THE EFFECT OF ENHANCED MATH IN
THE CAREER AND TECHNOLOGY CENTER
COSMETOLOGY CURRICULUM
ON STUDENT ACHIEVEMENT
AT ONE RURAL SCHOOL IN PENNSYLVANIA

A Dissertation in
Workforce Education and Development

by

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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy
May 2009
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ABSTRACT

This study, which was modeled after the Math-in-CTE Project (Hyslop, 2007), was intended to provide career and technical education (CTE) professionals important information about the rigorous legislative requirements imposed by The No Child Left Behind Act of 2001 (NCLB) and the 2006 reauthorization of the Carl D. Perkins Career and Technical Education Act (Perkins) along with detailed presentations of research on how student achievement can be improved to meet those requirements. Specifically, the study first examined whether professional development of a selected group of professionals (Cosmetology teachers) to help enhance the math in their curriculum improved the math achievement of their students as measured by the ACCUPLACER® CPT test. Secondly, the study examined whether professional development to help Cosmetology instructors enhance the math in their curriculum improved the math achievement of their students (as measured by the ACCUPLACER® CPT test) significantly more than the rest of the students in the school that did not have teachers with professional development. This first-time attempt at integrating mathematics into the CTE curriculum in the CTC did not result in a statistically significant level of improvement in the math achievement of the Treatment Group in the study. These results are expected to improve next year, and in subsequent years, as teachers grow in their knowledge of math and their confidence in presenting math to their students in more effective and engaging ways. This base study year has provided a great start to a program that is expected to greatly benefit teachers and students in all CTE programs of study. As Dr. Gene Bottoms of the Southern Regional Education Board has stated: “High-quality...
CTE joined with rigorous academic studies is a key strategy for ensuring more students graduate prepared for postsecondary studies and careers” (Bottoms, 2008, p. 21).
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ACKNOWLEDGEMENTS

I would like to first thank my Committee Chairman and Thesis Advisor, Dr. Richard A. Walter, for his direction and guidance in sharpening the focus of this work. I also heartily thank the other Committee members, Dr. Cynthia Pellock and Dr. William J. Rothwell, for their continuous support and guidance. I especially would like to thank Dr. Edward Yoder for his commitment, dedication, and untiring help whenever I needed it.

A tremendous amount of gratitude goes to Dr. Mary Kisner, Dr. William Bush, Mr. Richard Serfass, Mrs. Peggy Sheffler, Mr. Jim Gregory, Mrs. Marge Stevenson, Mrs. Nancy Shepulski, and Mrs. Marge Green for their inspiration, encouragement, knowledge, and friendship.

Special thanks go to my Cosmetology teachers, Mrs. Amy Bush, Mrs. Kim Cosklo, and Mrs. Susan Birtch as well as the SCCTC students, without their support and dedication this study would not have been concluded.

A very special thank-you to Mr. Dan McGrath for all his help in this ambitious research project and for always going above and beyond to assist me whenever needed.

My family, to whom I have dedicated this dissertation, and everyone involved with this project have given me a new appreciation for the meaning and importance of family and friends. I hope you will follow the motto that has inspired me for so long: “Live well, laugh often, and love much”.
DEDICATION

This dissertation is dedicated to my entire family. First, my husband, Raymond and my four sons, Charlie, Frankie, Marty, and Gavin, for always supporting and encouraging me to never give up! I also dedicate this work, with sincere gratitude, to the memory of my mother, Carol Williams, who always inspired me to do my best; to Dr. Raymond and Lena Davis, the best in-laws a person could wish for; to my sisters, Mrs. Nancy Bush, Mrs. Gloria Baker and Mrs. Robin Michaels, as well as my brother, Mr. Ralph Williams, for their support, encouragement, words of wisdom, and sense of humor; also to the memory of my brother, Mr. James Williams, who has always been in my heart and who I know is very proud; and finally to my Dad, Frank Williams, who gave me the strength and faith to keep going and is showing that to me even now as he enters hospice care and still has the best attitude and the courage to handle any challenges that come his way.

