEKS, 1989). These texts are older and many emphasize the learning of answers through simple memory and recall methodology rather than focusing on higher-order thinking skills and understanding in context, application, and manipulation.

Research supports the notion that how much a teacher knows about the subject he/she teaches is an important determinant of how effective the teacher will be in the classroom, especially in the fields of mathematics and science (Kanstoroom, 1999). Mathematics and science teachers must have the appropriate tools to teach as well as the
mastered content to utilize the tools effectively. In 1978, Weiss (1978) found that only 28% of elementary teachers from a longitudinal survey over three years felt qualified to teach science and mathematics with sufficient resources and that, on the average, ninety minutes were spent on reading instruction compared to seventeen minutes of science instruction a day. One reason cited was due to the availability of reading materials versus science materials (Weiss, 1978).

Effective Programs Which Link Pedagogy and Content

To assist preservice teachers in their preparation for entering classrooms, Bentley, Ebert, and Ebert (2000) and Howe and Jones (1998), along with many other experts, recommend that mathematics and science educators provide opportunities for reflection that lead to developing competence in their content and instruction. Instructors must provide various aspects of teaching mathematics and science, including not only the pedagogical component, but the content component as well (Carnes, Shall, Brown, Munn, 1998; Crowther & Bonnstetter, 1997; Lowery, 2002). Knowing and more importantly, understanding the specific content as well as the instructional approaches to teach that content has been shown to significantly enhance the quality of the lesson for preservice teachers as well as in-field teachers. These dual pedagogical and content driven courses afford preservice teachers greater opportunities to focus on content and instructional strategies at deeper levels and they address anxieties associated with teaching mathematics and science to become more confident teachers (Niess, 2001; Crowther & Bonnstetter, 1997, Lowery, 2002; Wright and Nassar, 1991).

Unfortunately, in many colleges and universities across the nation, most preservice mathematics and science teachers are not taking enough mathematics and
science classes as part of their undergraduate teacher preparation experience, which can lead to a lack of confidence teaching that respective content. The National Survey of Science and Mathematics Education (NSSME, 1993) found that 50% of elementary school science teachers completed fewer than six semesters of science content courses. This compares with 28% of middle school science teachers and only one percent of high school science teachers. On the other hand, 28% of the high school science teachers had completed more than 20 college semester science content courses in their field, compared with 8% of the middle school science teachers and one percent of the elementary science teachers. As a follow-up, the NSSME survey also asked the mathematics and science teachers to evaluate themselves in terms of how well prepared they felt to teach these subjects. Almost all mathematics teachers at all levels felt well prepared to present applications of mathematical concepts, but a large number of high school teachers did not feel well prepared to use manipulatives, cooperative groups, and computers, and to teach students from a variety of cultures or students with learning disabilities. Although the use of calculators in elementary education is recommended by the National Council of Teachers of Mathematics standards, only 55% of the elementary teachers felt prepared to incorporate calculators as an integral part of their classes. From this, it seems safe to conclude that instruction methods were more abundant in elementary teachers' curriculum (e.g. cooperative learning, use of manipulatives, use of learning disabilities) and content courses were more abundant in secondary teachers' curriculum. Similar patterns were found for the science teachers. One exception is that, of the three grade ranges, the high school science teachers felt most comfortable with hands-on work, while elementary teachers felt the least prepared. Significantly, only 40% of high school
science teachers and 31% of the middle school science teachers felt well prepared to use
computers as part of science instruction. (The National Survey of Science and

Beneficial methods courses, including strategies to teach mathematics and
science, are usually content specific and learning experiences stem from a constructivist
instructional approach and immediate access to field experiences in classrooms (Lowery,
2002; Brindley, 2000; Kelly, 2000). The school-based context and collaborative setting
allows student teachers to learn from each other, students and teachers in the field
(Lowery, 2002). Effective programs to train teachers usually include close cooperation
with local school districts, state education agencies, and institutions of higher education.
Included in these programs are the following ideas: linking preservice teachers with
content masters, allowing for time to develop professionally and dialogue with experts,
and teaching content in order of increasing complexity (Sausner, 2002; Morrell &
Carroll, 2003; Lowery, 2002). Collaborative student teacher/in-field teacher partnerships
reap benefits including an increase in confidence and self-efficacy by infusing curriculum
content with appropriate pedagogy and an increase in active learning, whereby students
and teachers construct their own knowledge together based on real-life situations.
(Morrell & Carroll, 2003; Wright and Nassar, 1991). According to Crowther &
Bouznetter (1997), it is important for teacher preparation programs to recognize that by
the time preservice education majors take their mathematics and science methods
courses, their previous attitudes whether negative or indifferent have been reinforced by
the traditional college courses which they have already taken. This validates why so
much time in methods courses must be spent initially convincing the preservice teachers
that subjects such as mathematics and science are interesting. These methods courses within teacher preparation programs must include scientific content and thinking processes in relation to real life and society as well as the connection to solving real life problems. This, in turn, will lead prospective teachers to view mathematics and science as an integral part of everyday in their classrooms, rather than isolated subjects to be taught (Raney, Tomlin, Basista, Slattery, 1998).

The government realizes that mathematics and science are two subjects where training is imperative, because of the low preparedness and low self-efficacy prospective teachers report within these disciplines. In 1998, Congress amended the Higher Education Act to enhance the quality of teaching in the classroom by improving training programs for prospective teachers and the qualifications of current teachers. In 2002, the monetary award for this enhancement of quality teachers rose to $460 million which was awarded via 123 grants to states and partnerships to improve teacher preparation. Most grantees have focused their efforts on reforming requirements for teachers, providing professional development to current teachers, and recruiting new teachers (Ashby, 2002).

In order to increase their self-efficacy of teaching mathematics and science, some of the grants went towards teacher training programs in states, whereby content and pedagogy in mathematics and science were taught simultaneously. An example would be the Massachusetts Coalition for Teacher Quality and Student Achievement, who reported that they wanted to improve teacher candidates with exposure to schools earlier than was typical in training programs. To do so, they revamped their curriculum so that several teacher preparation courses, like mathematics and science, were in-field experiences and pre-exposed education majors to classroom teaching before the culmination of the student
Teaching experience in the program (Ashby, 2002). Another effort of this $460 million grant was to ensure that the appropriate credentials were available to prospective teachers. For instance, many state grantees are reforming their state certification requirements to ensure that new teachers have necessary training, skills and knowledge in the appropriate field. One major problem, as already reported in this literature review, is the fact that many states do not have a separate middle school certification. Most middle school mathematics and science teachers have an elementary or high school certification. However, recognizing that this does not adequately address the preparation needs of middle school educators, state officials intend to use part of the grant money to create new certifications, as exemplified in Illinois (Ashby, 2002). These new programs and courses within should hopefully, allow future teachers to feel more comfortable not only with content, but with how to relate the information to middle school adolescents.

An overarching motif found above is that the mathematics and science teaching self-efficacy of preservice teachers can be improved through a partnership of pedagogy and content (Carroll & Morrell, 2003; Ramey, Temlyn, Basina, Slattery, 1998; Graham & Fennell, 2001). However, an increase in mathematics and science content does not automatically ignite an increase in efficacy. An increase in mathematics and science knowledge might have a positive impact on the preservice teacher’s view on his/her ability to teach the subject, which might indirectly lead to an increase in self-efficacy. Likewise, as teachers gain additional experience in linking the mathematics and science content with pedagogy, they will be able to identify and understand the big ideas confronting both them and their students, leading to an increased confidence about the subject(s). Consequently, mathematics and science teachers will be able to provide
engaging instructional opportunities that will meet their students' learning needs (Graham & Fennell, 2001).

Examples of Programs Which Link Pedagogy and Content

As stated in the previous section, many studies in literature suggest positive correlations between science/mathematics experts and education majors with courses involving both the pedagogy of teaching and the content associated with that field. One example of this technique is the introduction of a biology content course designed for elementary education majors for three years in a collaborative manner between the School of Biological Sciences and the Teachers College in Illinois. Evidence collected proved to be positive and participants showed a greater satisfaction and confidence in science content. This was done through distilling patterns that emerged from the students' experiences in Biology 295, a course designed to teach pedagogy and content cohesively (Crowther & Boushstetter, 1997). Likewise, a possible link between science and mathematics experts with candidates in the school of education was proposed by Wright State University in Ohio. This university has fostered a unique environment where dual appointments are created for faculty within the College of Science and Mathematics and the College of Education and Human Services (Ramsay, Tomlin, Basista, & Slattery, 1998). The intent was to immerse the prospective mathematics and science teachers into content through collaboration with certified mathematicians and scientists as instructors. The goal of this program was to have students learn these subjects through direct inquiry and investigation. Participants quoted the following as positive consequences: more hands-on approaches to learning, better self-esteem, a higher level of confidence, and a more thorough understanding of content. The data
suggested that students, after two years of being in the program, were more receptive and welcoming to changes in science courses (Ramey, Tomlin, Basista, & Slattery, 1998).

Combining the same amount of hours of mathematics content and mathematics education pedagogy courses proved to be a positive experience for a group of student teachers who participated in an integrated content/methods series of courses entitled 'The Urban Alternative Preparation Program' (UAPP). The key factor in the success of this program was the same teacher for both the mathematics content courses and the mathematics education pedagogy courses. The syllabus for the integrated coursework was developed around the content requirements for the mathematics course. A constructivist approach guided all lessons. Results revealed that there was a change in the beliefs of teachers who participated in the program and they felt better equipped to teach mathematics with proper content training and the pedagogy to teach that very content (Hart, 2002).

Lastly, the City College of the City University of New York received a National Science Foundation grant to recruit and train future teachers of mathematics and science, entitled “Become a Teacher” (Gafney & Weiner, 1995). The notable statistics were that 89% of candidates in the program stated that their favorite subject in school was mathematics or science and 72% said that those subjects were their best academically. Confidence in content, tuition assistance, opportunities to combine several career areas, and information about course requirements were the most frequent advantages reported from this experience in the program. Students value the inquiry approaches and being in class with teachers who were confident in not only pedagogy, but content as well. The
link between content acquisition and how to infuse it in the classroom was noted as a positive aspect of this program (Gafney & Weiner, 1995).

It is evident from all examples cited of linking pedagogical classes with content classes that the collaboration technique proves to be positive. Various colleges and universities are now adopting new curriculums in the schools of education nationwide to build on the success of the pilot programs represented here. Prospective teachers are of no use to students if they only understand the pedagogy of how to teach or the content of what they are teaching. The key is to know both at the same time, according to all of the experts described in research.

Summary of Negative Perceptions of Mathematics and Science

As noted above, many experts agree throughout the empirical studies conducted that there would be a higher percentage of prospective mathematics and science teachers if they had a positive experience with mathematics and science in previous years. Also, a positive experience in a teacher preparation program with correct materials, adequate supervision and sufficient training will be more influential in their decisions to assume mathematics and science teacher roles. In addition to this, the number of mathematics and science prospects may increase if indeed, there is an increase in training time and professional development throughout teacher preparation programs as well as training and professional development opportunities for the duration of teaching once they enter the field. One recurring strategy noted throughout literature suggested that linking content courses with the pedagogy of how to teach the concepts is an effective strategy and one that makes prospective teachers feel more confident in their fields, leading to a possible increase in mathematics and science teacher candidates. This is especially true
for females, as they are shown throughout many reports to feel less confident with mathematics and science content.

Unqualified Teachers in America’s Classrooms

Introduction to Unqualified Teachers in America’s Classrooms

The objective of this section of the literature review is to discuss the issue of out-of-field teachers in America’s classrooms. Out-of-field teachers refer to those teachers who are improperly qualified for the positions that they currently hold. If the correct certification requirements are not met, the teacher is considered unqualified. Since there is a current shortage of mathematics and science teachers, these unqualified teachers are often placed in classrooms and are declining the quality of mathematics and science education. Another objective is to discuss several differences among states with respect to qualifying exams and certification programs. Finally, the author will discuss programs designed to increase the mathematics/science education undergraduate population. These are imperative to discuss, considering the No Child Left Behind Act could exacerbate the present shortage of qualified mathematics and science teachers.

Effects of Unqualified Teachers in Classrooms

Because of a serious mathematics and science teacher shortage, it has become common to find many teachers teaching out of license and hence, teaching without proper qualifications (Cooper & Hummert-Rossi, 1986; Gonzalez, 1999; Della-Piasta, Blake, Lopez, & Harley, 2001; Cornett, 1986; Roe, 1996). American students are more likely to be taught mathematics and science by teachers who majored in general education rather than in subject areas (DeLisio, 2000). Recommendations from the National Science Foundation included providing mathematics and science faculty with more resources to
train teachers and competitive salaries to retain them (Steen, 1986). In literature, higher student performance is reported when teachers have certification in their fields (Steen, 1986; Saunder, 2002).

Certain trends are shown in the literature regarding unqualified teachers. In 1982, half of all newly employed mathematics and science teachers were unqualified and lacked proper credentials to teach (Shymansky & Aldridge, 1982). Then, in 1984, this figure was validated once again in another study (Carl, 1984). To give a global comparison, the Condition of Education (NCES, 2001), stated in 1999 that American eighth grade students were as likely as their international peers to be taught science by a teacher with a bachelor's or master's degree major in biology, chemistry or science education. However, they were less likely than international peers to be taught science by a teacher who majored in physics and more likely to be taught science by a teacher who majored in general education. American eighth graders were less likely than their international peers to be taught by a mathematics teacher with a bachelor's or master's degree in mathematics. In 1999, 41% of American eighth graders had a mathematics teacher who majored in mathematics, a smaller percentage than the international percentage of 71%. American eighth graders were about as likely as their international peers to be taught mathematics by a teacher who majored in mathematics education (37% and 31% respectively). Finally, American eighth graders were more likely than their international peers to be taught mathematics by a teacher who majored in general education (54% and 32% respectively) (NCES, 2001).

Overall, in analyzing the findings within data from 1982-2000, statistics undoubtedly indicate a substantial number of teachers who are considered unqualified for
the positions that they held in mathematics and science classrooms. The most recent data from NCES (2002), stated that in the school year 2000-2001, over 17% of middle school science students and 23% of middle school mathematics students were instructed by unqualified teachers. Similarly, over 7% of high school science students and 10% of high school mathematics students were instructed by unqualified teachers.

The problem with these unqualified teachers is that American students are not getting quality learning (Della-Piani, Blake, Lopez, & Hurley, 2001). Teacher shortages often force school districts to hire teachers for mathematics and science positions with little or no background in these curriculum areas. As noted in the introduction, in 1999, out of 26 countries, U.S. 4th graders scored better than 16 countries in mathematics and only three countries outscored them in science. In mathematics, U.S. 8th-grade students outperformed their peers in 17 nations and performed lower than their peers in 14 nations in 1999. In science, U.S. 8th-grade students outperformed their peers in 18 nations and performed lower than their peers in 14 nations in 1999. However, in twelfth grade, U.S. students scored below the international average in both mathematics and science and out of 21 nations, the U.S. students ranked 16th in science scores and 19th in mathematics scores (NCES, 2001). Therefore, in the higher grades, performance and quality learning is declining. This is most likely a consequence of unqualified teachers in America’s classrooms (NCES, 2000, Della-Piani, Blake, Lopez & Hurley, 2001).

Differeni State Requirements for Teacher Certification

Many states in America require that prospective teachers pass a qualifying exam in order to become a certified teacher. However, certification requirements vary by state and often, do not have high expectations in mathematics and science for teachers (Della-
Pani, Blake, Lopez, & Burley, 2001). A study conducted by the Education Trust stated that some qualifying exams for teachers are pitched at distressingly low levels (Kastoroom, 1999). For example, Carnegie-Mellon University found that the passing scores for future teachers in Pennsylvania were so low that about 95% of those taking the tests passed them. For ten years, Pennsylvania had no cut off score in the areas of chemistry and physics, thus allowing all test takers to pass (Kastoroom, 1999). It would be beneficial for researchers to know the ratings of teachers or success of students in Pennsylvania's schools versus other states, due to the ease of passing the teaching requirements test.

In New Jersey, prospective teachers must complete a teacher preparation program at their college or university. After completing the teacher preparation program, all prospective teachers must pass a state test in order to become certified. Since education is state-mandated, each state is free to choose the certification requirement. New Jersey is one of several states that follow the Praxis testing policy. Formerly known as the National Teacher Examination (NTE), the Praxis is used by several states as the qualifying exam for teachers. However, only elementary and secondary teachers must take a portion of it. Special Education teachers do not have to take a test to practice teaching in New Jersey -- yet another disparity. Also, with the new scoring procedures put into place in 1999, students have to pass the Praxis at a lower rate (New Jersey Department of Education, 2004). Likewise, in Massachusetts in 1998, the Department of Education constructed a pilot teacher-qualifying exam, which was comprised of eight tedious hours of open-ended and objective style questions. The first pool of candidates to take this test was the 1998 graduates from colleges and universities in Massachusetts.
The results in June of 1998 depicted that only 17% of students passed. Massachusetts’ answer to this was to lower the passing score, thus allowing 54% of test takers to pass. In New Jersey and Massachusetts, the teachers are not getting smarter, but the passing score is getting lower.

**Partnership Programs Linking K-12 and Higher Education**

In the past, several states have initiated programs to relicense teachers in mathematics and science to fill the vacancies in schools (Cooper & Hummel-Rossi, 1986). There is a catastrophic decline in the number of persons preparing to teach science and mathematics and of those who are prepared, less than half take positions after they complete teacher preparation programs. Therefore, schools are forced to hire unqualified individuals (Shymansky & Aldridge, 1982). As the mean age of the mathematics and science teaching force rises and more experienced teachers seek employment in nonteaching jobs for salary reasons already discussed, mathematics and science learning will deteriorate. What is America doing about it? This dilemma must be solved and soon. A generation of school-aged children is far too precious a commodity.

As mentioned above, the No Child Left Behind Act promises to drastically improve the quality of education in the United States. Part of this act calls for teachers to be certified in the area they teach. Many states are anxious about this act and are asking experts in the fields of mathematics and science to train current teachers in schools who will lose their jobs if they are not considered highly qualified. The government realizes this need and set aside ‘The Mathematics and Science Partnerships’, which are allocated monies meant to foster relationships between school districts and university science and mathematics departments (Sausser, 2002).
In rural areas, where there is an overall teacher shortage, the lack of mathematics and science teachers is extreme. Institutions of higher education try to help recruit teachers by encouraging students to visit rural districts, posting job openings, selling the idea of teaching, providing internships to pre-expose students to teach, and holding recruiting fairs. Some rural schools ease the transition of new teachers by assigning mentors and in-service training with experts in mathematics and science at the university setting (Harmon, 2001). Some local universities are even entering the doors of secondary schools in their areas. The University of Missouri mathematics department recently asked high school teachers to give them the names of any students they think might have an aptitude for teaching. The school then sent letters to these 700 or so mathematics-oriented high school students, intending to attract them into teaching (Sausner, 2002).

In response to the critical need for science and mathematics educators, the National Science Foundation instituted a Science, Technology, Engineering, and Mathematics Teacher Preparation program to support partnerships between institutions of higher education and K-12 school districts. The partnerships will address local needs in recruiting teachers with strong backgrounds in science and mathematics into teacher certification programs and in retaining them in the teacher workforce (National Science Foundation, 2001). Two types of programs will be funded through $6.5 million: baccalaureate and five year degree programs for K-12 science, mathematics, engineering, and technology (SMET) teachers and model alternative certification programs to prepare individuals who possess SMET baccalaureate degrees for K-12 science and mathematics teaching (National Science Foundation, 2001). Another essential feature of this program is forging local partnerships among stakeholders – including higher education
institutions, school districts, and local partners, such as museums. The main benefit of such a program is a continuum of teacher education that extends through the induction years and beyond, helping facilitate teachers' transitions from preparation to practice (National Science Foundation, 2001).

In 2001, using a private grant, Chicago’s public school department teamed up with faculty at the University of Chicago to develop customized courses to bolster the mathematics instructional abilities of K-12 teachers. The two-year effort involved two university faculty members, graduate students and 120 teachers. Presently, the pilot course is being deployed to ten other local colleges and universities. Chicago’s goal is to get more than half of its 19,000 teachers recertified in mathematics (Clayton, 2001).

The National Science Foundation has been an instrumental vehicle for helping to foster the Graduate Teaching Fellows in a K-12 Initiative. In these programs, graduate level scientists act as resources for science teachers and student teachers in K-12. With experts as references, the teachers had a fuller understanding of the complexities of teaching science, an understanding of inquiry-based science teaching and an enhanced understanding of science content (Thompson, Collins, Metzgar, Joenton, & Shepherd, 2002).

Programs Attracting Second-Career Teachers

There are plenty of opportunities for individuals who did not major in education to become certified teachers, especially in mathematics and science. There are many programs available for alternative certification and these are designed primarily to attract more individuals into mathematics and science (Denton & Morris, 1991; Securro, 1989; Palaich & Burns, 1983). Many educators today have entered alternative teacher
certification programs, after working in a noneducational job. Chevron USA exemplifies such a program, by funding the ENCORE program. This program is designed to facilitate the entrance of nontraditional recruits into the profession with alternative certification (Madfes, 1991). The study concluded that the salary incentive is hardly attractive enough to make teaching a second career alternative; however, did conclude that satisfaction was high among second-career teachers and acknowledged the possibility that they are viable candidates to fill vacant teaching positions at area schools (Madfes, 1991). Although the ENCORE program is no longer in effect, it served as a benchmark study and now, started a ripple effect of programs funded by the National Science Foundation to recruit employees outside of the educational arena into the teaching force. Examples include California State University and San Francisco State, which train former business and industry professionals to teach middle and high school science and mathematics (Madfes, 1991).

"Troops to Teachers," was designed by the Department of Defense, to help discharged military personnel become certified teachers, and paid for their certification costs (Shaul, 2001). With the allocated $3 million, Congress helped prospective teachers find a job in mathematics and science fields. Of the 28% of them who chose teaching, 90% remained in teaching for at least one year.

Summary of Unqualified Teachers in America's Classrooms

It is evident from literature that unqualified teachers in America's mathematics and science classrooms negatively impact student learning. It is imperative to gain more prospective mathematics and science teachers not only through traditional teacher
preparation programs, but through alternative certification programs as well. These programs have proven in literature to be effective.

A Possible Recruitment of Mathematics and Science Liberal Arts Majors

Introduction to a Possible Recruitment of Mathematics and Science Liberal Arts Majors

This section of the literature review serves to link the previous factors in research which discuss reasons for the lack of mathematics and science teachers and majors with a possible solution to recruit more qualified mathematics and science teachers. The No Child Left Behind Act will most likely make the mathematics and science teacher shortage worse; therefore, it is imperative that policymakers and all constituents in higher education have a contingency plan to recruit more educators. Mathematics and science majors in liberal arts already possess the correct content qualifications and could help reverse this shortage. The benefits of partnering pedagogy experts with content experts will be discussed first. In this section, the teacher preparation programs will be discussed at several leading institutions to demonstrate that they are there and with the right communication, liberal arts majors could make the crossover. Next, the author will analyze the career development and choice process students undergo in higher education to possibly attract them into teaching. Following this will be a delineation of the success of pilot programs, which have mathematics and science teacher recruitment as their aim.

Evidence of Quality Teacher Education Programs

As the mathematics and science levels of students are decreasing, it is imperative to cite that there are strong, quality education programs for pre-service teachers in higher education settings with appropriately qualified educators to teach mathematics and science education. Quality teacher preparation programs are readily available --
undergraduates are simply not choosing them. Nationally, there were 12,000 full-time professors in teacher education programs reported in 1992 compared to 14,000 in 1998 (NCES, 2002). NCES did not delineate how these teacher education professors were delineated (e.g., how many were science education, mathematics education, English education, etc.). The author speculates that the reason for this lack of data is due to the fact that many professors teach more than one class in teacher education programs.

Assuming that college faculty hold credentials appropriate to their teaching fields, it is evident that most institutions of higher education have appropriate teacher preparation programs. From the data reported, the number of teacher educators has increased in six years (as noted above) and is likely to continue to increase. The National Center of Education Statistics (2002) reported the top three bachelor's degrees awarded as business, social sciences/history, and education, respectively. It is assumed that because of this status and the fact that education is the third most sought after degree, most colleges and universities have a school of education or a college that awards a degree in education.

To demonstrate the presence of quality teacher education programs, the author has chosen several well-respected universities in the nation to discuss, including Pennsylvania State University, Ohio State University, Michigan State University, and the University of Michigan. The mathematics and science teacher education programs will be discussed as well as the quality of professors. It is imperative to discuss this, since this study investigates possible factors to attract mathematics and science majors into teacher education programs. Researching these factors leads the reader to assume there are quality mathematics and science teacher preparation programs at colleges and universities and undergraduates are simply not choosing these majors.
Pennsylvania State's College of Education (PSU) is ranked among the top 24 in the country, approved by the Pennsylvania Department of Education and accredited by the American Psychological Association, the National Council on Rehabilitation Education and the National Council for Accreditation of Teacher Education. Pennsylvania State University offers teacher preparation programs in 21 specialty areas, including, but not limited to bilingual education, special education, early childhood, elementary, mathematics, language/literacy, social studies, and science education. This university offers undergraduate and graduate programs in education. All faculty members in mathematics education have doctorate degrees in an appropriate area, among other impressive credentials. The science education programs, both undergraduate and graduate, are designed to help educators extend knowledge and skills in science teaching, science content and educational research. The science education faculty members all have doctoral degrees, prior teaching experience, an extensive amount of science training, and are associated with writing grants and major science organizations, such as the National Science Foundation, who help to sponsor alternative certification programs and science literacy across the nation (Penn State University, 2004).

Ohio State University (OSU) is also ranked in the top 20 schools of education for the past 13 years and is one of the premier educational institutions in the United States. Faculty members in the School of Education are frequent recipients of national grants in recognition of their efforts to successfully apply research to enhance the profession. Their website states that faculty offer high-quality programs that prepare students to teach, lead and collaborate in a changing, diverse world. Their teacher education programs pioneered the preparation of teachers to teach in urban settings and require
prospective teachers to spend at least four years learning their academic areas before applying for the graduate program to acquire teaching skills. Confidence in content seems to be a recurring theme at this university, which research supports as a positive indicator of mathematics and science teachers’ success in classrooms. All full-time faculty members in mathematics and science education possess doctoral degrees in appropriate fields and were described as a faculty who uses current technology to assist future teachers with curriculum and instruction (Ohio State University, 2004).

For the eighth consecutive year, Michigan State University (MSU) received the U.S. News and World Report’s award for best elementary and secondary education programs in the nation. This achievement is indicative of outstanding, qualified faculty, close relationships with practicing teachers, strong research centers, and innovative teacher education programs. The MSU teacher preparation programs are known for providing prospective teachers with opportunities to gain the critical knowledge and skills needed to help children learn. The College of Education, in collaboration with departments in eight other MSU colleges, provides a wide range of teacher education options. Students who choose to follow a career path in education follow a five-year long internship that leads to a bachelor’s degree in a disciplinary major, like mathematics or science, plus certification. There are 20 major fields from which to choose. Out of a total of 55 faculty members listed in the directory, 12 are involved in mathematics and/or science education teacher preparation programs and possess doctoral degrees. Areas of expertise include scientific literacy, mathematics literacy, assessment, educational policy/practice, professional development, secondary education, research on teaching,
learning pedagogy, collaborative reform efforts, and curriculum applications (Michigan State University, 2004).

The University of Michigan is another exemplary teacher preparation program, in which prospective teachers work with youth, teachers and teacher educators to develop the understandings, skills, and habits of mind for teaching. The faculty is viewed as a cooperative team who combine and connect challenging educational and academic coursework with guided experiences in schools. Mathematics and science teacher certification includes a sequenced three-term program of professional study based upon strong academic preparation. Courses involve both content and pedagogy. Classroom experience always coincides with coursework. The mathematics and science student teachers are referred to as content-area specialists. Throughout the mathematics and science teacher preparation programs, prospective teachers develop habits of critical reflection, the ability to learn from their own practice, and a disposition to design instruction to meet the needs of their students. The faculty members in the mathematics and science teacher preparation programs all possess doctoral degrees as well (University of Michigan, 2004).

From the major education programs analyzed, the theme that pervaded each university was that the mathematics and science education faculty all possess the highest degree available, engage in scholarship, and are all involved at the local, state and national levels in reform movements, curriculum development and evaluation, technology advancements, and professional development.
Link Between Education Majors and Liberal Arts Majors

Teacher preparation programs which have content and pedagogy as a focus benefit mathematics and science liberal arts majors as well as teachers who have a low self-efficacy with mathematics and science content. Several examples of programs that have a double focus on content and pedagogy were discussed in a previous section and all yielded positive results, which allowed future teachers to feel more confident with content—the major obstacle that mathematics and science teachers face in teacher preparation programs. The author proposes that liberal arts majors might feel the same positive effect as a result of a program which combines pedagogy and content. They may not want to teach because they do not feel confident in pedagogy. This is the reverse problem from education majors, who do not feel confident in content. Therefore, the literature suggests that both mathematics/science majors and mathematics/science education majors would benefit from being paired together, because they have opposite concerns regarding teaching mathematics and science.

There is a lack of evidence reported in literature of communication between schools of liberal arts and schools of education. It is often the case that these two schools at the same university virtually have nothing to do with one another. The author hypothesizes that students majoring in mathematics or science might not even consider teaching, because of lack of exposure to the possibility. Many undergraduate students who major in mathematics or science might not know about the salary, job requirements, teacher benefits, alternative certification programs, and career advancement opportunities. Laura Bush stated: “Our best high-school students are not enrolling in our
colleges of education. We need to get them from mathematics and science professions into teaching" (U.S. Department of Education, 2001, p.1).

The Career Development or Choice Process

It is imperative to discuss how undergraduates go about the career selection process if this study aims to attract them into teaching. Career choice has been a topic of discussion in literature for many decades. Factors which influence the career choice process include, but are not limited to: change, past experience, personal characteristics, interest, aptitude, and values (Pappas et. al, 1972). Concerns over career counseling continue to be heard on college campuses. The sense of deliberating a choice that will be for a lifetime can become a bit overwhelming when one has no idea of what he/she wants. Career assessments are useful in helping people uncover interests, values, personality, and skills. Suggestions to foster involvement in various career opportunities include: completing an internship, getting involved with a career mentor, describing a dream job scenario, completing field research, reading about job descriptions that could be potential career paths, and joining groups that link students with professionals in a specific field of interest (Sagedra & Lewis, 2001).

Determining the path of a career is not easy for most people. The career choice process occurs throughout a life cycle, as individuals make a series of decisions that have occupational results. An example of an institution that puts emphasis on the career development process is the Henry Ford Academy. This institution was designed to prepare students to be contributing members of society in the 21st century and to develop appropriate careers based on student values, strengths, and preparedness for respective careers. The Academy was the nation's first charter school and was developed jointly by
a global corporation, public education, and a non-profit cultural institution in the fall of 1997 (Walz, Lambert, & Kirkman, 2002). The purpose was to help students connect what they were learning in school with real life experiences or careers. This frame of mind has pervaded many programs and career centers at various institutions of higher education for many years. Career development is a lifelong process and career counseling helps an individual explore a variety of career options, narrow his/her options based upon interests and abilities, and make a career decision with a defined plan to obtain his/her goals.

There remains a perennial problem of college students’ indecisiveness regarding their future careers. Gordon (1998) defined four categories of undecided students: tentatively undecided, developmentally undecided, seriously undecided, and chronically undecided. Tentatively undecided students are close to making a career decision, but may need additional time or information to commit. Developmentally undecided students need a better understanding of themselves and also desire heightened awareness of their career possibilities. Seriously undecided students may experience levels of anxiety about a career choice. Lastly, chronically undecided students exhibit excessive anxiety about making a career choice. Consequently, they choose to postpone the decision making process (Gordon, 1998). Regardless of what indecisive category students fall into, the fact remains that they have not chosen a career yet and their minds are vulnerable to new opportunities. Furthermore, even if students have chosen a major, there is a high probability that their minds could change if presented with the right information (Gordon, 1998; Gates, 2002). This thought will be explored in a future section.
Obstacles to overcome in more recent years include overcoming a language barrier due to the fact that many Americans speak English as a second language. Edwin L. Herr, in discussing some of the emerging issues in career assessment voiced his concern stating that a more diverse population translates into a more diverse workforce, therefore, there needs to be a more diverse career assessment system to accommodate differences (Herr, 2001). There is little doubt that the need for adapted forms of career assessment for multicultural populations is going to explode over the next decade. If career counselors are going to maintain a place of respect within these cultures, they are going to have to find new ways of embracing diversity.

How do college students determine which career paths they are going to enter? Certainly, college students are not the only individuals deciding which career to enter; however, they are the target group for this study and most appropriate to discuss. Determining a career path involves a multi-faceted approach to self discovery, including but not limited to the development of one's personal philosophy, understanding the psychology of career choice, gaining occupational self-understanding, and formulating a personal plan for self-development (Griswold, 1974). These four components can be broken down into several steps that college professors, advisors, parents, and faculty use to guide students in the path towards career ascertainment. However, before the steps of career development and career choice are identified, it is imperative to denote background information regarding the characteristics of undergraduate students.

There are multiple variables that affect or influence the profession or career path that individuals are inclined to take. First, the author would like to present a brief overview of factors that are out of the college and university's control. The fact remains
that students come from all over, with different experiences, families, morals, values, and opportunities. The college and the influential individuals at the college have no control over factors that students have prior to entering the university or a major program.

Gender, sex bias, gender equity, and sex stereotyping are all introduced as variables which affect career selection (Teddlie & Stovall, 1993). Despite the increasing number of women entering the workforce, gender segregation exists in many career paths (Jacobs, 1999). Women are underrepresented in mathematics, science, engineering among others, while overrepresented in traditional fields, like education. Females are usually less likely to consider alternative careers and have fewer role models for success in nontraditional occupations. Nontraditional women were more likely in Gates' study (2002) to cite male role models as influencing their career choice and women who followed a traditional career path identified teachers and professors as most influential. Both traditional and nontraditional women cited their mothers as having influenced their choice of career, but nontraditional women were more likely to mention their father as a career influence (Gates, 2002).

Parents are an important influence on what occupations students consider (Sedlal, 1986; Gates, 2002; Lankard, 1995). Some researchers suggest that college students are influenced in the choice of careers more so by same-sex parents (Gecas & Seff, 1990; Sedlal, 1986; and Gates, 2002). Nevertheless, family influence is an important force in preparing youth for their roles as workers. Family background factors found to be associated with career development include parents' socioeconomic status, their educational level, biogenetic factors, and family income (Lankard, 1995). The variable that usually has the most effect on student educational plans and occupational aspirations
was parental education (Mortimer et al., 1992). This is because they pass along the importance of postsecondary education to their children. Family income is a big indicator of career development as well, because families with limited economic resources tend to direct them first to the males of the family and some parents, especially in lower classes, tend to place girls in homemaker roles (Mortimer et al., 1992). The greatest anxiety college students feel about their career decisions is in response to parents' negative reactions and involvement in the decision. Therefore, counselors should work with parents as well as students (Lankard, 1995).

Another important influence in career choice is the educator who recognizes a student's talent and encourages him/her to consider a particular area of study (Gates, 2002; Schroeder, Blood, & Maluse, 1993). Many students choose a field they think they will like and prove their ability in that field. Educators in secondary schools have a profound influence on many students in higher education.

After analyzing much research, the author has chosen a specific template or model of a career development or choice program, because it encompasses the literature explored. A step-by-step guide to choose a career involves these six major steps: getting ready, self-exploration, career exploration, making a decision, career preparation planning, and taking action and entering the field (Stevens, 2004). These categories, as defined by Dr. Tom Stevens, Ph. D., will be the basis for forming the author's main six steps of developing in the career choice process for undergraduates. There will be literature sources cited, which will serve to support the foundation of this template of the career choice process.
Step #1 - Getting Ready. This step involves assigning time to explore majors, schools, departments, and making a decision. The individual student has to mentally prepare for making this decision.

Step #2 – Self-Exploration. This step involves figuring out what the overall goal is that the student wants from his/her career. The individual student must figure out what makes him/her happy and what values are imperative to being a part of his/her career. Also, the key objective of gathering information about oneself is to make a list of the criteria the student is using to select a career, such as income, variety, vacation, amount of freedom, opportunities for advancement, work conditions, type of organization, entry and advancement requirements, mobility and geographic location, and working with others. Also, students list their skills and interests. This step includes increasing knowledge about oneself, including self-knowledge and clarification of values, interests and abilities, educational and occupational opportunities in the world of work and postgraduate schooling, and occupational implementation skills in job searching, communicating, resume writing, and interviewing (Ware, 1981).

Step #3 – Career Exploration. This step is imperative to examine, considering it forms the primary basis for the author’s study. In this step, students must explore general alternative career options and brainstorm all of the occupations or careers which include possibilities for them. In this step, students are looking into career research facilities or resources, interviewing people in the occupation, getting interviews with people in the field, considering the advantages/disadvantages of the careers, and analyzing the type of work the respective occupation employs. Many times, students in this step have an intended major. However, it could likely change, as revealed in literature.
According to a study by Hollenbeck & Peo (1998), undergraduates changed majors several times with exposure to alternative career options. Hollenbeck & Peo (1998) suggest that with guidance to undergraduates, more undeclared majors will be declared sooner with confidence. For those who have declared a major, with appropriate guidance, those same students are likely to change their mind during the course of their undergraduate experience. Lee, Clery, & Presley (2001) stated that providing beginning college students with a realistic set of expectations and experiences regarding teaching will help recruit future college students into the teaching profession. Early in their undergraduate work, Lee, Clery, & Presley (2001) suggest that colleges use work-study opportunities, internships, and volunteer programs to foster key recruitment of teachers as well. These have proven to recruit successful candidates into professions they knew little about before entering postsecondary education. If the students are exposed to new and exciting careers once entering college, they are likely to consider them and enter them with appropriate information given to them (Lee, Clery, & Presley, 2001; Hollenbeck & Peo, 1998).

There have been programs specifically designed to aid in the career development and choice process for undergraduates. These programs are vital to maintain in light of several statistics, including the following: Fifty percent of all pupils leave school lacking the knowledge or skills needed to find and keep a good job; fifty percent of adults in their late twenties have not found a steady job; and in the year 2000, the number of jobs in low-skill occupations constituted only 27% of all positions, while the number of positions in occupations requiring high skill levels reached 41% (Kelty, 1997). A review of rational literature relating to college attrition reveals numerous studies whose aim was to
determine reasons for attrition and the reasons that are associated with a lack of persistence in college. Most studies revealed that a lack of clear career goals and lack of preparedness led to more college dropouts each year (Colozzi, 1996). At the very minimum, some career counseling assistance is probably needed by 60% of currently enrolled undergraduate students at colleges and universities (Hoyt & Lester, 1995).

According to data from the Education Commission of the States, every state is currently involved in school-to-careers activities in some way. School-to-careers is a set of policy initiatives which combine education reform, work force preparation, and economic development (Kelly, 1997). One such example is Career Tracks, which is an alternative for college and university career centers that are experiencing an increased demand for service in a time of reduced financial and human resources, are committed to providing a quality practical training experience for those joining different professions, and are seeking to establish a meaningful and visible collaboration with academic programs and counselors (Walz, Lambert, & Kirkman, 2002). They work not only with undeclared majors, but with any person who is seeking information about alternative careers.

Major fairs are commonly held to showcase academic departments and programs for undergraduate college students deciding which career path to take. Major fairs usually include elements of career counseling, academic advising, and peer mentoring and also involve easy access to faculty, staff, advisors, and committed students in one place. According to Finck, Thomas-Clark, Krueger, & Berg-Kolin (2001), choosing a major is a primary task for some 13 million undergraduate students enrolled in over 10,000 institutions of higher learning nationwide. It is estimated that 20-50% of students
entering college are undecided about a major and that over 75% of students change their major one or more times during their academic careers (Finck, Thomas-Clark, Krueger, & Berg-Kolin, 2001)

Internships provide a way to immerse students in the career selection process. To facilitate internships, career services at various institutions of higher education solicit the support of alumni working in target professions to allow undergraduates to work with their companies to discover whether or not the profession is the real workforce pertains to their interests. Schools are very open to allowing prospective candidates to come in their doors, even without declaring education as a major. This way, individuals can ponder whether or not teaching fits their ideal career path (Walz, Lambert, & Kirkman, 2002).

Step #4 -- Making a Decision. This step is specifically meant to reduce the number of alternatives of career options for students. As students gather information about themselves and the world of work, students naturally begin to eliminate some career options. Once the decision is made, students must choose a major and fulfill the major requirements.

Step #5 -- Planning. In this step, students make a career preparation plan. They develop an academic major development plan, a life skills development plan, a work experience plan, and dates of expected degree completion.

Step #6 -- Action. This step involves trying out the career choice. Graduates enter the workforce after carefully delineating and carrying out the first five steps of the career development process and analyze their experiences.
As revealed above, this research is designed to meet students while they are still in step #3, when they are still in career development. Even though students will have chosen mathematics or science as an intended career thus far in their undergraduate studies, the research and statistics indicate that many undergraduate students change their major one or more times throughout their undergraduate duration and are apt to change if and when presented with certain information. In this study, students could still be partially in step #2, which is the self-exploration stage. They could regress when considering new careers after being presented with information about teaching. On the other hand, students could also be at the other end of the spectrum, and be almost ready to make a decision and choose a definite career path. Perhaps teaching is exactly what they were looking for to display their mathematics and/or science talent. Some might have already; however, the research does show that undergraduates are impressionable and likely to change their minds during their college experience. The research thus supports the fact that undergraduates, when presented with alternative career opportunities, are not only likely to consider them, but are likely to change or add another major (Walz, Lambert, & Kirkman, 2002; Finck, Thomas-Clark, Krueger, & Berg-Kolin, 2001; Hoyt & Lester, 1995).

Examples of Alternative Programs Made Available

Possible solutions to the mathematics and science teacher shortage problem include a possible revamp of current teacher preparation programs and/or certification requirements and making certification requirements accessible to recent current education graduates as well as those graduates who earned a science or mathematics degree in a liberal arts program. Most experts are in favor of alternative certification, considering the
amount of students majoring in mathematics/science education in traditional teacher preparation programs is not increasing; in fact, according to statistics mentioned in the introduction, those numbers are steadily declining. Alternative routes to certification, especially those proposed by institutions of higher education, will open doors for more qualified teachers in mathematics and science (Sausner, 2002; National Science Foundation, 1995; Taylor, 1997; Deaton & Morris, 1991; Scaurro, 1989). The subsequent paragraphs allude to several examples of where this is currently happening with success.

The University of Massachusetts at Amherst was involved in a mathematics-science technology education project, whose goal was to implement strategies for a national recruitment of students in the critical fields who were not in colleges of education (Carl, 1984). They acquired 5% more mathematics and science teachers as a result of their efforts.

African Americans, Hispanics, and American Indians constitute 30% of the United States K-12 population and yet, only eleven percent of mathematics and science teachers come from these ethnic groups (National Science Foundation, 1995). Alliance for Minority Participation (AMP) is a program designed to increase the number of minority students in the science and mathematics teaching workforce. Teacher preparation is a main component of this program and the National Science Foundation funded the program to link experts in the mathematics and science fields with minority prospective teacher candidates at various institutions of higher education (National Science Foundation, 1995). Although specific numbers were not given, the program was nevertheless depicted as positive and attracted many new minority recruits from liberal
arts fields and education fields as possible mathematics and science teaching candidates. Likewise, the Rocky Mountain Teacher Education Collaboration was awarded a grant by the National Science Foundation to improve the preparation of mathematics and science teachers and to recruit and retain women and minorities into the profession. Data collected suggested that women who are successful in science are creative, enjoy a challenge and an opportunity to analyze things, rely on their inner resources and describe themselves as independent thinkers (Taylor, 1997). Therefore, the program appealed to those attributes of women and as a result, gained prospective mathematics and science teachers.

The Field-Based Training Program (FBTP), which was designed to obtain more mathematics and science education majors at three colleges in Virginia linked mathematics and science teaching in the undergraduate level (Securo, 1989) with experts in industry (Palsich & Barnes, 1983). By establishing partnerships with mathematics and science experts, the programs developed aimed to lessen teacher anxiety and allow students to lean towards teaching mathematics and science at the middle or secondary level.

At Texas A&M University, a program was established to enable individuals with academic preparation in mathematics and/or science to become teachers as paid interns. Not many districts showed interest in this program from surveys administered. The key factor for this lack of interest was not enough time or options for scheduling interns with a mentor teacher to review content and teaching pedagogy, which once again, validates the importance of linking both aspects of teaching (Denton, 1988).
Partnerships for Excellence in Teacher Education is yet another National Science Federation–funded project to recruit mathematics and science teachers. The program gave financial support, provided professional development opportunities, and paired undergraduate mathematics and science majors with in-field teachers. Students commented that the experience being coupled with a certified in-field teacher was helpful and made their visions of teaching more positive (Ferguson, 2000).

Summary of a Possible Recruitment of Mathematics and Science Liberal Arts Majors

It seems evident that linking mathematics and science education majors with mathematics and science liberal arts majors would benefit both groups of individuals. The liberal arts majors would reap the benefits of learning the pedagogy of teaching while the mathematics and science education majors would become more confident in their content. Additionally, from the research indicated above, it seems likely that with the appropriate tools, information, and guidance, more liberal arts mathematics and science majors will consider or ideally, enter the teaching force. The statistics regarding the number of undergraduates who switch (or add) majors stand for themselves. The pilot programs mentioned in this section have had success in recruiting or at least, exposing mathematics and science majors to a profession in teaching. If more undergraduate mathematics and science students were exposed to the teaching profession, recruitment efforts might yield positive results. Therefore, this research study is needed and its implications are strong.
Summary and Conclusion

In conclusion, it seems evident that there is a shortage of mathematics and science teachers throughout every educational setting today (NCES, 2001). As the research suggests, salaries not only must increase to retain mathematics and science teachers, but salaries also must be comparable to non-educational jobs where the qualified teachers are going after they leave or before they enter the classroom. Higher salaries, salaries comparable to non-educational employment opportunities, alternative teaching requirements, better training, and more in-service and support have all contributed to the reasons underlying the lack of qualified mathematics and science teachers. National and statewide programs have been implemented to reverse this shortage of good teachers. Although alternative programs have proven to yield positive results, many of these programs are fairly recent, so the author proposes that in a few years, more of these studies should be replicated to reaffirm the data findings in those studies mentioned. It is vital to create successful programs to recruit mathematics and science teachers, as the research is not only suggesting a decline in mathematics and science teachers, but an influx of mathematics and science students.

Although the past decade has seen a slight decrease in mathematics and physical science interest in liberal arts, the number of students involved in liberal arts mathematics and science programs is still quite high and even expanding in the biological and life sciences. In literature, there is a gap of research discussing mathematics and science liberal arts majors and strategies put into place to attract these individuals into teaching. What if mathematics and science undergraduate majors were exposed to teaching as an alternative career option? If significant factors are discovered from this study, perhaps
implications of this research can guide colleges and universities to redesign teacher
preparation programs and address those factors which attract teachers. Student
performance will increase and the quality of mathematics and science will rise with more
qualified teachers.
CHAPTER III

METHODOLOGY

Introduction

This chapter will describe the methodology that was used for this study. To begin, the research design will be discussed as well as the population from which the sample was selected. The educational interventions used in this study will then be discussed, including recruitment efforts, sign-up procedures, random assignment to groups, and the control variables involved in all three groups of research participants. The hypotheses will then be stated to target each specific research question in this study. The section on data collection discusses the procedures used in each group of research participants to collect data and ensure anonymity. This section also includes an analysis of the survey instrument, The Career Decision Scale, and Informed Consent form each research participant completed. The statistical tests selected to assess each hypothesis are then described in detail as well as the data coding techniques used by the researcher in SPSS software. The last section discusses the limitations of this study, which provide the framework for making recommendations after the study is completed.

Research Design

This study employed a quasi-experimental design to assess the effect of an intervention on liberal arts mathematics and science majors' decisions to possibly enter the teaching profession. This study also assessed the impact of the level of intensity of the intervention as well as how the intervention specifically affected students at different
levels of certainty in career selection, undergraduate level, and gender. There were two
treatment groups and a control group with which to compare the treatment groups. The
research participants were randomly assigned to one of these three groups. When they
signed up to participate in this study via the recruitment letter (see Appendix C) or
website created at each university, students were aware of the procedure involving their
random assignment. On the day before the study, students were also sent a reminder
email that they would be randomly assigned to a group upon their arrival to the study the
following day. Each research participant in a group was given the same survey to
complete preceding and following the respective intervention, with the exception of the
control group, who did not receive an intervention (see Appendix J). Instead, the control
group simply read unrelated material from current periodicals in-between completing the
pre and post-survey. In addition to the survey, research participants in all groups also
received a career indecision inventory, which was used by the author to assign a numeric
value to each research’s participant’s present career indecision level. This assessment
tool was entitled The Career Decision Scale (see Appendix K) and has been used in
literature for many valid studies. It is described in greater length below.

The first group of research participants was given the survey (see Appendix J) to
complete before and after the most intensive intervention, a workshop PowerPoint
presentation about teaching and associated information about the profession, including,
but not limited to: information about the No Child Left Behind Act, global and national
trends in the workforce, stability in the job market, unemployment rates, alternative
routes to teaching, the shortage of mathematics and science teachers, etc (see Appendix
D). The purpose of this was to assess whether or not any increase in knowledge or
attitudinal favorability about the teaching profession took place over the time period in which the research participants were partaking in the workshop, with all other factors controlled.

The second group of research participants was given the survey (see Appendix J) to complete before and after the less intensive intervention, which included reading articles about the teaching profession, as well as information about the No Child Left Behind Act, global and national trends in the workforce, stability in the job market, unemployment rates, alternative routes to teaching, the shortage of mathematics and science teachers, etc. The specific four articles came from Merits (2000), Sausner (2002), Career Evolution (2000), and Watson (1999) (see Appendices E, F, G, & H). The purpose of this intervention was to assess whether or not any increase in knowledge or attitudinal favorability about the teaching profession took place as a result of reading four articles about the teaching profession and all associated information represented above, with all other factors controlled.

The third group of research participants, the control group, received no intervention regarding the teaching profession. This group of research participants was asked to complete the survey (see Appendix J) and as soon as the researcher received the surveys, the group was asked to read article(s), not related to the teaching profession from a vast array of resources chosen by the researcher. These resources came from current periodicals, including newspapers and magazines, and did not include any tragic information in the news, so as to possibly affect the research participant’s attitude in the post survey. Also, the research participants in the control group were not all asked to read a specific article, as then it would be considered a treatment group. After reading
the periodical of their choice from the researcher’s selection, the control group was then again asked to complete the same survey. The purpose of this was to assess whether or not any increase in knowledge or attitudinal favorability about the teaching profession took place over time as a result of external factors, since they were not exposed to an educational intervention regarding the teaching profession.

Study Participants

Population

The target population for this study consisted of undergraduate students in liberal arts colleges who are majoring or intending to major in mathematics or science at University A and University B. To frame the sample for this study, it is imperative to note the number of mathematics and science majors at the two universities. There were a total of 630 mathematics and science majors at University A and 487 mathematics and science majors at University B, making the total population 1117 students. At University A, the total number of mathematics and science majors in the College of Arts and Sciences for the 2004-2005 school year were as follows: Biology, 435 students; Chemistry, 65 students; Physics, 60 students; and Mathematics, 76 students. At University B, the total number of mathematics and science majors in the College of Arts and Sciences for the 2004-2005 school year were as follows: Biology, 350 students; Chemistry, 52 students; Physics, 55 students; and Mathematics, 50 students.

The researcher inferred from the literature reviewed that liberal arts majors were a target group of candidates who could potentially decrease the national mathematics and science teacher shortage, mainly because they have an interest and confidence in
mathematics and science already. Lack of confidence and fear of content were two primary factors contributing to the shortage of mathematics and science teachers. There were research participants in all three groups described above: a workshop intervention (most intensive intervention), a reading intervention (less intensive intervention), and no educational intervention regarding the teaching profession (control group used to compare with the two treated groups).

Sample

The sample was purposive in the sense that the research participants had to have an interest in possibly obtaining a mathematics or science degree or already have a declared major in mathematics or science. Letters were sent to the department chairs in the mathematics and science departments (including biology, chemistry, physics and mathematics) at both University A and University B to seek their assistance in this research endeavor (see Appendix A). Meetings were also set up with specific professors to discuss the intentions and implications of this study. The researcher specifically met with the department chairs of science and mathematics in August of 2004 at University A. The researcher then met with the four department chairs of biology, chemistry, physics and mathematics at University B between September and November of 2004. The professors sent letters of permission to the researcher to conduct the study at both University A and University B (see Appendix B).

A letter of recruitment and advertisement for this study was given to students primarily through introductory courses for majors or intended majors along with several other smaller classes, in which professors agreed to advertise for this study (see Appendix C). Students were primarily enrolled in introductory courses for majors, such as
"Principles of Chemistry" and "General Biology of Organisms" at University A, "MT Calculus I" at University A, and "Introduction to Biology" at both University A and University B. These class sizes ranged from 200-408 students per class. However, several students were recruited from other courses for mathematics and science classes as well, such as "Cell Biology" and "Calculus II" at University B. Since these courses are taken after the introductory courses, they have a smaller class size, so it is safe to say that a majority of students were recruited through introductory courses for majors. These class sizes range from 25-50 students. Because of this, freshman and sophomores were more likely to receive the recruitment letter compared to upper classmen, who most likely took those introductory courses as lower classmen.

The recruitment letters were either mailed electronically or personally handed out to students in classes at University A and University B by university professors (see Appendix C). Students were then asked to sign up for the study, with the understanding that they would be randomly assigned to the workshop group, reading group, or control group. A temporary website was created solely for this purpose at both institutions, with specific information about the study and an electronic form to submit if undergraduates chose to participate. The researcher met with technological experts at both University A and University B to set up this procedure. Students were then sent an electronic confirmation of their registration via email. Since the researcher was a doctoral student at University B, the researcher's email was used as a direct link from the website where students could sign up to participate electronically. At University A, a temporary email was created specifically for this study so undergraduates could sign up to participate electronically from the website created. Administrators and professors did not choose
how the students were recruited. Students were simply permitted to sign up for the study if they chose to do so. When students did submit the electronic registration, they included their address so the researcher could send them a reminder letter prior to the date of the study.

Educational interventions

There were two specific interventions that the author used in this study. The first intervention included a workshop for mathematics and science majors/intended majors in the school of liberal arts. It was the more intensive intervention as the researcher supplied undergraduates with information about the teaching profession through an informative workshop (see Appendix D). The second intervention included reading articles about the teaching profession and associated information. It was the less intensive intervention as it involved research participants reading articles about the teaching profession and associated information (see Appendices E, F, G, & H). Finally, there was also a control group who received no intervention about the teaching profession. Instead, this group was asked to read a random article, unrelated to education and the teaching profession, from a selection of periodicals the researcher provided. This process was described in the previous section. The sole reason for having this group of research participants was to have a comparison for those groups that were treated.

In the workshop group, the presenter was the researcher. The workshop included a PowerPoint presentation slideshow (see Appendix D), which included information about the following topics: information about the requirements of teaching; alternate routes to teaching; the shortage of mathematics and science teachers and the No Child Left Behind Act; the salary of teachers; the benefits associated with teaching; including
tenure, job security, and extra economic opportunities; the unemployment rate of individuals; the percent of individuals who switch majors and/or careers; and the economy and the global impact on the availability of jobs. This information primarily came from the articles that another group read in the second treatment group described next. Students were asked to complete a survey prior to and immediately following the workshop (see Appendix J).

The second group of research participants read excerpts from articles about the teaching profession and associated information (see Appendices E, F, G, & H). Students were instructed to complete the pre-survey and hand it to the administrator (see Appendix J). Then, students had to read the four short excerpts from the articles chosen by the researcher regarding the teaching profession. After reading the articles, the students were then asked to complete the post-survey and hand it to the administrator (see Appendix J).

The four articles (see Appendices E, F, G, & H) are discussed below to give the reader a detailed description of the information included in both treatment groups (workshop and reading groups).

The article from Mervis (2000) discussed the possibility of recruiting students to teach in secondary schools in the fields of mathematics and science, the importance of the linkage between the schools of liberal arts and education, and the necessity of teachers who feel confident in mathematics and science content. The article also cites many benefits of teaching and that exposing students to the profession could prove to yield positive results. Finally, the author speaks briefly about the benefit of tenure and its advantage in light of continual insecurity in a tight job market. Susnner (2002) discusses the shortage of qualified mathematics and science teachers and validates this shortage.
with statistics, including the possible ramifications of the No Child Left Behind Act. The article also examines how quality mathematics and science education is decreasing in schools because of the lack of qualified teachers. Career Evolution (2000) describes how the patterns of life and work are changing. The article cites the percentage of job changes and the uncertainty that pervades the American workforce and enforces the necessity of alternative career options for undergraduates who wish to enter a tight job market. It reveals statistics regarding the low percentage of Americans with longevity in specific jobs and the average rate of job tenure. Lastly, Watson (1999) explains the need for qualified mathematics and science teachers. His article emphasizes the need for departments in higher education to collaborate and work with one another to not only make sure future teachers have the proper mathematics and science training, but also to make certain that mathematics and science majors are exposed to alternative career options, like teaching. According to Watson, collaborative efforts involving faculty members in colleges of education and colleges in liberal arts ensures that undergraduates learn how to teach an academic subject at the same time they learn its content. National Science Foundation programs are cited to demonstrate that there are creative solutions to the problem of preparing people to teach science and mathematics in schools and higher education can help by exposing teaching to all majors as an attractive career, not just to traditional student teachers in an undergraduate setting, but to others who have a passion for mathematics or science.

The third group of research participants, the control group, read articles about unrelated information to this study. That is, research participants read articles about information other than education and the teaching profession. These periodicals consisted
of current magazines and were selected by the researcher prior to the study. However, due to the fact that the control group is a means for comparison, this group was not given the same exact article to read, because then they would be considered a treatment group. The article(s) did not contain any information about tragic news events, which could have altered the research participants' attitudes. This way, the article's content did not bias or affect the research participants' responses in the post-survey. Students were instructed to complete the pre-survey and hand it to the administrator (see Appendix J). Upon handing it in, the student read a periodical of choice from the resources chosen by the researcher, unrelated to the teaching profession. After reading the article(s) of choice, the students were then asked to complete the post-survey and hand it to the administrator (see Appendix J).

Hypotheses

Introduction

The author's hypothesis includes the idea that an intervention about the teaching profession could reverse the trend of a decreasing mathematics and science teacher workforce by recruiting mathematics and science majors/intended majors in liberal arts. This is due to the fact that research cites little communication between schools of liberal arts and schools of education. In addition to this, research also states that undergraduates have a lack of knowledge about the changing global economy, tight job market, current unemployment rates, and benefits of the teaching profession. If students had a true understanding of these concepts through a better system of communication between schools, perhaps they would be more attracted to the teaching profession.
The specific hypotheses, stemming from the research questions, are stated below. The research questions are replicated first, in the same fashion that they were presented in chapter one, for the reader to correlate with the hypotheses.

**Research Questions**

1. What would be the effect of presenting information about teaching careers to mathematics and science majors in schools of liberal arts? Would an intervention increase the knowledge of the teaching profession and all that is associated with it as well as the attitudinal favorability toward teaching as a career for undergraduate students?

2. Does the type of intervention matter with regard to students' knowledge about and attitudinal favorability toward the teaching profession? That is, does a more intensive intervention, a workshop about the teaching profession, impact undergraduates' knowledge and attitudinal favorability of teaching more so than a less intensive intervention, reading articles about teaching? And, does a less intensive intervention, reading articles about teaching, impact undergraduates' knowledge and attitudinal favorability of teaching more so than no intervention at all?

3. Is there a relationship between knowledge and favorability after an intervention about the teaching profession and associated information? In other words, is higher knowledge of the teaching profession associated with higher attitudinal favorability toward the teaching profession after an intervention?

4. Does an intervention about the teaching profession and associated information impact undergraduate students more at different levels of career uncertainty, as assessed by The Career Decision Scale? That is, after an intervention, do students have a higher
attitudinal favorability towards the teaching profession if they are more uncertain in their career choice?

5. Does an intervention about the teaching profession and associated information impact undergraduate students more at different levels of undergraduate education? That is, after an intervention, do students have a higher attitudinal favorability towards the teaching profession if they are a freshman, sophomore, junior or senior?

6. Does an intervention about the teaching profession and associated information impact undergraduate students more depending on their gender? That is, after an intervention, do students have a higher attitudinal favorability towards the teaching profession if they are male or female?

Individual Hypotheses

Note: T1 represents the pre-survey (before the intervention) and T2 represents the post-survey (after the intervention)

The study sought to test the following hypotheses:

1. Between T1 and T2, there will be a significant increase in knowledge of the teaching profession and in attitudinal favorability toward the teaching profession for the two treatment groups. However, between T1 and T2, there will be no significant increase in knowledge of the teaching profession or in attitudinal favorability toward the teaching profession for the research participants who received no intervention, the control group.

2. Between T1 and T2, there will be significant differences in knowledge of the teaching profession and attitudinal favorability toward the teaching profession between the three groups of research participants (workshop group, reading
group, control group). Those research participants afforded a more intensive intervention will demonstrate significantly higher knowledge and attitudinal favorability than those research participants offered a less intensive intervention, or no intervention at all. Therefore, knowledge and attitudinal favorability will increase significantly more in the workshop group than in the reading group and will increase more significantly in the reading group than the control group.

3. Between T1 and T2, higher knowledge of the teaching profession will be associated with higher attitudinal favorability toward the teaching profession for both treatment groups.

4. Between T1 and T2, high scorers on the career uncertainty scale in the treatment groups will report significantly higher attitudinal favorability toward teaching than low scorers on the career uncertainty scale. Therefore, a higher uncertainty score on the career assessment will be associated with higher attitudinal favorability toward the teaching profession after an intervention.

5. Between T1 and T2, after an intervention for the treatment groups, there will be significant differences in attitudinal favorability toward the teaching profession between the four undergraduate grade levels (freshmen, sophomores, juniors and seniors). Those research participants in lower undergraduate levels will demonstrate significantly higher attitudinal favorability than those research participants in higher undergraduate levels. Therefore, attitudinal favorability will increase significantly more in freshmen than in sophomores, juniors and
seniors; increase significantly more in sophomores than juniors and seniors; and increase significantly more in juniors than seniors.

6. Between T1 and T2, after an intervention for the treatment groups, there will be significant differences in attitudinal favorability toward the teaching profession between the two genders (male and female). Those research participants who are female will demonstrate significantly higher attitudinal favorability than those research participants who are male. Therefore, attitudinal favorability will increase significantly more in females than in males.

Data Collection

The study was piloted on January 31, 2005 with five undergraduate students at University B. The pilot group went through the same process that the undergraduate students went through during the real study in the workshop group, the intensive treatment group. Students arrived at University B and were asked to complete the pre-survey, the Career Decision Scale, view the PowerPoint presentation, and complete the post-survey. The PowerPoint presentation (see Appendix D) included the same information that was presented to the reading group, the less intensive treatment group. The information presented to the treatment groups revolved around topics such as: the teaching profession, the No Child Left Behind Act, global and national trends in the workforce, stability in the job market, unemployment rates, alternative routes to teaching, the shortage of mathematics and science teachers, etc. In the pilot study, undergraduate students were then asked for their feedback regarding the survey instrument as well as the information in the PowerPoint presentation during the workshop. The researcher then
altered questions that seemed ambiguous on the survey instrument and added information to the PowerPoint presentation according to the pilot group's feedback.

The data collection for this study took place on campus at University A and University B on February 16, 2005 and February 22, 2005, respectively. All three groups were located in a classroom setting. The data came from the survey (see Appendix J) that was administered both before and after the intervention in both treatment groups (workshop group and reading group) and after a time period in the control group, and from the Career Decision Scale (see Appendix K). Research participants completed an Informed Consent form (see Appendix I), two surveys (before and after the intervention in the treatment groups and before and after a time period in the control group), and the Career Decision Scale. While their real names had to be used on the Informed Consent form, students participants had the option of using an alias on the two surveys and Career Decision Scale. If they chose to do so, they were instructed to use the same alias on the pre and post-survey and Career Decision Scale so the researcher could code and match them accordingly. Student participants were also told that there would be no way to match the real name on the Informed Consent form with the alias they used on the other documents if they chose to use one. Therefore, student participants could remain anonymous to ensure confidentiality.

The instrument was divided into two sections (see Appendix J). The questions in the first section were based on the content in the four articles (see Appendices E, F, G, & H) selected by the researcher, which students in the treatment groups were exposed to by either reading them or attending a workshop about them (see Appendix D). The first section of questions asked about the knowledge that the research participant had about
the teaching profession and global economy, including: information about the requirements for teaching; alternate routes to teaching certification; the shortage of mathematics and science teachers and the No Child Left Behind Act; the salary of teachers; the benefits associated with teaching, including tenure, job security, and extra economic opportunities; the unemployment rate of individuals; the percent of individuals who switch majors and/or careers; and the economy and the global impact on the availability of jobs and traditional lifetime careers. The first portion of the survey was in multiple choice format and research participants were asked to choose the correct answer to each question. Scores were then calculated for each treatment group and the control group for both the pre-survey and post-survey. A scale was created to measure how many responses were correct, out of a total of 15 questions. Participants received one point for each question answered correctly. They could receive a minimum score of 0 and a maximum score of 15 on the scale. Their total number of correct responses represented their score on the knowledge scale.

The second set of questions asked about the favorability towards the teaching profession. This section included how the research participant felt toward the teaching profession and whether or not the following pieces of information increased his/her favorability toward the profession: information about the requirements for teaching; alternate routes to teaching certification; the shortage of mathematics and science teachers and the No Child Left Behind Act; the salary of teachers; the benefits associated with teaching, including tenure, job security, and extra economic opportunities; the unemployment rate of individuals; the percent of individuals who switch majors and/or careers; and the economy and the global impact on the availability of jobs and traditional
lifetime careers. The second portion of the survey included a likert scale to measure the intensity of research participants' attitudes toward the teaching profession. The likert scale included the following values: 1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree. Scores were calculated for each treatment group and the control group for both the pre-survey and post-survey. A scale was created to measure the research participants' responses on the 10 questions. Students could receive a minimum score of 10 and a maximum score of 40 on the scale. Their total number from the likert-scale responses represented their score on the atitudinal favorability scale.

Lastly, the Career Decision Scale was used to assess student certainty in their career choice (see Appendix K). The assessment tool was used because of its reliability and validity in past research. The Career Decision Scale has a specific scoring system and asks questions about career related issues. The lowest score a student could receive was a 16, meaning the student was the "most decided" in his/her career. The highest score a student could receive was a 64, meaning the student was the "least decided" in his/her career. These numbers came from answering 16 questions with a likert scale from 1-4. The score a research participant received for level of career decidedness was used to correlate with the atitudinal favorability score change in treatment groups from pre to post survey.

Data Analysis

To test all of the hypotheses listed in this section, SPSS software, version 13.0, was utilized and included many statistical tests to calculate results, including: frequency distribution, Pearson's R Correlations (partial), ANOVAs (ANCOVAs), and Paired Sample T-tests. Frequency distribution tables were created to present the demographic
information of all of the research participants. Using syntax commands in SPSS, the variables of name (variable 1), gender (variable 2), undergraduate class (variable 3), college/university (variable 4), and group assignment (variable 5) were coded to match the demographic specifications of each research participant. These are described in detail here. Gender: 0=male, 1=female; Undergraduate class: 1=freshman, 2=sophomore, 3=junior, 4=senior; College/University: 1=University A, 2=University B; Group Number: 1=workshop group, 2=reading group, 3=control group. The rest of the data was entered numerically, including career indecision score (variable 6) on the Career Decision Scale, total knowledge score on the pre-survey (variable 7), total knowledge score on the post-survey (variable 8), total attitudinal favorability score on the pre-survey (variable 9), and total attitudinal favorability score on the post-survey (variable 10). The method by which these scores were calculated was described in the Data Collection section. In addition to these scores, each research participant’s answer choice for each one of the 15 knowledge questions on the pre and post survey (variables 11 through 40) was entered into SPSS with the following commands: 1=choice A, 2=choice B, 3=choice C, and 4=choice D. Lastly, each research participant’s answer choice for each one of the 10 attitudinal favorability questions (which measured the intensity of research participants’ attitudes toward the teaching profession) on the pre and post survey (variables 41 through 60) was entered into SPSS with the following commands: 1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree.

The researcher tested for the additivity of the knowledge and attitudinal favorability scales by computing Cronbach’s alpha in the SPSS 13.0 software. The researcher calculated four Cronbach’s alpha values to measure the reliability of the pre-
survey knowledge section, post-survey knowledge section, pre-survey attitudinal favorability section, and post-survey attitudinal favorability section.

Each hypothesis was tested using a specific statistical test. For the ease of the reader, the author has constructed a table to coincide with all of the hypotheses listed above. Next to each hypothesis is the statistical test the author used to assess whether or not that specific hypothesis was found to be statistically significant in this study. Then, in parentheses, next to each statistical test, is a brief summary of what it was designed to measure and why it was chosen. This table will be replicated in the next chapter of this study with a third column added to display the results found after the study was conducted and whether or not they were statistically significant in this study.
Table 5

Summary of Data Analysis

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Statistical Test Utilized</th>
</tr>
</thead>
</table>
| 1. Knowledge about and attitudinal favorability toward the teaching profession will significantly increase from T1 to T2 after an intervention in the treatment groups; however, knowledge and attitudinal favorability will not significantly increase in the control group. | -- Paired Samples T test (to assess overall change in knowledge from T1 to T2 for treatment groups)  
-- Paired Samples T test (to assess overall change in attitudinal favorability from T1 to T2 for treatment groups)  
-- Paired Samples T test (to assess overall change in knowledge from T1 to T2 for control group)  
-- Paired Samples T test (to assess overall change in attitudinal favorability from T1 to T2 for control group) |
| 2. There will be a significant difference of both variables of knowledge and attitudinal favorability at T2 between the three groups. | -- ANOVA (to assess differences between workshop group, reading group, and control group, of change in knowledge from T1 to T2)  
-- ANOVA (to assess differences between workshop group, reading group, and control group, of change in attitudinal favorability from T1 to T2) |
| 3. There will be a high correlation between knowledge and attitudinal favorability at T2 for both treatment groups | -- Partial correlation (to assess if high knowledge is associated with high attitudinal favorability at T2 for both treatment groups with knowledge at T1 and attitudinal favorability at T1 as control variables) |
| 4. There will be a high correlation between career uncertainty and attitudinal favorability at T2 for both treatment groups. | -- Partial correlation (to assess if high career uncertainty is associated with high attitudinal favorability after an intervention with attitudinal favorability at T1 as control variable) |
| 5. There will be a significant difference of attitudinal favorability at T2 between the four undergraduate levels. (Younger undergraduate levels will have higher attitudinal favorability after an intervention.) | -- ANCOVA to assess differences in attitudinal favorability at T2 between four undergraduate classes (with T1 attitudinal favorability as a covariate) |
| 6. There will be a significant difference of attitudinal favorability at T2 between the two genders. (Females will have higher attitudinal favorability after an intervention.) | -- ANCOVA to assess differences in attitudinal favorability at T2 between males and females (with T1 attitudinal favorability as a covariate) |
Limitations

One limitation of this study is the sample size. Although the researcher made every effort to solicit and recruit students, there have been studies conducted in literature with thousands of participants. Even with the incentive of extra credit in science classes at University A and a monetary incentive at University B, the recruitment was limited to 189 students. Statistically, with the variables tested, it was a good sample size; however, there were several things to note that were of concern to the researcher. Between University A and University B, there are a total of 1117 majors in mathematics and science disciplines for the 2004-2005 school year. The sample in this study, 189 participants, represents 17% of the total population of mathematics and science majors at both universities. While the study was advertised to students predominantly through introductory classes for majors, it is imperative to mention that all undergraduate mathematics and science majors might not have known about the study because their specific professor did not endorse it or because they did not have a class for mathematics and science majors in the spring semester of 2005. Furthermore, even if mathematics and science majors received the advertisement through classes, they could have also had a scheduling conflict or a prior commitment.

As a result of this sample size, the external validity might be constrained in that the results cannot be generalized to the entire scope of higher education in the United States. Therefore, a second limitation of this study might include the fact that the study was limited to only two East coast, private, Catholic universities. Undergraduates at both universities had an excellent academic record in high school, a prerequisite for admission. The average SAT score for University A is 1300 and the students come from 45 states
and 29 countries. There are 9,000 undergraduates at University A with a 15:1 student teacher ratio. Twenty percent of students are minorities, with 52% women and 48% men comprising their undergraduate student body. At University A, there are 645 full-time faculty and nearly 98% hold a doctoral degree. Sixty-five percent of students at University A receive some form of financial aid. Likewise, the average SAT score for University B is 1100 and the students come from 40 states and dozens of countries.

There are 4,800 undergraduates at University B. The average class size at University B is 25 and there is a 14:1 student teacher ratio. Thirty percent of students are minorities and there is an even number of males and females. At University B, there are 802 full-time faculty and nearly 90% hold a doctoral degree. Ninety percent of students at University B receive some form of financial aid and 75% of these students receive aid directly from the university. Therefore, the external validity might not be extended to colleges and universities that are different from University A and University B demographically, financially, intellectually, and academically.

Another limitation is that knowledge and attitudinal favorability were measured short term – more specifically, over approximately two hours. There is no way to assess if an increase in knowledge and attitudinal favorability will be retained over a longer period of time.

Lastly, other limitations could have included the following. Students in the workshop group could have talked with one another, leading to possible data bias. There could have been attitude changes from pre to post surveys in either of the treatment groups or control group from external forces. Further studies should be replicated at
other universities to yield reliable results. Recommendations for further studies are included at the conclusion of this study.

Summary

This study's design allowed for random assignment of students to two educational intervention groups -- workshop or reading -- or a control group. The research design employed permits replication of this study by future researchers. The sample in this study came from a population which included mathematics and science majors, intended majors, or students enrolled in mathematics or science courses for majors at University A and University B. The hypotheses were designed to target the research questions proposed in this study. The research procedures involved in this study, including the completion of the survey, *Career Decision Scale*, and the Informed Consent form were described in this section and the methodology was delineated in great detail, including the statistical tests for each of the six hypotheses. Limitations concluded this chapter and will be discussed again in a future section on recommendations for future researchers.
CHAPTER IV
DATA ANALYSIS AND FINDINGS

Introduction

This chapter serves to discuss all of the findings in this study, following the methodology, research design, educational interventions, and hypotheses described in chapter three. The chapter begins with a demographic breakdown of research participants, including sample characteristics and resulting bias, and a reliability analysis of the survey instrument used. The subsequent sections include each hypothesis, the statistical test employed to analyze it, and a detailed discussion of its findings. A written summary of all of the study's findings concludes the chapter along with a summary table highlighting each hypothesis and whether or not it was statistically significant in this study.

Sample Characteristics

The purpose of this study was to test the effect of an intervention about teaching on liberal arts majors that had an interest in mathematics or science. The sample consisted of 189 undergraduates in liberal arts who were either declared mathematics and science majors, intended mathematics and science majors, or were enrolled in a class for mathematics and science majors only. The researcher recruited 189 research participants in the end. All students enrolled in the mathematics and science classes were invited to be a part of the study, so long as they had a potential interest or a declared major in mathematics or science. Demographic information was requested prior to the completion
of the surveys in all three groups – workshop, reading, and control group – which
included the research participant’s gender, undergraduate class, school, and group
assigned. The four tables and figures below illustrate the demographic breakdown of
study participants.

Table 6
Sample Characteristics: Gender

<table>
<thead>
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<th>Rank</th>
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<tbody>
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<td>Male</td>
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<tr>
<td>Female</td>
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<td>61.4</td>
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Table 7
Sample Characteristics: Undergraduate Class

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<td>Sophomore</td>
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<td>Junior</td>
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<td>9.5</td>
</tr>
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<td>Senior</td>
<td>19</td>
<td>10.1</td>
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Table 8  
*Sample Characteristics: College/University*

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<th>Rank</th>
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<tr>
<td>University B</td>
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<td>22.2</td>
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Table 9  
*Sample Characteristics: Group Assignment*

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<thead>
<tr>
<th>Rank</th>
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<tr>
<td>Reading Group</td>
<td>63</td>
<td>33.3</td>
</tr>
<tr>
<td>Control Group</td>
<td>63</td>
<td>33.3</td>
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</table>
Figure 4. Gender of Research Participants
Figure 5. Undergraduate Class of Research Participants
Figure 6. Higher Education Institution of Research Participants
Figure 7. Random Group Assignment of Research Participants
The resulting sample from this study had several important implications for research. The sample size had little variation in some variables. The statistics noted above for the sample characteristics revealed a greater proportion of females participating in this study, which could bias the data. Specifically, there were 116 females compared with 73 males who participated in the study. Although the researcher could not control this, it is imperative to mention that the unequal distribution of gender could alter the findings from this study. The mathematics and science major population at both University A and University B is described below in regards to the gender variable. The researcher used this population information to compare with the sample in this study.

At University A, there is an estimated 52% female and 48% male population in the sciences, in which they group all chemistry, biology, biochemistry, and physics majors. Also, at University A, there is an estimated 58% female and 42% male population in mathematics. At University B, there is an estimated 50% female and 50% male population in biology, 60% female and 40% male population in Mathematics, 69% female and 31% male population in Chemistry, and 11% female and 89% male population for physics. The greater proportion of female majors in mathematics and chemistry seem to balance out the greater proportion of male majors in physics at University B. Also, at University B, the percentages of gender breakdown for mathematics, chemistry, and physics majors seem more exaggerated, compared to biology majors, since they have a much lower number of majors, as stated in chapter three. For instance, the 50% male population for biology majors at University B represents 175 out of 350 students whereas the 99% male population for physics majors represents 31 out of 35 students. Therefore, when numbers instead of percentages are
analyzed, it is safe to say the estimated gender breakdown is balanced. The table below compares the sample characteristics in this study with the population characteristics of mathematics and science declared majors according to gender at University A and University B. This study’s sample also includes students who might have been intended majors or in classes for majors only and not yet declared majors. The population from both universities was used as a means of comparison for the sample represented in this study.

Table 10

<table>
<thead>
<tr>
<th>Estimated Gender Population of Mathematics and Science Majors at University A and University B</th>
<th>Gender Sample of Mathematics and Science Declared/Intended Majors in this study from University A and University B</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 50% male</td>
<td>38.6% male</td>
</tr>
<tr>
<td>~ 50% female</td>
<td>61.4% female</td>
</tr>
</tbody>
</table>

Similarly, the statistics for undergraduate class level reveal that a greater proportion of freshmen and sophomores participated in this study, which could also bias the data. Specifically, there were 85 freshmen and 67 sophomores versus 18 juniors and 19 seniors who participated in the study. Unlike the information for gender, the comparison for the actual number of majors according to undergraduate class level in this study was difficult to examine with the population since many students who participated might not have declared mathematics or science as their major(s) yet. This is because the students who participated could have either been mathematics or science declared majors, mathematics or science intended majors, or enrolled in a mathematics or science class for majors. Because the number of majors reported in chapter three at University A and
University B only included declared majors, a segment of this study’s sample would not fall into the same category. Therefore, a population and sample comparison would not be a true comparison. Instead, since both University A and University B have relatively close undergraduate level class sizes, the reader compared the sample characteristics in this study with an equal distribution of all four undergraduate class levels to show the bias in this variable. A reliable study would include an equal representation of all four undergraduate class levels. However, the sample in this study shows little variation in the data for undergraduate class level. Although the researcher could not control this, it is imperative to mention that the unequal distribution of undergraduate class level could alter the findings from this study. The table below compares the sample characteristics in this study with the characteristics of the population distribution of mathematics and science declared/intended majors according to undergraduate class level.

Table 11

<table>
<thead>
<tr>
<th>Estimated Undergraduate Class Population of Mathematics and Science Declared/Intended Majors at University A and University B</th>
<th>Undergraduate Class Sample of Mathematics and Science Declared/Intended Majors in the Study from University A and University B</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 25% freshmen</td>
<td>45.0% freshmen</td>
</tr>
<tr>
<td>~ 25% sophomores</td>
<td>35.4% sophomores</td>
</tr>
<tr>
<td>~ 25% juniors</td>
<td>9.5% juniors</td>
</tr>
<tr>
<td>~ 25% seniors</td>
<td>10.1% seniors</td>
</tr>
</tbody>
</table>
The sample demographics of both gender and undergraduate class are very
dissimilar to the population. Therefore, the ability to generalize the findings to the larger
population is thus constrained. Because the sample included only majors/intended majors
in mathematics or science and was not random, the possibility of bias is heightened as
well.

As discussed in chapter three, the knowledge portion of the survey instrument
(see Appendix J) included fifteen questions in multiple choice format regarding the
teaching profession and associated information. Following this was the attitudinal
favorability portion of the survey instrument, consisting of ten questions with a four-point
likert scale to measure the intensity of research participants' attitudes toward the teaching
profession. If the research participant's choice on a question was "strongly agree," data
entry for that question became a "4." That would indicate that the research participant's
choice was most in agreement with the respective statement. The other choices on the
likert scale were 3, which meant the research participant agreed with the statement, a 2,
which meant the research participant disagreed with the statement or a 1, which meant
the research participant strongly disagreed with the statement.

The survey itself had four choices for each question on the knowledge portion of
the survey, which non-education majors had to answer. Assuming that students had no
prior knowledge of the teaching profession, many questions in the pre survey were
answered incorrectly. Therefore, when testing the reliability of the knowledge portion in
this survey instrument, the Cronbach's alpha was lower than normal (.655), because of
the non-education majors' lack of knowledge about the teaching profession. However,
most of these same knowledge questions were answered correctly after an intervention in
the treatment groups and Cronbach's alpha increased (.357). It is imperative to mention that the reliability of the knowledge scale was low. The researcher speculates that the low alpha value was due to the liberal arts majors' lack of knowledge about the teaching profession. Also, considering the control group's answers were included and they received no intervention, the Cronbach's alpha value could have been conceivably lower than it would have been if only the treatment groups' data was computed.

The attitudinal favorability scale constructed by the researcher demonstrated a high degree of reliability. The alpha values for the pre-survey and post-survey of attitudinal favorability were .680 and .792, respectively.

The hypotheses are replicated below for the reader to familiarize him/herself with again and the data analysis follows, in the same order the hypotheses are organized.

**Individual Hypotheses**

Note: T1 represents the pre-survey (before the intervention) and T2 represents the post-survey (after the intervention)

The study sought to test the following hypotheses:

1. Between T1 and T2, there will be a significant increase in knowledge of the teaching profession and in attitudinal favorability toward the teaching profession for the two treatment groups. However, between T1 and T2, there will be no significant increase in knowledge of the teaching profession or in attitudinal favorability toward the teaching profession for the research participants who received no intervention, the control group.

2. Between T1 and T2, there will be significant differences in knowledge of the teaching profession and attitudinal favorability toward the teaching profession
between the three groups of research participants (workshop group, reading group, control group). Those research participants afforded a more intensive intervention will demonstrate significantly higher knowledge and attitudinal favorability than those research participants offered a less intensive intervention, or no intervention at all. Therefore, knowledge and attitudinal favorability will increase significantly more in the workshop group than in the reading group and will increase more significantly in the reading group than the control group.

3. Between T1 and T2, higher knowledge of the teaching profession will be associated with higher attitudinal favorability toward the teaching profession for both treatment groups.

4. Between T1 and T2, high scorers on the career uncertainty scale in the treatment groups will report significantly higher attitudinal favorability toward teaching than low scorers on the career uncertainty scale. Therefore, a higher uncertainty score on the career assessment will be associated with higher attitudinal favorability toward the teaching profession after an intervention.

5. Between T1 and T2, after an intervention for the treatment groups, there will be significant differences in attitudinal favorability toward the teaching profession between the four undergraduate grade levels (freshmen, sophomores, juniors and seniors). Those research participants in lower undergraduate levels will demonstrate significantly higher attitudinal favorability than those research participants in higher undergraduate levels. Therefore, attitudinal favorability will increase significantly more in freshmen than in sophomores, juniors and
seniors; increase significantly more in sophomores than juniors and seniors; and increase significantly more in juniors than seniors.

6 Between T1 and T2, after an intervention for the treatment groups, there will be significant differences in attitudinal favorability toward the teaching profession between the two genders (male and female). Those research participants who are female will demonstrate significantly higher attitudinal favorability than those research participants who are male. Therefore, attitudinal favorability will increase significantly more in females than in males.

Quantitative Findings

Table 12 below reports means, standard deviations, and standard errors on the pre-tests and post-tests. These serve as a reference when reviewing the partial correlation and ANCOVA results to follow.

Table 12

<table>
<thead>
<tr>
<th>Test</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment Groups</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Test Knowledge</td>
<td>126</td>
<td>6.17</td>
<td>1.905</td>
<td>.170</td>
</tr>
<tr>
<td>Post-Test Knowledge</td>
<td>126</td>
<td>10.04</td>
<td>2.408</td>
<td>.215</td>
</tr>
<tr>
<td>Pre-Test Favorability</td>
<td>126</td>
<td>27.36</td>
<td>4.092</td>
<td>.365</td>
</tr>
<tr>
<td>Post-Test Favorability</td>
<td>126</td>
<td>30.41</td>
<td>4.524</td>
<td>.403</td>
</tr>
<tr>
<td><strong>Control Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Test Knowledge</td>
<td>63</td>
<td>5.57</td>
<td>1.873</td>
<td>.236</td>
</tr>
<tr>
<td>Post-Test Knowledge</td>
<td>63</td>
<td>5.37</td>
<td>1.954</td>
<td>.246</td>
</tr>
<tr>
<td>Pre-Test Favorability</td>
<td>63</td>
<td>25.84</td>
<td>5.042</td>
<td>.635</td>
</tr>
<tr>
<td>Post-Test Favorability</td>
<td>63</td>
<td>26.10</td>
<td>4.234</td>
<td>.533</td>
</tr>
</tbody>
</table>

**Hypothesis 1**

The researcher's first hypothesis stated that with an intervention regarding the teaching profession and associated information, knowledge of the profession would
increase as well as attitudes favorability toward the profession (treatment groups: workshop and reading groups). This hypothesis also stated that there would be no significant increase in both knowledge and attitudinal favorability for students in the control group. The researcher will discuss the treatment group findings first, followed by the control group findings.

A Paired-Samples T-Test was run to test if knowledge significantly increased after an intervention regarding the teaching profession and associated information. The result of the Paired Samples Test is presented in Table 13 for the treatment groups.

The results of the Paired Samples Test indicate that a significant increase in knowledge was found in both treatment groups. The mean prior to the intervention was 6.17 and the mean after the intervention was 10.04 in the treatment groups. The mean increase of 3.873 on the knowledge portion of the survey from T1 to T2 indicated that either the workshop or articles in the reading group provided enough information about the teaching profession to significantly increase knowledge. The t value of 15.754 was significant at the .001 level.

A Paired-Samples T-Test was run to test if attitudinal favorability significantly increased after an intervention regarding the teaching profession and associated information. Therefore, only the treatment groups' data (workshop group and reading group) was analyzed. The result of the Paired Samples Test is presented in Table 14 for the treatment groups.

The results of the Paired Samples Test indicate that a significant increase in attitudinal favorability was found in the treatment groups. The mean prior to the intervention was 27.36 and the mean after the intervention was 30.41. The mean increase
of .056 on the attitudinal favorability portion of the survey from T1 to T2 indicated that either the workshop or articles in the reading group provided enough information about the teaching profession to significantly increase attitudinal favorability. The t value of 10.783 was significant at the .000 level.

For the control group, a Paired-Samples T-Test was run to test if knowledge significantly increased in the control group. The author hypothesized that there would be no significant increase in knowledge since the control group received no intervention about the teaching profession. The result of the Paired Samples Test is presented in Table 15 for the control group.

The results of the Paired Samples Test indicate that no significant increase in knowledge was found in the control group. The mean difference (.206) on the knowledge portion of the survey from T1 to T2 indicates that no significant knowledge increase took place over time. The t value of 1.652 was not significant at the .297 level.

For the control group, a Paired-Samples T-Test was run to test if attitudinal favorability significantly increased in the control group. The author hypothesized that there would be no significant increase in attitudinal favorability since the control group received no intervention about the teaching profession. The result of the Paired Samples Test is presented in Table 16 for the control group.

The results of the Paired Samples Test indicate that no significant increase in attitudinal favorability was found in the control group. There was not a significant mean difference (.254) on the attitudinal favorability portion of the survey from T1 to T2 indicating that no significant attitude increase took place over time. The t value of .759 was not significant at the .469 level.
Table 13

Knowledge Change in Treatment Groups from Pre to Post Survey

<table>
<thead>
<tr>
<th>Knowledge Pairs</th>
<th>Mean Difference</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Knowledge – Pre Knowledge</td>
<td>3.873</td>
<td>15.754</td>
<td>.009*</td>
</tr>
<tr>
<td>(N=126), *p&lt;.01</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14

Attitudinal Favorability Change in Treatment Groups from Pre to Post Survey

<table>
<thead>
<tr>
<th>Attitudinal Favorability Pairs</th>
<th>Mean Difference</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Attitudinal Favorability –</td>
<td>3.056</td>
<td>10.783</td>
<td>.000*</td>
</tr>
<tr>
<td>Pre Attitudinal Favorability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N=126); *p&lt;.01</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 15

Knowledge Change In Control Group from Pre to Post Survey

<table>
<thead>
<tr>
<th>Knowledge Pairs</th>
<th>Mean Difference</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Knowledge – Pre Knowledge</td>
<td>-206</td>
<td>-1.052</td>
<td>.297</td>
</tr>
<tr>
<td>(N=63)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 16
Attitudinal Favorability Change in Control Group from Pre to Post Survey

<table>
<thead>
<tr>
<th>Attitudinal Favorability Pairs</th>
<th>Mean Difference</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Attitudinal Favorability - Pre Attitudinal Favorability</td>
<td>254</td>
<td>.729</td>
<td>.469</td>
</tr>
</tbody>
</table>
(N=63)

Note: *p<.01

Hypothesis 2

The researcher's second hypothesis stated that the research participants afforded a more intensive intervention would demonstrate significantly higher knowledge and attitudinal favorability than those research participants offered a less intensive intervention or no intervention at all. Therefore, knowledge and attitudinal favorability would increase significantly more in the workshop group than it would in the reading group and more in the reading group than in the control group.

Using the post survey knowledge score as the dependent variable, an Analysis of Variance, ANOVA, was run to test for these significant differences of means between the three groups of research participants. The ANOVA F value of 99.741 was significant at the .000 level indicating that there were, indeed, significant mean differences on the knowledge scale obtained between the three groups at the time the post-survey was administered. These results are presented in Table 17 (F=99.741, df=2, 186, p<.01).

Tukey's post hoc test was utilized to assess where significant differences were found. A significant mean knowledge difference of 1.317 was found between the workshop and reading groups with means of 10.70 and 9.38, respectively. Likewise, a significant mean knowledge difference of 5.333 was found between the workshop and control group with
means of 10.70 and 5.37 questions answered correctly, respectively. Furthermore, a significant mean knowledge difference of 4.016 was found between the reading group and control group with means of 9.38 and 5.37 questions answered correctly, respectively. These results are presented in Table 18. Therefore, the researcher’s hypothesis was supported; with a more intensive intervention, research participants’ knowledge increased significantly more than with a less intensive intervention or no intervention at all.

Using the post survey attitudinal favorability score as the dependent variable, an Analysis of Variance, ANOVA, was run to test for significant differences of means between the three groups of research participants. The ANOVA F value of 26.998 was significant at the .000 level indicating that there were, indeed, significant differences of means of attitudinal favorability obtained between the three groups at the time the post-survey was administered (a maximum score of 40 with 10 questions rated between 1 and 4 each). These results are presented in Table 19 (F=26.990, df 2, 186, p<.01). Tukey’s post hoc test was utilized to assess where significant differences were found. A significant mean attitudinal favorability difference of 2.635 was found between the workshop and reading groups with means of 31.73 and 29.16, respectively. Likewise, a significant mean attitudinal favorability difference of 5.635 was found between the workshop and control group with means of 31.73 and 26.10, respectively. Furthermore, a significant mean attitudinal favorability difference of 3.000 was found between the reading group and control group with means of 29.10 and 26.10, respectively. These results are presented in Table 26. Therefore, the researcher’s hypothesis was supported; with a more intensive intervention, research participants’ attitudinal favorability
increased significantly more than with a less intensive intervention or no intervention at all. The intervention seemed to affect research participants' attitudinal favorability more than their knowledge. The significant mean increases between groups supports this. The mean difference between the workshop group and reading group on attitudinal favorability was 2.635 compared to the mean difference on knowledge, which was 1.317. Similarly, the mean difference between the workshop group and control group on attitudinal favorability was 5.635 compared to the mean difference on knowledge, which was 5.333. The statistics revealed that an intervention is necessary to increase research participants' knowledge and attitudinal favorability. The mean differences were significant and after an intervention, the mean of knowledge increase and the mean of attitudinal favorability increase were much higher in both treatment groups than in the control group.

Table 17

Knowledge Differences (Workshop, Reading, and Control Groups): ANOVA

<table>
<thead>
<tr>
<th>Group</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>99.741</td>
<td>.000*</td>
</tr>
<tr>
<td>Within Groups (N=188)</td>
<td>186</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 18

**Impact of Educational Interventions on Knowledge (Descriptives)**

<table>
<thead>
<tr>
<th>Post Knowledge</th>
<th>M</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop Group</td>
<td>10.70</td>
<td>2.107</td>
<td>63</td>
</tr>
<tr>
<td>Reading Group</td>
<td>9.38</td>
<td>2.524</td>
<td>63</td>
</tr>
<tr>
<td>Control Group</td>
<td>5.37</td>
<td>1.954</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>8.48</td>
<td>3.162</td>
<td>63</td>
</tr>
</tbody>
</table>

*Note: M= Mean; *p<.01*

Table 19

**Attitudinal Favorability Differences (Workshop, Reading, and Control Groups): ANOVA**

<table>
<thead>
<tr>
<th>Post Attitudinal Favorability</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>26.990</td>
<td>.000*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>186</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N=188); *p&lt;.01</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 20

**Impact of Educational Interventions on Attitudinal Favorability (Descriptives)**

<table>
<thead>
<tr>
<th>Post Attitudinal Favorability</th>
<th>M</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workshop Group</td>
<td>31.73</td>
<td>4.622</td>
<td>63</td>
</tr>
<tr>
<td>Reading Group</td>
<td>29.16</td>
<td>4.047</td>
<td>63</td>
</tr>
<tr>
<td>Control Group</td>
<td>26.30</td>
<td>4.224</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>28.97</td>
<td>4.867</td>
<td>63</td>
</tr>
</tbody>
</table>

*Note: M= Mean; *p<.01*
Hypothesis 3

The researcher’s third hypothesis in this study centered on the relationship between two variables – knowledge of the teaching profession and attitudinal favorability toward teaching as a possible career choice. Specifically, the hypothesis stated that after an intervention regarding the teaching profession, higher knowledge of the teaching profession would be associated with higher attitudinal favorability toward the teaching profession for both treatment groups (workshop and reading groups). The researcher basically predicted that research participants with higher knowledge would also demonstrate significantly more favorable attitudes towards the teaching profession. To test for this relationship, a Partial Pearson Correlation Coefficient (Pearson r) was run on SPSS. Knowledge and attitudinal favorability after the intervention were analyzed to see if an increase in one variable was positively associated with an increase in the other variable. However, to account for the pre-survey responses, the two variables of knowledge and attitudinal favorability on the pre-survey were controlled. In this study, the r value between the two variables of knowledge and attitudinal favorability toward the teaching profession after an intervention for the treatment groups was .205, as depicted in Table 21. Although this indicates a low correlation between the two variables, it was significant at the .023 level. Therefore, there is a low significant correlation between knowledge and attitudinal favorability, suggesting an increase in one variable is associated with an increase in the other.
Table 21

The Relationship Between Knowledge and Attitude on the Post Survey

<table>
<thead>
<tr>
<th></th>
<th>Post Knowledge</th>
<th>Post Attitudinal Favorability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N=122)</td>
<td></td>
</tr>
<tr>
<td>Post Knowledge (after intervention)</td>
<td>1.000</td>
<td>0.205**</td>
</tr>
<tr>
<td>Post Attitudinal Favorability (after intervention)</td>
<td>0.205**</td>
<td>1.006</td>
</tr>
</tbody>
</table>

** p<.05

Note: ** p<.05

Hypothesis 4

The researcher’s fourth hypothesis in this study centered on the relationship between two variables – undergraduates’ career indecision (as measured by the Career Decision Scale) and attitudinal favorability toward teaching as a possible career choice. Specifically, the hypothesis stated that after an intervention regarding the teaching profession, higher career uncertainty would be associated with higher attitudinal favorability toward the teaching profession for both treatment groups (workshop and reading groups). The researcher basically predicted that research participants with a higher score on a career indecision assessment would demonstrate significantly more favorable attitudes towards the teaching profession, with the prediction that if a research participant was more undecided in his/her career choice, he/she might consider teaching more so than a fellow research participant who had a firm grip on his/her future career choice. To test for this relationship, a Partial Pearson Correlation Coefficient (Pearson r) was run on SPSS. Pre-survey attitudinal favorability had no significant relationship with career indecision scores. Career indecision scores and attitudinal favorability after the
intervention were analyzed to see if high career indecision scores were associated with high attitudinal favorability. However, to account for the pre-survey responses, the variable of attitudinal favorability on the pre-survey was controlled. In this study, the r value between the two variables of career indecision and attitudinal favorability toward the teaching profession after an intervention for the treatment groups was .088, as depicted in Table 22. This indicates no association between the two variables. Therefore, in this study, there is no indication that undergraduate students who are less decided in their careers are any more likely to be influenced by an intervention about teaching and change their attitudes toward this profession than students who are decided in their careers.

It is imperative to note that there was variation in the career indecision scores as assessed by The Career Decision Scale (see appendix K). The lowest score a student could receive was a 16, meaning the student was the “most decided” in his/her career. The highest score a student could receive was a 64, meaning the student was the “least decided” in his/her career. These numbers came from answering 16 questions with a likert scale from 1-4. Therefore, if all 16 questions were answered with a “1”, the student’s score became 16 and if all 16 questions were answered with a “4”, the student’s score became a 64. In this study, the minimum score was 16 and the maximum score was 58 (range of 42), with a mean of 31.30 and a standard deviation of 8.674. The scores were slightly skewed toward the “decided” side. The figure below depicts this.
Figure 8. Frequency Distribution of Career Indecision Score of Mathematics and Science Declared/Intended Majors
Table 22

<table>
<thead>
<tr>
<th></th>
<th>Career Uncertainty</th>
<th>Post Attitudinal Favorability</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N=123)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post Knowledge (after intervention)</td>
<td>1.00</td>
<td>0.088</td>
</tr>
<tr>
<td>Post Attitudinal Favorability (after intervention)</td>
<td>0.088</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Hypothesis 5

The researcher’s fifth hypothesis in the study stated that after an intervention for the treatment groups, there would be significant differences in attitudinal favorability toward the teaching profession between the four undergraduate grade levels—freshmen, sophomores, juniors, and seniors. Furthermore, it was suggested that those research participants who were in lower undergraduate levels would demonstrate significantly higher attitudinal favorability than those research participants in higher undergraduate levels. Therefore, attitudinal favorability would potentially increase significantly more in freshmen than in sophomores, juniors and seniors; increase significantly more in sophomores than juniors and seniors; and increase significantly more in juniors than seniors, with the hypothesis that lower undergraduate levels are more undecided in their career paths and would be more open to new career ideas. Using pre-survey attitudinal favorability as a covariate and post-survey attitudinal favorability as a dependent variable, an Analysis of Covariance (ANCOVA) was run to test for significant differences between the four undergraduate levels of education. The F value of .485 was
not significant at the .093 level, indicating that there were no significant differences between the four undergraduate levels in their attitude toward considering the teaching profession as a career option at the time the post-survey was administered (a maximum score of 40 with 10 questions rated between 1 and 4 each). These results are presented in Table 23. For the treatment groups, the mean attitudinal favorability in the post-survey for freshmen, sophomores, juniors, and seniors was 30.34, 30.15, 29.18, and 32.62, respectively (out of a possible score of 40). From these statistics, no significant differences between the four undergraduate classes were reported. These results are presented in Table 24. Therefore, the researcher’s hypothesis was not supported. In this study, there is no indication that undergraduate students who are lower classmen are any more likely to be influenced by an intervention about teaching and change their attitudes toward this profession than undergraduate students who are upper classmen.

The lack of variation among the research participants in the sample could account for bias in data in this hypothesis. It is plausible that the lack of significance in this hypothesis could be due to the unequal distribution of participants in each undergraduate class. From the sample characteristics noted in this chapter, there were 85 freshmen, 67 sophomores, 18 juniors, and 19 seniors represented in this sample. Because of the surplus of lower classmen and the low number of upper classmen represented, the results could have been biased due to little variance in the undergraduate class variable. If the undergraduate class levels were evenly represented, the results might have revealed significant results. Although the researcher could not control this unequivocal representation of undergraduate class level, it is imperative to mention this could have altered the findings from this study.
Table 23

Attitudinal Favorability Differences (Undergraduate Class): ANCOVA

<table>
<thead>
<tr>
<th>Post Attitudinal Favorability</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Groups</td>
<td>126</td>
<td>.485</td>
<td>.693</td>
</tr>
</tbody>
</table>

(N=126)

Table 24

Impact of Educational Intervention on Attitudinal Favorability for Undergraduate Class (Descriptives)

<table>
<thead>
<tr>
<th>Post Attitudinal Favorability</th>
<th>M</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshmen</td>
<td>30.34</td>
<td>4.346</td>
<td>62</td>
</tr>
<tr>
<td>Sophomores</td>
<td>30.15</td>
<td>5.142</td>
<td>40</td>
</tr>
<tr>
<td>Juniors</td>
<td>29.18</td>
<td>3.488</td>
<td>11</td>
</tr>
<tr>
<td>Seniors</td>
<td>32.62</td>
<td>3.776</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>30.41</td>
<td>4.524</td>
<td>126</td>
</tr>
</tbody>
</table>

Note: M= Mean

Hypothesis 6

The researcher’s sixth hypothesis in the study stated that after an intervention for the treatment groups, there would be significant differences in attitudinal favorability toward the teaching profession between the two genders – males and females. Furthermore, it was suggested that those research participants who were female would demonstrate significantly higher attitudinal favorability than those research participants who were male. Therefore, attitudinal favorability would potentially increase significantly more in females than males, with the notion that females are historically
more attracted by the benefits associated with teaching, as noted in the literature section of this study, and would be more likely to consider a possible career in teaching. Using pre-survey attitudinal favorability as a covariate and post-survey attitudinal favorability as a dependent variable, an Analysis of Covariance (ANCOVA) was run to test for significant differences between the genders. The F value of .673 was not significant at the .013 level, indicating that there were no significant differences between the genders in their attitude toward considering the teaching profession as a career option at the time the post-survey was administered (a maximum score of 40 with 10 questions rated between 1 and 4 each). These results are presented in Table 25. For the treatment groups, the mean attitudinal favorability in the post-survey for males and females was 30.19 and 30.34, respectively. From these statistics, no significant differences between two genders were reported. These results are presented in Table 26. Therefore, the researcher's hypothesis was not supported. In this study, there is no indication that undergraduate students who are female are any more likely to be influenced by an intervention about teaching and change their attitudes toward this profession than students who are male.

Similar to hypothesis five, the lack of variation among the research participants in the sample could account for bias in data in this hypothesis. It is plausible that the lack of significance in this hypothesis could be due to the unequal distribution of participants according to gender. From the sample characteristics noted in this chapter, there were 116 females and 73 males represented in this sample. Because of the surplus of females, the results could have been biased due to little variance in the gender variable. If gender was evenly represented, the results might have revealed significant results. Although the
researcher could not control this unequivocal representation of gender, it is imperative to mention this could have altered the findings from this study.

Table 25

*Attitudinal Favorability Differences (Gender): ANCOVA*

<table>
<thead>
<tr>
<th>Post Attitudinal Favorability</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Groups</td>
<td>126</td>
<td>.673</td>
<td>.13</td>
</tr>
</tbody>
</table>
(N=126)

Table 26

*Impact of Educational Intervention on Attitudinal Favorability for Gender (Descriptives)*

<table>
<thead>
<tr>
<th>Post Attitudinal Favorability</th>
<th>M</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>30.19</td>
<td>4.557</td>
<td>47</td>
</tr>
<tr>
<td>Females</td>
<td>30.54</td>
<td>4.529</td>
<td>79</td>
</tr>
<tr>
<td>Total</td>
<td>36.41</td>
<td>4.524</td>
<td>126</td>
</tr>
</tbody>
</table>

*Note: M= Mean*

Summary of Data Analysis

The analysis of data in this study yielded several interesting and statistically significant findings. There is evidence that after an intervention, which presents information about the teaching profession and associated information to undergraduates, knowledge increases significantly. Likewise, there is also evidence that after an intervention, which presents information about the teaching profession and associated information to undergraduates, attitudinal favorability also increases significantly. From the statistics run in this study, it also can be concluded that the more intense the
intervention is, the more likely undergraduate students will consider the teaching profession, because there was a significantly higher increase in knowledge and attitudinal favorability after the workshop intervention compared to the reading group who read articles containing the same information in the workshop. Therefore, it seems safe to suggest that a more intensive intervention will yield a higher increase in knowledge and attitudinal favorability. Although the correlation was low, this study did show a significant relationship between knowledge and attitudinal favorability, suggesting an increase in one variable is associated with an increase in the other. In other words, the more undergraduate liberal arts majors know about teaching and the benefits associated with the profession, the more favorable they view the teaching profession.

From this study, it is interesting to note there were several findings that did not yield statistically significant results. The variables of career indecision/uncertainty, undergraduate level, and gender did not yield significant results in regards to their relationship with attitudinal favorability. With the research cited and analyzed in the literature portion of this study, it was hypothesized that the more undecided students were in their careers, the more likely they would be influenced by a possible career choice in teaching. Similarly, within the same research cited, it was also hypothesized that undergraduates who were lower classmen would be more influenced by optional career choices, with the preconceived notion that they were more undecided in their careers because they were newer to the college environment and less likely to have made a definitive career choice. Both career indecision and undergraduate class were not found to have a significant impact on undergraduates' attitudes toward the teaching profession in this study. Lastly, in the literature portion of this study, research also suggested that
females were more likely to be attracted into the teaching profession, because of historical statistics that they comprise almost three-fourths of the profession, along with the fringe benefits that accompany the profession, including but not limited to: child care benefits, hours, emotional nature of the job, etc. However, gender was not found to have a significant impact on undergraduates' attitudes toward teaching in this study.

As reported in each analysis section above, the low variability in the sample for both undergraduate class and gender could have biased the data. Since there was a surplus of females compared to males and a surplus of lower classmen compared to upper classmen, the insignificant relationships reported between undergraduate level and attitudinal favorability as well as gender and attitudinal favorability could have resulted from the biased sample in this study. It is imperative to note that the findings could be different and/or significant in future replications of this study that include a true representation of the mathematics and science major population or an even split of both genders and all four undergraduate classes. Because the sample demographics were very dissimilar to the population, the ability to generalize findings to the larger population is thus constrained.

A summary of the results of this study is presented below. It is replicated from the methodology section of this study, with a new column displaying the calculated results.
<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Statistical Test Utilized</th>
<th>Results</th>
</tr>
</thead>
</table>
| 1. Knowledge about and attitudinal favorability toward the teaching profession will significantly increase from T1 to T2 after an intervention in the treatment group; however, knowledge and attitudinal favorability will not significantly increase in the control group. | -- Paired Samples T test (to assess overall change in knowledge from T1 to T2 for treatment groups)  
-- Paired Samples T test (to assess overall change in attitudinal favorability from T1 to T2 for treatment groups)  
-- Paired Samples T test (to assess overall change in knowledge from T1 to T2 for control group)  
-- Paired Samples T test (to assess overall change in attitudinal favorability from T1 to T2 for control group) | -- p < .01  
-- p < .01  
-- not significant  
-- not significant |
| 2. There will be a significant difference of both variables of knowledge and attitudinal favorability at T2 between the three groups. | -- ANOVA (to assess differences between workshop group, reading group, and control group, of change in knowledge from T1 to T2)  
-- ANOVA (to assess differences between workshop group, reading group, and control group, of change in attitudinal favorability from T1 to T2) | -- p < .01  
-- p < .01 |
| 3. There will be a high correlation between knowledge and attitudinal favorability at T2 in both treatment groups. | -- Partial correlation (to assess if high knowledge is associated with high attitudinal favorability at T2 for both treatment groups with knowledge at T1 and attitudinal favorability at T1 as control variables) | -- p < .05  
-- not significant |
| 4. There will be a high correlation between career uncertainty and attitudinal favorability at T2 for both treatment groups. | -- Partial correlation (to assess if high career uncertainty is associated with high attitudinal favorability after an intervention with attitudinal favorability at T1 as control variable) | -- not significant |
| 5. There will be a significant difference of attitudinal favorability at T2 between the four undergraduate levels. (Younger undergraduate levels will have higher attitudinal favorability after an intervention.) | -- ANCOVA to assess differences in attitudinal favorability at T2 between four undergraduate classes (with T1 attitudinal favorability as a covariate) | -- not significant |
| 6. There will be a significant difference of attitudinal favorability at T2 between the two genders. (Females will have higher attitudinal favorability after an intervention.) | -- ANCOVA to assess differences in attitudinal favorability at T2 between males and females (with T1 attitudinal favorability as a covariate) | -- not significant |
CHAPTER V

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This chapter will explore the study’s findings and discuss their implications for the future of mathematics and science education. The chapter begins with a summary of all statistical results, followed by a discussion of how educators and institutions of higher education can use these findings to recruit more qualified mathematics and science teachers. The researcher will conclude with several recommendations for future replications of this study, in light of the limitations addressed in chapter three.

Summary of Results

The hypotheses tested in this study focused on three distinct groups – two that were considered treatment groups, who received information about the teaching profession and associated information, and a control group, who did not receive information about the teaching profession. The research participants included 189 male and female freshmen, sophomores, juniors, and seniors at University A and University B. There were six main hypotheses in question and many findings were significant.

The first hypothesis suggested that a workshop or reading intervention about the teaching profession would increase the knowledge of the research participants. In addition to this, the attitudinal favorability toward the teaching profession would increase as well. To test this hypothesis, two Paired Sample T Tests were run, comparing the pre-survey knowledge score and pre-survey attitudinal favorability score with the post-survey
knowledge score and post-survey attitudinal favorability score. Both Paired Sample T tests for knowledge and attitudinal favorability, with t values of 15.754 and 10.783 respectively, proved to be statistically significant at the .000 level, indicating that the workshop and the articles selected by the researcher for the reading group proved to increase the research participants’ knowledge and attitude toward the teaching profession. These findings were significant, because they support the notion that exposing liberal arts mathematics and science majors to the teaching profession yields positive results and attracts them toward the profession. This hypothesis also stated that there would be no significant difference in knowledge or attitudinal favorability between pre and post-surveys in the control group and there were no significant differences found. Both T values for knowledge (-1.052) and attitudinal favorability (.729) were not significant at the .297 level and .469 level, respectively.

The second hypothesis explored whether or not the type of intervention had a significant impact on the knowledge and attitudinal favorability obtained by the research participants in the treatment groups. After an Analysis of Variance (ANOVA) was run, F values of 99.741 and 26.990 revealed a statistically significant difference found for both knowledge and attitudinal favorability between the workshop group and reading group, between the workshop group and control group, and between the reading group and control group. The p values were all significant at the .000 level, suggesting that a more intense intervention yields a higher increase in both knowledge and attitudinal favorability. Therefore, this is evidence that having undergraduate students attend a workshop about the teaching profession increases their favorability towards teaching more so than reading articles about the teaching profession. Furthermore, having
undergraduates read articles about teaching proves to increase their attitude towards the profession as well, considering there was a significant difference in knowledge and attitudinal favorability scores between the reading group and the control group. The intervention seemed to affect research participants' increase in attitudinal favorability more compared to their knowledge increase and the statistics supported this. The statistics revealed that an intervention is necessary to increase research participants' knowledge and attitudinal favorability. The mean differences were significant and after an intervention, the mean of knowledge increase and the mean of attitudinal favorability increase were much higher in both treatment groups than in the control group.

The third hypothesis tested the direct relationship between knowledge and attitudinal favorability. A Pearson R correlation was run and although the correlation was low (.205), it nevertheless was statistically significant at the .023 level, suggesting that an increase in knowledge is associated with an increase in attitudinal favorability. With a higher sample size, the researcher suggests that this relationship could conceivably demonstrate a stronger value, because it is significant already with 189 research participants. With the immense literature denying the communication between schools of liberal arts and education, it seems plausible to suggest that many liberal arts majors do not get exposed to elements of the teaching profession. This correlation explored the relationship between the two variables of knowledge and favorability. It connected the two and it seems safe to conclude that when undergraduates are exposed to information about the teaching profession, they are more likely to view it in a more favorable fashion and consider it a career option.
The fourth and fifth hypotheses were similar, in that they assessed the relationship between career indecision and undergraduate class level with attitudes towards teaching. To test the former, another Pearson R Correlation was run to see if there was an association between career indecision and attitudinal favorability after an intervention about the teaching profession. It was hypothesized that a higher career indecision score, as revealed by the Career Decision Scale, would be associated with a higher attitudinal favorability after an intervention. In hypothesis five, it was assumed that lower classmen, such as freshmen and sophomores, would be more likely to be affected by an intervention about teaching. The statistics did not reveal significant results. In hypothesis four, the Pearson’s R value of .088 was not significant at the .329 level. In hypothesis five, an Analysis of Covariance was run (ANCOVA) with pre-survey attitudinal favorability as a covariate, and the F value of .485 was not significant at the .693 level. Therefore, both hypotheses were not supported. However, there seems to be a positive anecdote to this finding. Since the Paired Sample T Tests in hypothesis one suggested that an intervention about teaching had a significant impact and significantly increased both research participants’ knowledge and attitudinal favorability, interventions in future studies should be directed to all undergraduate levels, not only lower classmen or more undecided students, because they are all equally affected. Since there was much variation in career indecision scores, it seems safe to conclude that students who are more decided in their careers are just as likely to consider teaching as students who are less decided in their careers. However, since there was little variation in the variable of undergraduate class, the insignificant findings could merely be a result of a biased sample, with a surplus of
lower classmen represented. Future replications of this study should strive for a more even distribution of undergraduate class levels to yield significant results.

The sixth hypothesis investigated whether or not gender had a significant impact on the recruitment of future mathematics and science teachers. Because females historically represent the majority of the teacher workforce, it seemed likely that more females would be affected by an intervention about the teaching profession. However, in this study, this hypothesis did not hold true. In fact, when an Analysis of Covariance (ANCOVA) was run, the F value of .673 was not significant at the .013 level, suggesting no relationship between gender and favorable attitudes toward teaching. However, since there was little variation in the variable of gender, the insignificant findings could merely be a result of a biased sample, with a surplus of females represented. Future replications of this study should strive for a more even distribution of both genders to yield significant results.

Discussion

There has been an ongoing crisis in education concerning the quality of mathematics and science education in America's schools. Few would argue that the education of students is one of the most important concerns in America because of the growing population, increasing wave of technology, international competition with other industrialized countries, and the fundamental principle that we are responsible for educating the future. From the literature reviewed, the researcher stresses that two-thirds of all mathematics and science teachers will be retiring in the next decade (Sausner, 2002). In addition to this, many current teachers in mathematics and science classrooms will lose their jobs if they are not deemed highly qualified by state education personnel.
due to the implementation of the No Child Left Behind Act, George W. Bush's plan calls for every teacher to be highly qualified by the end of the 2005-2006 school year; therefore, every teacher who is currently teaching mathematics and science without proper credentials will lose his/her job (U.S. Department of Education, 2004; Truhan, 2002). What does that translate into? A pool of job openings for qualified individuals who feel comfortable in mathematics and science content.

Research has suggested that there have been many attempts to recruit individuals into mathematics and science education and several roadblocks have always stopped this from happening. Most skeptics do not get past the notion of salary – that there are higher paying jobs for individuals who have an interest in mathematics or science (Ingersoll, 1999; Rumberger, 1987; Flowers, 1982; Madfes, 1991; Hudson, 1996; Ferguson, 2000). This is a key factor in the recruitment of mathematics and science teachers and one that cannot be overlooked. However, when salary is pro-rated to a 12 month scale instead of a 9 month scale, literature also supports the fact that there is not as much of a gap between mathematics and science education jobs and mathematics and science non-education employment opportunities (Palaich & Burnes, 1983; Ycotis & Nickel, 1983). When considering the gap that does exist, however, it is imperative to mention the benefits that accompany the teaching profession, including, but not limited to: tenure, job security, hours, extra economic opportunities, and other fringe benefits. In a global economy full of insecurity and rapid company buyouts, it seems plausible that these benefits associated with teaching could attract mathematics and science individuals from liberal arts fields.

The second most commonly reported reason for lack of interest in mathematics/science education stems from fear of content (Merseth, 1983; Tosun, 2000). Since mathematics
and science majors do not have that fear, there was a need for a study that potentially attracted those individuals into teaching. There was a gap in literature which explored this considerable marriage between liberal arts mathematics/science majors and teaching. If the benefits of teaching were advertised, perhaps undergraduate mathematics and science majors would be attracted to the profession. The information presented to students in this study came from Mervis (2000), Sausner (2002), Career Evolution (2000), and Watson (1999). Research has supported the fact that there is little communication between the schools of education and liberal arts, so it seems safe to suggest that many liberal arts majors, specifically mathematics and science majors, do not know about teaching and the benefits that coincide with the profession (Watson, 1999). If undergraduate students learned about the advantages of the teaching profession, perhaps they would be more inclined to enter it and reverse the trend of a decreasing mathematics and science teacher workforce. This study's findings suggest that it is possible to recruit liberal arts majors, specifically mathematics and science majors into the teaching profession.

Considering most students in this class were recruited through introductory courses, the researcher further suggests that implications from this study could conclude that early majors are likely to be impacted by an intervention about the teaching profession. The first step involves supplying information about the teaching profession to these liberal arts majors. In research, it was reported that many students do not consider teaching because of the lack of information about the profession. This is primarily because communication between schools of liberal arts and schools of education is sometimes non-existent (Watson, 1999). If students do acquire information about the teaching profession, associated benefits, a pro-rated salary, information
surrounding the global economy, and unemployment rates, they seem to consider the teaching profession as a possible career choice. In both treatment groups, research participants' knowledge significantly increased and furthermore, their attitude toward entering the profession also significantly increased. Statistics also revealed that an increase in knowledge was significantly linked to an increase in attitudinal favorability, so undergraduate students are more inclined to view teaching in a more favorable light when information is provided to them about it. Therefore, institutions of higher education need to establish better communication between schools and give undergraduate students possible career alternatives other than those within their specific disciplines or schools.

To further validate this study's findings, the control group, who received no intervention, had no significant increase in both knowledge and attitudinal favorability. This offers validation that an intervention regarding the teaching profession is necessary to create this increase in attitude toward teaching. This is mostly because there is such a lack of communication between schools of liberal arts and education. If the communication was present, perhaps more early mathematics and science majors would consider teaching as a possibility. The societal benefits would then be threefold: there would be more qualified mathematics and science teachers in America's classrooms, who are confident in mathematics and science content; student mathematics and science scores would increase as a result of this increase of qualified mathematics and science teachers; and the growing shortage of mathematics and science teachers would start to reverse. Therefore, the findings from this study infer that there needs to be a better communication system between schools in universities. Students in liberal arts should be
exposed to alternative career options that are within their field, but perhaps in another school, such as a career teaching mathematics or science in the school of education. One recommendation made in the next section involves reporting this study's findings to department chairs at colleges and universities. This is imperative, because the study's findings revealed that with communication and information given to undergraduate mathematics and science majors about an alternative career option, they were likely to consider teaching more.

This study also reported statistically "insignificant" findings which, ironically, have significant implications for the future of education. One relationship that statistics reported insignificant was between career uncertainty and attitudinal favorability toward the teaching profession. The researcher had originally hypothesized that if students were more uncertain in their career choices, they would be more likely to consider alternative career options, like teaching in this study. However, since this correlation was not significant, it can be inferred that students at all levels of career certainty are apt to consider new alternatives with the right information provided to them. This implication can be implied because of the normal distribution of the career indecision scores that were noted in chapter four. From the statistics in the treatment groups, it was concluded that an intervention was enough to recruit possible future teachers — wow, it can be added that that information about the teaching profession should be supplied to all undergraduate students, regardless of how decided they are in their career choice, because they are equally as impressionable. Future studies should be conducted to assess this with a larger sample size, assuming the sample size is normally distributed again.
The study also found no significant differences in undergraduate class level and their attitudinal favorability toward the teaching profession. The researcher originally hypothesized that if students were in a lower undergraduate class, they would be more likely to consider alternative career options, like teaching in this study. In the findings, there were no statistically significant differences found for increased attitudinal favorability between the four undergraduate classes. If the four undergraduate classes were normally distributed, two inferences could be made: 1) students in all undergraduate levels are likely to consider new alternatives with the right information provided to them; and 2) information about the teaching profession should be supplied to all undergraduate students, regardless of their undergraduate level, because they are equally as impressionable. However, there was a problem with these implications that the data revealed. The data did not take into account the tremendous bias in the sample. From the statistics noted in chapter four, there were 85 freshman, 67 sophomores, 18 juniors, and 19 seniors represented in this sample. With the surplus of lower classmen, one cannot make inferences as if there was a normal distribution of undergraduate class levels in the sample. Because the sample differed from the population, the ability to generalize these findings is constrained. The findings for the relationship between undergraduate class and attitudinal favorability seem to have biased because of the low variability in this variable. Therefore, the findings could have been altered. Future studies should be conducted to assess this with a larger sample size and a more equal variation in undergraduate class level of research participants.

Lastly, the study found no significant differences in gender and their attitudinal favorability toward the teaching profession. The researcher originally hypothesized that
if students were female, they would be more likely to consider a teaching career due to their dominance of the profession in literature. In the findings, there were no statistically significant differences found between the genders. If the two genders were normally distributed, two inferences could be made: 1) both male and female students are likely to consider new alternatives with the right information provided to them; and 2) information about the teaching profession should be supplied to both males and females, because they are equally as impressionable. However, there was a problem with these implications that the data revealed. The data did not take into account the bias in the sample. From the statistics noted in chapter four, there were 116 females and 73 males represented in this sample. With the surplus of females, one cannot make inferences as if there was a normal distribution of both genders in the sample. Because the sample differed from the population, the ability to generalize these findings is constrained. The findings for the relationship between gender and attitudinal favorability seem to have biased because of the low variability in this variable. Therefore, the findings could have been altered. Future studies should be conducted to assess this with a larger sample size and a more equal variation in the gender of research participants.

With the No Child Left Behind Act going into effect by June of 2006, it is imperative to examine the worst effect of this Act — the impending shortage of qualified mathematics and science teachers (U.S. Department of Education, 2004). To add to this issue, both the student enrollment in Kindergarten through twelfth grade and student interest in mathematics and science are increasing at a steady rate (NCES, 2004). Therefore, we will have an influx of students in mathematics and science classrooms without qualified teachers to instruct them. Since fear of content is one of the primary
reasons individuals choose not to enter mathematics and science education, if America could somehow attract individuals from liberal arts, classrooms could be filled with qualified teachers who feel comfortable with their content. Those individuals would then have a job with security, tenure, and extra economic opportunities and the students would have qualified teachers, adding to the value of their education.

Therefore, this study has added to literature in several ways. There is a plethora of research which inquires about reasons individuals do not enter mathematics and science education. Likewise, there is much research surrounding how students view teaching, the career decision making process, and the surplus of teacher education programs that are actively trying to recruit mathematics and science teachers everyday. Furthermore, there is an abundance of literature which supports the fact that there is little communication between schools and little awareness of alternative career options for undergraduate students. However, there remains a gap in literature about what could attract mathematics and science liberal arts majors into teaching. They remain a target pool of candidates who could fill voids in mathematics and science classrooms because they do not fear the content. This study aimed to solicit future mathematics and science teachers by giving liberal arts majors information about teaching to attract them to the profession. When the researcher did this, the undergraduates’ (most early mathematics and science majors) attitudes significantly increased toward the profession, making them more likely to consider it as a career option. By replicating this study at other universities in the future, perhaps more liberal arts majors will be exposed to the teaching profession and associated benefits and increase their attitudes toward it. In this way, this research
adds to the growing literature in the field of education, specifically higher education and the future of mathematics and science teachers.

Recommendations for Further Research and Practice

Although many significant findings were concluded from this study, there are some recommendations that should be considered for future researchers. The results from this study do allow future researchers to duplicate the study, including the research design and entire methodology section of this study. In chapter three, several limitations were revealed. The researcher will state recommendations for future replications of this study in light of those limitations described and target each one specifically. The researcher will then add new limitations that were revealed after the study was conducted. These recommendations will add to the reliability of this study’s findings in the future:

1. This study should be replicated with a larger sample size. The researcher did face some difficulty recruiting students. After hours of communication, recruitment techniques, and monetary and extra credit incentives, the researcher truly strived to recruit as many research participants as possible and received 189 participants. The statistics revealed this represented 17% of the total population of mathematics and science majors at University A and University B. While students might not have received the advertisement or had a scheduling conflict, the study should be repeated in an attempt to gain more participants. If future studies were funded by a national organization, perhaps the monetary incentive would be larger and more research participants would participate. If the sample size was increased, and significant results found, the reliability of the findings would certainly increase as well.
2. This study should also be replicated at other institutions of higher education. Because the research was conducted at two private, Catholic, Northeastern universities, the external validity of the findings is somewhat limited. A limitation noted in chapter three revealed that University A and University B have distinct characteristics that separate them from other institutions of higher education. If the study was replicated at different types of colleges and universities, perhaps other factors would be discovered that attract mathematics and science teachers. Only then would the external validity increase to include all students in higher education.

3. In the methodology section of this study, it was noted that although the knowledge and attitudinal favorability increased significantly in the treatment groups, it was measured short-term. A follow-up survey could be administered to see how many of the research participants in the workshop and reading group actually did choose teaching as a career after the intervention in this study. Furthermore, if they did not choose teaching, perhaps a qualitative study could be designed to assess the reasons participants did not select teaching over a long-term period.

4. The study should also be replicated to account for the bias in this study, including, but not limited to, gender and undergraduate class level. Limitations noted that there was a surplus of females (compared to males) and freshmen and sophomores (compared to juniors and seniors) who participated in this study. While the researcher had no control over this, it could have biased the results found in this study. There was little variation in these variables. Hopefully, future replications
of this study will reveal less bias in gender and undergraduate class level to yield reliable results. Conceivably, a larger sample size would also help lower the bias, as more student participants would increase the possibility of a greater variety in gender and undergraduate class level. Because the sample differed from the population, the ability to generalize these findings to the larger population is constrained.

5. Likewise, if all students were recruited, including both “late majors” as well as “early majors in introductory courses”, the implications could be externally applied to all mathematics and science majors, not just early majors, which this sample seemed to target. Therefore, in future replications of this study, the researcher should aim the recruitment techniques to target the classes for majors other than the introductory courses. The number of mathematics and science majors in these classes that are upper classmen would conceivably be higher, considering they took the introductory courses for majors as lower classmen. However, the researcher notes this will be a challenge, considering that classes for mathematics and science majors after the introductory courses are quite small. Therefore, to recruit more students from these smaller classes might prove to be difficult.

6. If statistically significant results are reported from replications of this study, the findings should be communicated to the mathematics and science department chairs at institutions of higher education, so they are aware of the necessity of communication between schools of liberal arts and education about possible
alternative career choices for undergraduates within the mathematics and science fields.
References


New Jersey Department of Education. Internet Home Page. Retrieved February 13, 2004 from: www.state.nj.us/education/


Appendices
Appendix A

Letter Requesting Endorsement of Study
October 12, 2004

11 Baybury Court
East Hanover, NJ 07936

Dear Dr. [Name of professor/departmen chair here]:

Hello! My name is Caelyn Klembis and I am a doctoral student at Seton Hall University. I am currently working on my Dissertation study with Dr. Martin Finkelstein in the Department of Educational Leadership, Management and Policy in the College of Education and Human Resources. I know we have been in contact already, but this letter is a formal way to request permission to run my study with students in your program. I seek your help only with facilities, advertising and allowing students to participate in my study, which ideally will take place in the early spring semester of 2005.

Formally, my overall research question is: Would presenting information about the teaching profession to undergraduate math and science majors in the college of liberal arts prove to increase both their knowledge and their favorability toward a teaching career in the public school? I hypothesize that with the right intervention, liberal arts math and science majors will increase both their knowledge about and attitudinal favorability towards the teaching profession. I also hypothesize that a more interactive intervention, such as a workshop will prove to increase students’ attitudinal favorability toward teaching more so than a less interactive intervention, such as reading articles.

In this study, I will have three groups of research participants to assess whether or not an intervention that provides explicit and accurate knowledge about the teaching profession has a positive impact on increasing students’ knowledge and attitudinal favorability toward teaching. Those students that sign up to participate in the study will have an understanding that they will be randomly assigned to one of three groups. The first group involves students who will attend a workshop about the teaching profession and complete a survey immediately before and immediately after the workshop. The second group involves a reading intervention, in which students will read articles about the teaching profession and complete a survey both before and after reading the articles. The last research group will serve as a control group who will complete a survey at two distinct times, without receiving any intervention and their data will be used primarily to compare the two treatment groups against. The time it would take for students in the treatment groups to participate in my study would be 1 1/2 hours.

The survey includes a knowledge-based assessment as well as personal opinions on topics such as: math and science education; the future of America’s teachers; teacher comparisons to other career options in math and science; alternate routes to teaching; the shortage of math and science teachers and the No Child Left Behind Act; the salary of teachers; the benefits associated with teaching, including tenure, job security, and extra economic opportunities; the unemployment rate of individuals; the percent of individuals who switch majors and/or careers; and the economy and the global impact on the availability of jobs. The survey will be administered two times in each group; in the treatment groups, immediately before and after the intervention and in the control group, two different times with no intervention in-between. At the time of the first survey, students in all groups will also complete a career decision assessment, entitled “The Career Decision Scale”, which has been validated and replicated in many research studies. The only assistance I ask of you is to help me advertise for this important study through classes of students majoring in math and/or science in the school of liberal arts and distribute the flyer, which is enclosed, so students can sign up to participate. The workshop group will attend the workshop so all data collection and survey completion would be handled by myself. My other intervention of reading articles simply involves handing out the appropriate packet to students and the directions will be enclosed, after those students are assigned by myself. Those research participants in the control group will simply have to complete two surveys at different times. I appreciate your help immensely. I also will discuss any pre-requisites you need from me prior to running my study. As soon as it passes through the Institutional Review Board, I will have an exact date and time as to when I would like to do this. If that is convenient for you as well.

It is also imperative to mention that all student participation will be voluntary and only students that sign up will be permitted to participate in the study.

Student survey answers and responses will be strictly confidential with names appropriately coded in a numerical data system to ensure anonymity.
The research participants' data will be securely stored on a computer with a password to ensure the system as well as the document so that the researcher will be the only person to have access to that data. Again, students' names will be correlated to specific numbers to uphold strict confidentiality.

I believe that research has real and important implications for education. The No Child Left Behind Act will potentially make the shortage of math and science teachers worse. Therefore, it seems imperative to examine if exposing liberal arts math and science majors to the Act itself along with information surrounding the teaching profession is enough to recruit some of these undergraduates into the field of teaching, whether that be through traditional teacher preparation programs or alternate routes opportunities. Implications from this study could lead to more qualified teachers in math and science classrooms, which results in a higher quality of education for students, the major risk at stake here.

If you are interested or have any questions, please contact me at (973)819-1868 or e-mail me at klembeck@sne.edu. If you do not permit me to run this study, I ask that you please send me a letter of permission on your letterhead. I will need to show this letter to the Institutional Review Board for Human Subjects Research at Seton Hall University. My address is on this letter. Thank you kindly for your time and consideration.

Sincerely,

Carolyn Klembeck
(973) 819-1868
klembeck@shu.edu

Enc.: Flyer on Student Participation in Study
Appendix B

Letters of Permission to Conduct Study
Ms. Carolyn Klemballa  
11 Baybury Court  
East Hanover, NJ 07936  

Dear Ms. Klemballa:  

I am writing to inform you that the faculty in the Biology Department at University is willing to support your studies with the Biology students as described in your dissertation proposals entitled "The Effects of an Intervention to Increase Liberal Arts Math and Science Majors' Knowledge of and Attitudinal Favorability toward the Teaching Profession" as long as this is strictly, unequivocally voluntary and no penalty or disadvantage of any sort for students, explicitly or implicitly. We also understand your proposed studies are pending for approval from the Institutional Review Board for Human Subjects Research at University. As you indicated to me at the meeting on Tuesday, October 26, 2004, you expect to conduct your research during the Spring 2005 semester.  

Please contact the individual faculty in arranging the questionnaires with his/her students and keep me informed with your correspondences. The Department office agrees to assist your studies mentioned above primarily by aiding with advertising to recruit students.  

If you have any further need for verification of our agreement, please do not hesitate to contact me at 973 761 9043.  

Sincerely,  

[Signature]  
Suile L. Chang, Ph.D.  
Professor and Chair of Biology 

cc. the Biology Department files
October 19, 2004

Ms. Carolyn Klemballa
41 Baybury Court
East Hanover, NJ 07936

Dear Ms. Klemballa:

With this letter, let me provide you with formal permission from the Department of Physics at University to conduct certain studies as described in your proposals now pending with the Institutional Review Board for Human Subjects Research at Seton Hall University.

In particular, the Department agrees to assist your dissertation research primarily by aiding with advertising to recruit students. We expect this research to be conducted during the Spring 2005 semester.

if you have any further need for verification of our agreement, please do not hesitate to call.

Sincerely,

Parviz Ansari
Chair and Professor of Physics
October 13, 2024

Ms. Carolyn Klembala
11 Buxton Court
East Hanover NJ 07936

Dear Ms. Klembala:

With this letter, let me provide you formal permission from the Department of Chemistry & Biochemistry, hereafter referred to as the Department, to conduct certain studies as described in your proposal, as approving, as the Institutional Review Board for Human Subjects Research at Stevens Hall University.

In particular, the Department agrees to assist you in obtaining any necessary research permits and to provide any necessary resources. We expect the research to be conducted during spring 2023.

If you have any further need for verification of our agreement, please do not hesitate to call.

Sincerely,

Nicholas H. Snow, Ph.D.
Professor and Chair

G. Chemistry & Biochemistry Faculty
Dr. Maria S. Kleinman
Ms. Carolyn Klemmalla
11 Baybury Court
East Hanover, NJ 07936

Dear Ms. Klemmalla:

With this letter, let me provide you with formal permission from the Department of Mathematics at University to conduct certain studies as described in your proposals now pending with the Institutional Review Board for Human Subjects Research at Seton Hall University.

In particular, the Department agrees to assist your dissertation research primarily by aiding with advertising to recruit students. We expect this research to be conducted during the Spring 2005 semester.

If you have any further need for verification of our agreement, please do not hesitate to call.

Sincerely,

[Signature]

Bert G. Wachsmuth
Chair, Math/CS Department
October 6, 2004

Ms. Carolyn Klemballa
11 Raybury Court
East Hanover, New Jersey 07936

Dear Ms. Klemballa,

With this letter, let me provide you formal permission from the Department of Mathematics, hereafter described as the department, to conduct certain studies as described in your proposal now pending with the Institutional Review Board for Human Subjects Research at the department.

In particular, this Department agrees to assist your Ph.D. dissertation research primarily by aiding with advertising to social students, providing a reasonable level of access to paper supplies and use of the Department copier, and by coordinating physical space in which to conduct interviews. We expect this research to be conducted during Spring, 2005.

If you have any further need for verification of our agreement, please do not hesitate to call.

Regards,

[Signature]

Gerald E. Krouse, Chairman
Department of Mathematics
Ms. Carolyn Klemballa  
11 Baybury Court  
East Hanover, NJ 07936  

December 3, 2004  

Dear Ms. Klemballa:  

Thank you for your inquiry about possible research collaborations with us here at  
I am eager to assist you with your dissertation project. With this letter, let me  
provide you with formal permission from the Environmental Studies Program to  
conduct certain studies as described in your proposals now pending with the  

In particular, the Program agrees to assist your dissertation research primarily by aiding  
with advertising to recruit students. We expect this research to be conducted during the  
Spring 2005 semester.  

If you have any further need for verification of our agreement, please do not hesitate to  
call.  

Sincerely,  

Eric Strauss  

Dr. Eric G. Strauss, Director of Environmental Studies
Appendix C

Student Recruitment Letter
A Study about the Future of Quality Math and Science Education and Teachers in America’s Math and Science Classrooms

Dear Student,

Hello! My name is Carolyn Klemballa and I am a doctorate student at Seton Hall University. I am currently working on my Dissertation study with Dr. Martin Finkelstein in the Department of Educational Leadership, Management and Policy in the College of Education and Human Resources. I am conducting research on the future of math and science Education for students as well as the future of math and science teachers in America’s classrooms. I believe that research has real and important implications for the future, especially a future in which math and science education for America’s students is declining each year. With your help and willingness to give up approximately 1½ hours of your time, my research will hopefully yield possible solutions to help reverse the decrease of quality math and science education for students in math and science classrooms across the country. With your signature on the sign-up registration form, you are indicating that you are willing to be a part of my study in one of three groups, which you will be assigned to. All include the same time allocation.

In this study, I will need the assistance of many research participants who are majoring or intending on majoring in math and/or science in the school of liberal arts (Arts and Sciences). If you would be so gracious as to sign up to help me with this research endeavor, I would be most appreciative. When you do sign up to be a participant, please note that you will then be randomly assigned to one of three groups. The first group involves students who will attend a workshop about the teaching profession and complete a survey immediately before and immediately after the workshop. The second group involves a reading intervention, in which students will read articles about the teaching profession and complete a survey both before and after reading the articles. The last research group will complete a survey at two distinct times. It is imperative to note that the group assignment will be random. The survey includes a knowledge-based assessment as well as personal opinions on topics such as: math and science education; the future of America’s teachers; teacher comparisons to other career options in math and science; alternate routes to teaching; the shortage of math and science teachers and the No Child Left Behind Act; the salary of teachers; the benefits associated with teaching, including tenure, job security, and extra economic opportunities; the unemployment rate of individuals; the percent of individuals who switch majors and/or careers; and the economy and the global impact on the availability of jobs. At the time of the first survey, students in all groups will complete a career decision assessment as well entitled “The Career Decision Scale”.

It is also imperative to mention that all student participation will be voluntary and only students that sign up will be permitted to participate in the study.

Student survey answers and responses will be strictly confidential with names appropriately coded to a numerical data system to ensure anonymity.

The research participants’ data will be securely stored on a computer with a password to enter the system as well as the document so that the researcher will be the only person to have access to that data. Again, students’ names will be correlated to specific numbers to uphold strict confidentiality.

Your participation and assistance is vital to the success of my study and I would greatly appreciate your help! Please note that all responses from participation will be held in strict confidence. If you would like to help me in this pursuit of research and potential implications for students, please consult the website (from your professor) where you can sign up for this study and I will be in contact with you. I thank you in advance for your help and participation.

Thank you,

Carolyn Klemballa
Appendix D

PowerPoint Presentation for Workshop Group
Have You Considered a Career in Teaching?

Carolyn Klenhalla
Dental Student
State Farm University
Spring 2005

Welcome
Thank you for coming today.

Current and projected shortages of qualified teachers in math and science: national overview

There remain a critical need for teachers in the area of math and science in America's schools.

Current and projected shortages of qualified teachers in math and science: national overview

Current and projected shortages of qualified teachers in math and science: historical and current shortages

Schools now have to hire many more math and science teachers a year for the next decade in order to handle a growing student population and maintain effective math and science instruction (National, 2004)

As you can see, fewer teacher education majors are specializing in math and science. The need is growing for certified and qualified math and science teachers!
Increasing Student Enrollment

Student enrollment is increasing!

The societal costs of a shortage of "qualified" teachers

The answer is NO!
Those teachers in math and science classrooms are not qualified to teach those subjects. They are simply assigned to teach because of high student enrollment!
Consequences of the Projected Shortage of "Qualified" Math and Science teachers

Teacher quality in math and science classrooms

Student interest in math and science

Consequences of the Projected Shortage of "Qualified" Math and Science teachers

Student Performance in math and science

Time in years (360 to present)

= other countries

= U.S.

Economic and other benefits of a teaching career

Economic and other benefits of a teaching career: preconceived notion

Today, many math and science majors say that they are not entering teaching because of low salaries compared to non-educational employment (accounting, engineering, computer careers). Here is a true preconceived notion:

It's all relative...

The Human Capital Costs of a Shortage of Qualified Math and Science Teachers

Specifically, according to NCES, in 2000, 56% of math students and 46% of science students in grade K-12 were being taught by teachers who did not major in math and/or science. Many teachers are "emergency" teachers - not qualified to teach these subjects. (Urban districts have less than 50% of certified teachers in math classrooms) (Sautter, 2002).

Teacher training

Economic and other benefits of a teaching career

Economic + all other benefits of a teaching career: comparisons to other majors

<table>
<thead>
<tr>
<th>Major</th>
<th>130,000 Times the Value of the Degree</th>
<th>130,000 USD</th>
<th>130,000 GBP</th>
<th>130,000 SEK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering and computer sciences (Electrical, Computer, Computer engineering)</td>
<td>28,000</td>
<td>138,364</td>
<td>209,979</td>
<td>208,852</td>
</tr>
<tr>
<td>Engineering and computer sciences (Chemical, Mechanical, Civil, Materials)</td>
<td>25,000</td>
<td>130,060</td>
<td>205,700</td>
<td>208,621</td>
</tr>
<tr>
<td>Business and Management (Accounting, Marketing, Finance, Economics)</td>
<td>25,000</td>
<td>130,060</td>
<td>205,700</td>
<td>208,621</td>
</tr>
<tr>
<td>Business and Management (Law)</td>
<td>36,000</td>
<td>137,700</td>
<td>209,979</td>
<td>208,852</td>
</tr>
<tr>
<td>Business and Management (Economics)</td>
<td>30,000</td>
<td>130,060</td>
<td>205,700</td>
<td>208,621</td>
</tr>
</tbody>
</table>

Note: All figures have been increasing in value due to the same rate. Add in the teaching benefits of job security and income.

Economic and other benefits of a teaching career: comparisons to other majors

<table>
<thead>
<tr>
<th>Major</th>
<th>Economic Benefits</th>
<th>Other Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>$26,780</td>
<td>$28,240</td>
</tr>
<tr>
<td>Biology</td>
<td>$27,240</td>
<td>$28,240</td>
</tr>
<tr>
<td>Chemistry</td>
<td>$28,913</td>
<td>$30,124</td>
</tr>
<tr>
<td>Computer Science</td>
<td>$36,224</td>
<td>$37,564</td>
</tr>
<tr>
<td>Computer Science and Information Science</td>
<td>$48,425</td>
<td></td>
</tr>
</tbody>
</table>

Source: PayScale (2009)

Economic and other benefits of a teaching career: Case Study

Cranbrook McKnight College’s Buse Institute

Economic and other benefits of a teaching career: Case Study

Cranbrook McKnight College’s Buse Institute

Economic and other benefits of a teaching career: fringe benefits

Fringe Benefit #1

- **In public schools, the median number of school days is 180 per year.**
- Add 10 more to the numbers above for principal teachers, professional development, and planning, and the usual work days for teachers is still shorter than 180 days.

Fringe Benefit #2

- **In many professions, it is very difficult to make scheduled time off for a sick child or other family member.**
- However, in teaching, the "substitute teacher" solution is a natural part of school life. Indeed, in classrooms, teaching assistants are frequently expected to replace sick teachers. According to research by D. Department of Education, American school teachers work about 100 days a year, with 30 of those days being substitute teaching days.

Source: PayScale (2009)

Economic and other benefits of a teaching career: fringe benefits

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Source: PayScale (2009)
Economic and other benefits of a teaching career: fringe benefits

- Higher Benefits:

  **The teacher's role** and work site provide teaching an attractive alternative to those who wish to balance work and family needs. The teacher's role involves significant leisure time, often with the teaching day finishing early, which helps in appreciating the value of leisure. Teachers can enjoy longer vacations, flexible work schedules, and other benefits such as health insurance and retirement plans. In short, when the kids are in school, it’s more of a job. Teaching in the family community is in the area that helps to give the role of teachers a protected form of professional job performance. 2 teachers can have further employer-employee relationships, but each teacher retains and has a sense of employment. (Pedrini, 2001)

Economic and other benefits of a teaching career: more incentives

- Many research suggestions suggest that the following incentives would enhance both teacher and student job satisfaction:
  - Income-related benefits
  - Benefits in an enjoyable environment
  - Improved work opportunities
  - Growth of the Union
  - Increased salary and benefits in some areas

Do these lead you to give a career in teaching a second look?

Economic and other benefits of a teaching career: salary incentives

- In this line of work, many people have succeeded when comparing when comparing what teaching may be a 3 to 4-year job. Changes in teachers' benefits (such as job security, access to 2-year college, and 2-week vacation) can make changes in ways in which additional incentives...

Economic and other benefits of a teaching career: Case Study: Kinsale, NJ - Salary Guide

- Case Study: Kinsale, NJ - Salary Guide

  - Grade Level: 10-12
  - Type: Full-Time
  - School: Kinsale High School
  - Salary: $50,000 - $100,000
  - Benefits: Health insurance, retirement plans, vacation days, sick leave, paid holidays, professional development

  - Note: This is an example of a salary guide. Every year, the amount can be increased.

Economic and other benefits of a teaching career: Additional Income Opportunities

- Additional Income Opportunities

  - Income from substitute work
  - Income from tutoring
  - Income from consulting
  - Income from writing
  - Income from research
  - Income from presenting

  - Look at the potential economic opportunities teaching has to offer!

  - Note: Income from substitute work is actual income from substitute work.

Economic and other benefits of a teaching career: Why teach?

- Reporting, Teaching, and Coaching: 2 in 1992

  - Section of the teacher's pay
  - Individual's pay
  - Team's pay
  - Total pay
  - Additional pay
  - Total additional pay
  - Total income

  - Source: NAE (1992-93)
Adding a further
wrinkle:
*The No Child Left Behind Act*

= A Law signed by Congress that went into effect in the 2005-2006 school year.
= Requires that all teachers pursue adequate subject certification.
= Compelled states/cities to create standards deemed appropriate by the states/cities to decide how to measure teachers' performance.


Adding a further (new) wrinkle:
*The No Child Left Behind Act*

= A shortage of math and science teachers + No Child Left Behind Act = Plenty of jobs for math and science-trained professionals.


The current restructuring of the American workforce

Economic and other benefits of a teaching career: better communication about career opportunities

What if there was a better connection and awareness between Schools of Education and Liberal Arts? Why if you knew about teaching being Liberal Arts major? Would that communication make a difference? Research suggests it will. (Wilson, 1999)

Economic and other benefits of a teaching career: the main obstacle besides salary

Most teachers spend in college 4-5 years and in the classroom the first year. You do not have to be good (Wilson, 1999, Mann, 2005).

Could teaching be an option for you?
The current restructuring of the American workforce: US vs. other countries

The United States has the most unstable, flexible and fast-changing labor market. (Economist, 2006; U.S. Department of Labor, 2004)

The current restructuring of the American workforce: Unemployment

In the US, over the past two years, 360,000 people have been filing from unemployment. (Economist, 2004) In November of 2006, the unemployment rate was 5.5%. This compared to the people who are out of work. This had been steady for 6 months. In 2006, the number of workers was half of the number, unemployed, in 1981, 360,000, or 7.8 million. These 10 million workers represented 20% of total employment in November 2006. In the US, simple 4% of economic growth, layoffs over the past two years have been wide-spread and even.

The current restructuring of the American workforce: downsizing companies

They are everywhere. Companies downsize because of economic uncertainty. In the American worker (125 million people) are subject to workforce restructuring. (Economist, 2006)

The current restructuring of the American workforce: disappearing careers

Is the sense of a single, lifelong "career" disappearing? In America? In some quarters, including political and corporate, job hopping is normal. But in the US, it is becoming increasingly rare.

The current restructuring of the American workforce: job tenure

According to the Employment and Training Report, average tenure of a job is 3 years. (Economist, 2006)

Right now, the average employed tenure at one job for workers age 25-34 is 2.2 years.

The current restructuring of the American workforce: average age of jobs

According to the Employment and Training Report, average age of a job is 34 years. (Economist, 2006)
The current restructuring of the American workforce: The U.S. Census Speaks

Does this scare you? How would you feel as a teacher with the benefit of secure in an unstable economy and world?

How would you feel with summers off to conduct research, hold another passion or career?

How would you feel with a set salary, but with a multitude of opportunities for extra income?

Thank you for attending my workshop!

Carolyn Klembalia
Doctoral Student
Seton Hall University
Spring 2005

References


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Appendix E

Article #1 for Reading Group: Mervis (2000)
Universities train most of the nation's science and math teachers. But it's the job of local school districts to ensure that they keep up with their field once they enter the classroom. That bifurcated system needs to be ended, says a new report from the National Research Council (NRC), if the country hopes to improve student performance in math and science. That message is likely to be repeated next month, sources say, when a high-profile commission issues its recommendations on how to improve the quality of the nation's math and science teachers—and puts a price tag on the reforms.

"Universities have to attract students to their education departments, but after they graduate and find jobs as teachers they are no longer a client of the university," says panel member Mark Saul, a teacher at Bronxville High School outside New York City and an adjunct professor of mathematics at City College of New York. "And school administrators have to deal with so many noneducational crises that they're happy if the kids are in their seats and there's a licensed teacher in each room. As a result, attention to the actual act of instruction gets lost."

The NRC panel says that the best way to improve teacher education is to make it a continuum, with school districts taking more responsibility for the initial preparation of new teachers and university faculty playing a bigger role in ongoing professional development. The change will require both sectors ... (universities and school districts) to work together more closely. It also recommends that universities improve the content of undergraduate science and math courses for prospective teachers, model appropriate practices for teaching those subjects, and do more research on the art of teaching and how students learn. In turn, school districts should make better use of teachers who have mastered these skills, giving them more opportunities to share their knowledge with their colleagues and with student teachers.

Such a partnership already exists in Maryland, notes panelist Martin Joinson, a professor of mathematics education at the University of Maryland, College Park, in the form of four Professional Development Schools (PDSs). PDSs bring together prospective teachers and experienced staff in a formal arrangement that goes beyond both regular student teaching and standard after-school workshops. "In the past, we would send students to a school and they'd be assigned to one teacher," says Johnson. "We're asking the school to incorporate the student teacher into a broader range of experiences, with input from other faculty members as well as other teachers."...
The National Science Foundation has already begun to support the types of partnerships the NRC panel calls for. It has asked for $20 million next year to expand a program on university-based Centers for Learning and Teaching with teacher training as one of three primary foci.

The NRC report also dovetails with the pending recommendations of a blue-ribbon federal commission headed by former U.S. senator and astronaut John Glenn. "I was struck by the amount of overlap," says Linda Rosen, executive secretary to the commission. "There's a growing sense that we have to break down the barriers between elementary and secondary schools and higher education and bring all the available talent to bear on the problem of math and science teacher education." . . .

Although Lewis welcomes the heightened attention on teacher education, he says that reports won't help unless they are backed up by a national consensus that teachers count...

... Persuaded to Teach?

U.S. schools will need to hire 20,000 math and science teachers a year for the next decade to handle a growing student population and high rates of retirement, according to government estimates. Where they will come from is anyone's guess, as schools are already having trouble finding qualified people. To help fill the gap, a National Research Council (NRC) committee suggests tapping a talent pool that is relatively underrepresented among teachers: newly minted Ph.D.s.

In a report issued last week, the committee says many more recent science Ph.D.s would be willing to teach high school science and math if the government helped with the transition, if the certification process were compressed, and if they could retain ties to research. The committee recommends that the NRC help states with pilot projects that, if successful, could be expanded nationwide. But some educators are skeptical, noting that Ph.D.s may not be properly trained and that the research and teaching cultures are very different.

"If public schools could place an ad that read: 'Good salaries, good working conditions, summers off, and tenure after 3 years,' I think they'd get a good response from graduate students," says Ronald Morris, a professor of pharmacology at the University of Medicine and Dentistry of New Jersey in Piscataway and chair of the NRC panel, which last summer surveyed 2000 graduate students... as well as interviewing professional educators. "But most Ph.D.s don't know about the opportunities, because they are generally far removed from the world of K-12 education."

The report notes that while 36% of respondents say they had considered a K-12 teaching job at some point in their training, only 0.8% of the scientific Ph.D. workforce is actually working in the schools. "That's a significant pool of talent that we're ignoring," says Morris, who acknowledges that none of his 40 postdocs over the years has chosen to go into high school teaching. . . . Morris agrees that high school teaching isn't appropriate for all Ph.D.s. But he believes that an array of incentives, including federally funded fellowships for retraining and summer research projects, might be just the ticket for those looking for a way out of a tight academic job market.
Appendix F

Article #2 for Reading Group – Sausnet (2002)
Less than a month before school was due to start this year, Edward MacKniak, assistant superintendent of personnel and administration in Hamden, Conn., still had to find four high school science teachers and a high school math teacher. His district had explored all of the usual means of finding qualified teachers. No luck. Eventually MacKniak turned to an Internet hiring site to try to fill the vacancies. If none could be found that way, MacKniak would seek special temporary certification from Connecticut’s department of education to allow otherwise unqualified applicants to take the jobs. The temporary licenses are called durational shortage permits, and unfortunately, they’re a way of life when it comes to filling science and math jobs in his state. This is true (in 2002) even though Connecticut pays its teachers well above the national average salary ($61,918 vs. $46,728).

“The people just aren’t there, we can’t find the candidates,” MacKniak says. “It’s a product of the number of vacancies, and I see an upward trend in the sciences.” The chronic shortage produces two kinds of alarming statistics: First, the National Research Council reports that U.S. students continue to perform among the worst of all industrialized countries when it comes to math and science; 82 percent of all 12th graders are not proficient in science and 72 percent of all eighth graders are not proficient in math. Second, the National Center of Education Statistics found in school year 1999-2000, that 26 percent of math students and 16 percent of science students in grades K-12 were being taught by teachers who had neither a major or minor in the subject they were teaching.

Districts bemoaning the shortage now can confidently anticipate that it’ll soon get worse. NCES statistics say as many as 2.7 million new teachers will be needed by 2008. And this figure doesn’t take into account some of the more revolutionary aspects of the No Child Left Behind Act. The law promises to dramatically improve the quality of education in the U.S., but the responsibility for meeting that goal trickles down to each school district, its superintendent, board of education, and teachers. Of course, every political faction and interest group has its own take on how districts can truly ensure that no child is left behind given K-12’s economic realities.

The idea that there aren’t enough qualified math and science teachers has been an accepted fact for some time. It was reinforced in 2000 with a report from the National Commission on Mathematics and Science Teaching for the 21st Century, chaired by former Senator John Glenn. The report found that two of every three teachers would be retiring in the next decade.

This ever-present shortage doesn’t mean kids are cutting back on taking science and math classes, though. “There definitely is a crisis in the supply of high-qualified
science teachers," says Gerard Wheeler, executive director of the National Science Teachers Association. "That said, there's no doubt in my mind that there will always be some warm body in front of the kids." That warm body is often a teacher who's certified, and well qualified, to teach something else. Assigning teachers out of their fields has been the predominant way that many districts have coped with the shortage of math and science teachers. "In some urban district sit sounds like the percentage of certified math teachers is less than 50 percent, which is really scary," says Robert Reys, professor of mathematics education at the University of Missouri. The practice of assigning teachers out of field for one or two classes each day, like the larger problem of the chronic shortage, is one that is largely hidden from students and parents.

The practice of filing holes in a master schedule with out-of-field placements will theoretically come to a halt at the beginning of the 2005 school year when the "highly qualified" provisions of NCLB go into effect. Summed up, the law requires that teachers in core academic areas, including math, science, English, history, foreign language and arts, not only have a four-year degree, but are also certified by their state as having demonstrated competence in the subjects they are teaching. ... While setting up the nationwide requirement for highly qualified teachers, NCLB leave much of the definition of the term to the states. ... The idea is to open the pipeline. To begin introducing younger generations to teaching as one possible career choice.
Appendix G

Article #3 for Reading Group – Economist (2002)
Many still question claims that the patterns of working life are changing. But in the United States anecdotal signs are increasing: more frequent job changes, more freelancing, more working at home, more opportunity but also more uncertainty. The old social contract between employers and workers is being shredded. It is still unclear what will replace it.

In a slightly shabby classroom in Manhattan, a young man in a neat blue suit introduces himself to the group as Walter—and then sets about describing the lessons from his job search. "Be prepared, know your story, and network, network, network." That was the way that Walter jumped from a job in the construction industry in Canada to one in human resources in New York; and, if the current job does not work out, that will be the way that he will jump to his next job. The network will be ready, his "brand" established. The teacher repeats the message: start preparing now for the job after the one that you are looking for at the moment, because "you are going to be doing this again" . . .

Many. . . particularly in Europe, believe that the same forces—technology, globalization, the shift towards services—are leaving workers to the mercy of a new and ruthless variety of capitalism. In a new book, "Sharing the Wealth", Ethan Kapstein of the University of Minnesota argues that governments are now playing a game of "beggar-thy-labour" which will stir up a social backlash against globalization.

In continental Europe unemployment stands at 10% and more people are being forced to accept part-time work. In Japan, according to the Asahi daily newspaper, the number of businessmen diagnosed as clinically depressed has risen rapidly. Sararimies cower into their shrinks on Saturdays and Sundays because the more frightening meetings happen on Mondays. In the United States, critics point out that, despite eight years of economic growth, lay-offs over the past two years have been more widespread than ever. Meanwhile, median wages for male workers are still lower in real terms than they were in the 1970s.

What on earth is happening? The broad answer is that it depends on where you live and what you do. The "insecurity" that is suddenly so frightening to a sarariman in Tokyo has long been normal for a construction worker in Dallas (and not that odd for a construction worker in Tokyo either). There are also different costs: an unemployed worker in Germany receives benefits many American workers can only dream about. On the other hand, most arguments about "the end of the career" usually end up focusing on the world's biggest, most flexible, unstable, and fastest-changing labor market—the United States.
Some pour cold water on the whole idea that the traditional American career is disappearing. David Neumark, an economist at Michigan State University, points to plenty of professions—teachers, doctors, even labour economists—in which job-hopping remains rare, and to plenty of others, such as the building trade, in which job-hopping has been the norm for generations. The basic measure of job stability is how long people have been in their current job. In 1993 the median figure was 3.6 years, a shade higher than in 1983. The figures for other countries show no great changes either.

And yet the American figures are distorted by two phenomena: the ageing of the baby-boomer generation, born between 1946-64, who account for 47% of the workforce and have now reached an age when most of them do not want to move; and the increase in mothers returning to permanent jobs.

Some parts of the workforce display unmistakable signs of change. Job tenure for men aged 35 and over has decreased since 1983. And the average 32-year-old in America has already worked for nine different firms. There has also been a sharp increase in job insecurity. Most polls show that Americans—particularly older male workers with long tenure—are more frightened than ever of losing their jobs.

Most important of all, there are solid reasons why careers should change, probably at an increasing rate. Ken Goldstein, an economist at the Conference Board, a business-research group, points to the switch of jobs from big manufacturing firms to small, service ones. Companies with fewer than 100 workers account for half the American workforce and are responsible for two out of three new jobs. Even the biggest manufacturers, such as General Electric, try to act "small" by organizing their operations into a network of autonomous units.

This means that the old model of a career, in which an employee worked his way up the ladder in a single company, is becoming rarer. Small service firms seldom have more than three layers; and even big companies, which still possess more of a hierarchy, tend to promote people in jumps. There is also a much higher chance of being ousted. Although the United States has been creating more than 100,000 net new jobs a month, it is also true that over the past two years some 300,000 people have been filing first-time claims for unemployment each week, indicating that many must endure the stressful experience of losing their jobs before finding another one. About one in ten American workers, or 12.5 million people, are either independent contractors or on some sort of temporary contract. Around 10 million people work outside their corporate office at least three days a month (double the proportion in 1993).

... So careers may not be "over", but they are becoming a bit more flexible, and are likely to become ever more so. Is this revolution welcome? Optimists claim that a flexible workforce is basically a happier workforce. One recent survey of work trends by researchers at Rutgers University and the University of Connecticut found that 91% of Americans said that they liked their jobs ...

But there are worries. To begin with, there is overwork. On average, Americans work 1,957 hours a year, more than those in other rich countries. According to the Economic Policy Institute, a think-tank, the average middle-income married couple with children now works a
combined 3,335 hours a year, eight work-weeks more than in 1979. Much of this increase has come from middle-class mothers going to work instead of staying at home.

Cell-phones and beepers act like electronic leashes, keeping people perpetually tied to their job. One study by the Families and Work Institute, a New York-based charity, showed that about 75% of college-educated 25-32-year-olds in Manhattan work more than 40 hours a week; in 1977 only 55% did. . .

Many people want their lives to have some predictability. But the fashion for flattening hierarchies makes it more difficult to plan their careers. A few make spectacular leaps. Most stay at the same level for years, insecure and frustrated. . .

The full benefits and losses of more flexible, insecure careers will become evident only when the American economy slows down. But for most, the lesson is stark: educate yourself, and then re-educate yourself. . . The need for continual re-education extends even into the later stages of most working lives. Few can any longer afford to rest on their laurels, or to rely on experience which rapidly becomes obsolete because of technological change . . . Some American employers are offering an implicit (and sometimes explicit) deal to their employees: accept that we may have to sack you and, in exchange, we will make sure that you have the marketable skills needed to find another job.

But many firms and workers still find this idea unsettling. Establishing a new understanding between the two looks like being one of the great social, political and economic challenges of the next few decades. Until that happens, like most other workers, high or low, you are on your own. It may be time to start building your "brand" and getting out there to network, network, network.
Appendix H

Article #4 for Reading Group – Watson (1999)
Secretary of Education Richard W. Riley has warned that in the next decade, our public schools will need to hire 2.2 million teachers, to keep pace with rising enrollments and to replace a generation of teachers who are about to retire. Preparing the teachers is the greatest current challenge and responsibility of higher education, and the need for improved education of teachers is particularly acute in science and mathematics. Various reports, among them the Third International Mathematics and Science Study of 1996, have indicated that many teachers of science and mathematics in elementary and secondary schools are not well trained in those subjects.

Our need for teachers with sound undergraduate training in science and mathematics may be fortuitous though; it provides a great opportunity for colleges with nearly empty science departments to fill their upper-division courses with students who plan to become teachers. Addressing this new audience could rejuvenate many departments, perform a much-needed national service, and—as an added bonus—quite possibly recruit more students to major in the sciences.

The solutions to the problems facing science education are far from simple, but several points are clear. What is not needed are individual science departments approaching this issue independently from other science departments and from colleges of education. What is not needed are departmental curricula designed only for students expected to become scientists. What is not needed are faculty members who disparage careers in teaching, and who discourage their better students from moving in any direction other than toward a doctorate.

What we do need are drastic reforms. We need departments within colleges of arts and sciences willing to collaborate with each other and with colleges of education to prepare interdisciplinary curricula that will give future teachers both a sound background in science and math, and training in how to teach this material in elementary and secondary schools. We also need departments willing to completely rethink their curricula for other students who will not be majoring in science or moving toward a doctoral degree. And we need faculty members willing to add group-learning and other pedagogical approaches to the lecture format.

The National Science Foundation has supported some major reform projects to bring together faculty members from scientific disciplines and colleges of education to produce multidisciplinary curricula or new tools for beginning teachers. The faculty members in these projects come from a wide range of institutions, including research...
universities and community colleges. The courses that they have produced make extensive
use of interactive materials and data, letting students make discoveries based on their own
inquires rather than simply replicating experiments in a "cookbook" fashion.

Collaborative efforts involving faculty members in colleges of education and in
colleges of arts and sciences can insure that students learn how to teach an academic
subject at the same time that they learn its content.

More science departments and colleges of education must agree to work together to prepare
teachers. Unfortunately, relations between these two groups, when they are not simply
oblivious to each other, typically feature more conflict than collaboration. Administrators
should reward the collaboration that already exists between individual faculty
members in schools of education and in the sciences, and provide incentives for
deans and department heads to encourage such collaborations among their faculties.

Some institutions have taken the first steps. In addition to the N.S.F. projects mentioned
above, the colleges of engineering at New Mexico State University and the University of New
Mexico are developing a new course for future teachers that shows them how to instruct
students about electricity, for example, using the chemistry of the battery, as well as the
environmental and economic issues associated with electrical energy. And Arizona State
University has created a post-baccalaureate program for science and mathematics majors
who want to teach their subjects in middle schools.

Although these projects are only a beginning, they demonstrate that creative solutions to
the complex problems of preparing people to teach science in our public schools are
possible, and that higher education can help put bright, well-prepared, and well-
equipped teachers in every science classroom - not just teachers who passed a science
course or two during their college years.
Appendix I

Informed Consent Form for Study
RESEARCHER INFORMATION

My name is Carolyn Kembalis and I am a doctoral student at Seton Hall University. I am currently working on my Dissertation study in the Department of Educational Leadership, Management and Policy in the College of Education and Human Resources. I am writing to ask for your permission to take part in my study.

EXPLANATION OF THE PURPOSE OF THE RESEARCH AND EXPECTED DURATION OF STUDENT PARTICIPATION

I am conducting research on the future of math and science education for students as well as the future of math and science teachers in America’s classrooms. I believe that research has real and important implications for the future, especially a future in which math and science education for America’s students is declining each year. With your help and willingness to give up approximately 1 1/2 hours of your time, my research will hopefully yield possible solutions to help the future of math and science education for all students.

EXPLANATION OF PROCEDURES

In this study, I will need the assistance of many research participants who are majoring or intending to major in math and/or science in the school of liberal arts (Arts and Sciences). When you signed up to be a part of this study, it was with the understanding that you would be randomly assigned to one of three groups. The first group involves students who will attend a workshop about the teaching profession and complete a survey immediately before and immediately after the workshop. The second group involves a reading intervention, in which students will read articles about the teaching profession and complete a survey both before and after reading the articles. The last research group will complete a survey at two different times. It is imperative to note that the group assignment will be random. The time it would take for students to participate is approximately 1 1/2 hours.

EXPLANATION OF SURVEY INSTRUMENT AND CAREER DECISION ASSESSMENT

The survey includes a knowledge-based assessment as well as personal opinions on topics such as: math and science education; the future of America’s teachers; teacher comparisons to other career options in math and science; alternate routes to teaching; the shortage of math and science teachers and the No Child Left Behind Act; the salary of teachers; the benefits associated with teaching, including tenure, job security, and extra economic opportunities; the unemployment rate of individuals; the percent of individuals who switch majors; and/or careers; and the economic and the global impact on the availability of jobs. The survey will be administered two times in the workshop group and the reading group, before and after the intervention and in the survey group, two different times within a three week period. At the time of the first survey, students in all groups will complete a career decision assessment, entitled “The Career Decision Scale”, which assesses how “certain” students are in their career/major choice. A sample of a question would be: “Teaching is a desirable profession, especially considering the current unemployment rate,” in which students would rate their opinion on a likert scale (1 = strongly disagree, 5 = strongly agree, etc.)
PARTICIPATION IS VOLUNTARY

It is imperative to mention that all student participation will be voluntary and only students that sign up will be permitted to participate in the study. It is not mandatory that students participate, but the researcher is extremely grateful to any student who chooses to participate. If at any point the student feels uncomfortable or for any reason chooses to stop participating, no negative consequences will occur. Refusal to participate or discontinuing participation at any time during the study will involve no penalty for the student.

ANONYMITY AND PROTECTING A PARTICIPANT’S IDENTITY

Student survey answers and responses will be strictly confidential with names appropriately coded to a numerical data system to ensure anonymity.

DATA AND CONFIDENTIALITY

The research participants’ data will be securely stored on a computer with a password to enter the system as well as the document so that the researcher will be the only person to have access to that data. The computer will be in a locked cabinet in a locked room. Again, students’ names will be correlated to specific numbers to uphold strictest confidentiality.

ACCESS TO DATA AND CONFIDENTIALITY

All records will be kept confidential as noted above and the data will be stored in a locked cabinet in a locked room with a password to enter the system and specific document containing the data. Only the researcher will have access to the data.

RISKS TO SUBJECTS

The researcher anticipates no negative consequences for a research participant’s choice to participate or not participate in the study. The researcher anticipates no risks to research participants at all.

BENEFITS FOR PARTICIPATING

Students who participate will receive the benefit of participating in a study, potentially identifying factors which may increase the pool of math and science teachers. Implications from such research could reverse the declining pool of math and science teachers.

ALTERNATIVE PROCEDURES

The researcher has given the research participant the choice to participate in the study, with the understanding that he/she would randomly be assigned to one of the three groups described above. If the research participant chooses not to participate in one of these three options, there is no other alternative and the research participant can choose to not participate in the study at all, which will result in no penalty or negative consequences for that student.
CONTACT INFORMATION

If the research participant has questions regarding this study, he/she can contact the researcher and/or her mentor by calling Seton Hall University Higher Education Department at (973) 761-5997. The student may leave a message for either the researcher, Carolyn Klemaska or her mentor, Dr. Martin Finkelstein, who will then get back to the student as soon as possible to answer any question or send the results of the study accordingly upon its completion.

INFORMED CONSENT FORM

Student research participants will be given a copy of this signed and dated Informed Consent Form to keep for their records.

I have read the material above, and any questions I asked have been answered to my satisfaction.

_________________________________________  ___________________________
Subject or Authorized Representative         Date

Please sign and date both consent forms (above). Return one to the researcher or professor and keep one for your records. Thank you.
Appendix J

Survey Instrument Used in this Study
Part I: Please answer the following questions by writing the correct letter/answer on the line preceding each statement.

1. In recent research, students reported which of the following government interventions would make them consider teaching more?
   a. if the certification process were more compressed and fast
   b. help with the career transition
   c. federally funded fellowships for research
   d. all of the above

2. In research, all of the following are contributing to people's decisions to become certified teachers through alternative routes, other than traditional teacher preparation programs, except:
   a. tenure and job stability
   b. easier requirements for certification
   c. increase of mothers going back to work
   d. strong communication between schools of liberal arts and education to promote teaching to all majors

3. Specific National Science Foundation programs, which are directed towards recruiting math and science teachers, promote alternative routes to teaching by:
   a. focusing on content first and then "how to teach" pedagogy, after content is mastered
   b. focusing on "how to teach" pedagogy first and then content, after pedagogy is mastered
   c. focusing on both "how to teach" pedagogy and content simultaneously
   d. focusing solely on "how to teach" pedagogy, since content mastery is assumed.

4. In research, it is denoted that graduate students do not enter the teaching profession in high rates because of the following reason:
   a. lack of knowledge about teaching opportunities and benefits (tenure, job security, hours, etc.) because they are so far removed from the world of K-12 education
   b. lack of collaboration and communication between schools of liberal arts and schools of education regarding the benefits of teaching
   c. low teaching salaries compared to other career options
   d. all of the above

5. In research, which of the following statements is not true regarding math and science education in America's schools?
   a. Math and science courses are primary subjects in America's classrooms.
   b. There remains a shortage of qualified math and science teachers in America's schools
   c. Student interest in math and science is declining in America's schools.
   d. There is an impending law in the US Congress that will create an even greater shortage of math and science teachers.
6. How many math and science teachers will US schools need to hire per year for the next decade to handle a growing student population and higher rates of retirement for teachers?
   a. 5,000
   b. 10,000
   c. 20,000
   d. 50,000

7. How does the United States fair in comparison to other countries in math and science test scores and grades?
   a. The US scores higher and more favorably than most industrialized countries.
   b. The US scores considerably lower than most industrialized countries.
   c. The US scores about the same as other industrialized countries.
   d. There is no trend with the US scores compared to other industrialized countries.

8. Which of the following is the reason that The “No Child Left Behind Act” will drastically worsen the shortage of math and science teachers?
   a. teachers in math and science will receive a drastic salary cut
   b. teachers who are uncertified will be able to stay in their jobs, but have to be mentored and will receive a much lower salary than their certified colleagues.
   c. math and science teachers will be forced into English and other humanities classrooms because that is where the United States scores the lowest and the country needs more teachers in those areas.
   d. uncertified teachers in math and science classrooms will lose their jobs unless they can demonstrate competence on a state-mandated test or have a degree/comparable undergraduate coursework by the end of the 2005-2006 school year.

9. In the year 1999-2000, what percent of US math students and US science students in Kindergarten through twelfth grade were being taught by a teacher than neither majored nor minored in the subject they taught?
   a. 5% of math students and 5% of science students
   b. 10% of math students and 3% of science students
   c. 11% of math students and 7% of science students
   d. 26% of math students and 16% of science students

10. The average salary for US teachers Kindergarten through twelfth grade in the year 2002 was:
   a. $38,728
   b. $41,728
   c. $45,728
   d. $48,728

11. In research, how is the American traditional “career” depicted and perceived in the 21st century?
   a. students and college graduates are networking everyday to pursue alternative employment opportunities because of job insecurity and the notion of “one secure career” disappearing
   b. students and college graduates are not confident with one major and/or career, and spend much time working part-time jobs, sometimes in addition to their regular job(s)
   c. students and college graduates are assuming independent contracting jobs to ensure job stability and security in their career(s)
   d. all of the above
12. Although the US created more than 100,000 net new jobs a month in the year 2000, from 2000-2002, how many people filed first time claims for unemployment each week?
   a. 100,000
   b. 200,000
   c. 300,000
   d. 400,000

13. Compared to other countries, the US:
   a. has a more stable labor force as jobs are secure and available
   b. has a less stable and faster changing labor force as jobs are insecure, and sometimes unavailable
   c. is comparable to other countries as the whole world has a stable labor force
   d. is comparable to other countries as the whole world has an unstable and flexible, fast changing labor force

14. In 1998, what was the average number of years that people were in their current jobs?
   a. 2.5 years
   b. 3.6 years
   c. 7.8 years
   d. 10.5 years

15. In the last five years, new companies with fewer than 100 workers account for what percent of the American workforce?
   a. 20%
   b. 30%
   c. 50%
   d. 60%

Part II: Please answer the following questions by writing the number that most represents your feelings towards each of the following statements. Please write the number on the line preceding each statement. Please use the scale below.

Likert Scale for Questions:
1= strongly disagree
2= disagree
3= agree
4= strongly agree

1. I think alternative methods of becoming a certified teacher (other than an undergraduate degree) will attract more math and science teachers in the future.
2. I think that government action and laws will make math and science majors (in arts and sciences) consider teaching as a profession.
3. Teacher salaries would entice me into the teaching profession.
4. Tenure and job security would entice me into the teaching profession.
5. Knowing the unemployment rate would entice me into the teaching profession.
6. Learning about the teaching profession and its benefits will make me consider teaching math/science as a career option.
7. The educational welfare and progress of the United States’ math and science students is important to me.
8. Qualified and certified teachers in math and science classrooms is important.
9. Job stability is important.
10. I am willing to consider teaching math and science as a career choice.
Appendix K

The Career Decision Scale
# CAREER DECISION SCALE

**THIRD REVISION (1976)**

by Samuel H. Oulroy, Clarke G. Case, Jane Wise, Barbara Yank, and Maryanne Koschar

---

**NAME**

**DATE OF BIRTH**

**CLASS/GRADE**

**AGE**

**SEX**

This questionnaire contains some statements that people commonly make about their educational and occupational plans. Some of the statements may apply to you, others may not. Please read through them and indicate how closely each item describes you in your thinking about a career or an educational choice by circling the appropriate number on the answer sheet. An example is given below.

<table>
<thead>
<tr>
<th>I am excited about graduating and going to work.</th>
<th>Exactly like me</th>
<th>Very much like me</th>
<th>Only slightly like me</th>
<th>Not at all like me</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

If you are excited about going to work and feel no hesitation about it, you would circle "4" to indicate that the description is exactly the way you feel. If the item is very close, but not exactly the way you feel — for example, you're generally excited about going to work after you graduate, but are experiencing some minor concerns about it — you would circle the number "3." You would circle "2" if the item describes you in some ways, but in general it is more unlike than like your feelings; for example, if you are generally more concerned than excited about work after graduation. Finally, you would circle "1" if the item does not describe your feelings at all. That is, you are experiencing a great deal of concern and no excitement about graduation and work.

Please be sure to give only one response to each item and answer every item.

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96 Printed in the U.S.A.

This form is printed in green ink on grey paper. Any other version is unauthorized.
1. I have decided on a career and feel comfortable with it. I also know how to go about implementing my choice.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

2. I have decided on a major and feel comfortable with it. I also know how to go about implementing my choice.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

3. If I had the skills or the opportunity, I know I would be a __________ but this choice is really not possible for me. I haven't given much consideration to any other alternatives, however.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

4. Several careers have equal appeal to me. I'm having a difficult time deciding among them.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

5. I know I will have to go to work eventually, but none of the careers I know about appeal to me.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

6. I'd like to be a __________, but I'd be going against the wishes of someone who is important to me if I did so. Because of this, it's difficult for me to make a career decision right now. I hope I can find a way to please them and myself.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

7. Until now, I haven't given much thought to choosing a career. I feel lost when I think about it because I haven't had many experiences making decisions on my own and I don't have enough information to make a career decision right now.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

8. I feel discouraged because everything about choosing a career seems so "diffy" and uncertain. I feel discouraged, so much so that I'd like to put off making a decision for the time being.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

9. I thought I knew what I wanted for a career, but recently I found out that it wouldn't be possible for me to pursue it. Now I've got to start looking for other possible careers.

   | CIRCLE ANSWER |
   | Like Me | Not Like Me |
   | 4       | 3         | 2         | 1        |

10. I want to be absolutely certain that my career choice is the "right" one, but none of the careers I know about seem ideal for me.

    | CIRCLE ANSWER |
    | Like Me | Not Like Me |
    | 4       | 3         | 2         | 1        |

11. Having to make a career decision bothers me. I'd like to make a decision quickly and get it over with. I wish I could take a test that would tell me what kind of career I should pursue.

    | CIRCLE ANSWER |
    | Like Me | Not Like Me |
    | 4       | 3         | 2         | 1        |

12. I know what I'd like to major in, but I don't know what careers it can lead to that would satisfy me.

    | CIRCLE ANSWER |
    | Like Me | Not Like Me |
    | 4       | 3         | 2         | 1        |
13. I can't make a career choice right now because I don't know what my abilities are.

CIRCLE ANSWER
Like Me Not Like Me
4 3 2 1

14. I don't know what my interests are. A few things 'turn me on' but I'm not certain that they are related in any way to my career possibilities.

CIRCLE ANSWER
Like Me Not Like Me
4 3 2 1

15. So many things interest me and I know I have the ability to do well regardless of what career I choose. It's hard for me to find just one thing that I would want as a career.

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16. I have decided on a career, but I'm not certain how to go about implementing my choice. What do I need to become a
_____{anyway?}

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17. I need more information about what different occupations are like before I can make a career decision.

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18. I think I know what to major in, but I feel I need some additional support for it as a choice for myself.

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19. None of the above items describe me. The following would describe me better: (write your response below).

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\begin{array}{|c|c|c|c|}
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