I hope that the work you see here will represent you all well and make you proud. Everything I have done, and will do in the future, is because of all of you.
Chapter 1

INTRODUCTION

Young people in the U.S. should be adequately prepared academically to be competitive in the workforce. A highly qualified workforce has helped fuel economic prosperity in the United States, but now other countries are catching up with and even surpassing America’s performance (Losen, 2006).

Our Career and Technology Centers can play a vital role in preparing this future workforce. However, on a variety of academic measures the Susquehanna County Career and Technology Center (SCCTC) students reflect the national trend of performing relatively well on international tests of reading, but only in the middle of the pack on tests of science and mathematics, with one-quarter performing at the lowest achievement levels. While all career and technical programs have embedded mathematics in their content, frequently it is taught in a way that students do not see the connections to standard mathematics instruction.

An approach to helping teachers help students improve their math achievement was researched by the National Research Center for Career and Technical Education (NRCCTE, 2006). The Math-in-CTE project completed by NRCCTE in 2005 (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006) demonstrated that teachers using a career and technical (CTE) curriculum enhanced with mathematics can raise students’ math test scores. The impact of professional development on teacher behavior and student performance was discussed and found to be crucial and very beneficial in attaining the goal of raising the level of academic achievement of CTE students (Stone et al., 2006). The NRCCTE model was used to provide professional development to a small group of
teachers at the SCCTC to assess the potential influence it had for making a difference in math achievement for students in that program.

Gene Bottoms, David Pucel, and Ione Phillips, of the Southern Regional Education Board (Bottoms et al, 1997), addressed, in *A Guide to Preparing a Syllabus Designing Challenging Vocational Courses*, the following:

High Schools That Work key practices provide new definition and much higher standards for high school vocational-technical education. To achieve this new vision, educators will have to change their curriculum and instructional practices. Quality learning today calls for students to master a range of related academic, technical, intellectual and personal skills. All teachers must be part of a team that works to achieve this goal. Quality vocational-technical programs reinforce academic standards and provide authentic contexts for making learning meaningful. Quality academic programs reinforce vocational standards and use real-world problems to make learning more meaningful. (p. 18)

**Significance of the study**

The Carl D. Perkins Career and Technical Education Improvement Act of 2006 (Carl D. Perkins, 2007) through 2012 was passed to ensure that today’s students will be ready for tomorrow’s reality, whether it is in college or the workforce. Schools need to design curricula that will help the nation compete in a challenging global economy. Under the Perkins Reauthorization Act, for the first time, career and technical education will be held accountable for continuous improvement in performance, measured by the proficiency of the student. CTE programs will face new pressures to show that they are
academically rigorous and guiding high school students through a line up of courses that prepares them for college or the workplace.

As the expectations and requirements for CTE programs have risen in recent decades, the end goal for CTE participants has changed significantly. Across the United States, CTE programs are being asked to prepare students for postsecondary education or career employment. CTE is no longer just for the non-college bound; it is an alternative route to decent employment and further learning for its participants. This new “bar” for quality has placed great stress on local programs and schools—and on state governments that oversee career and technical education at the high school level.

The demands are significant on both the academic and technical front. Students should leave high school with the ability to perform academically like all students in the state’s high schools. Moreover, the technical preparation must also be of high quality: responsive to employer needs and adequate to meet employer expectations in the local labor market. How well are Pennsylvania’s CTE programs doing? According to Jobs for the Future (2005) much improvement is needed if CTE in Pennsylvania is to play its rightful role as an important contributor to the economic strength of the state and the economic advancement of its residents.

Gene Bottoms and Ione Phillips, with the Southern Regional Education Board (SREB), emphasized the need for integrated curriculum in “Teaching for Understanding through Integration of Academic and Technical Education” (Bottoms & Phillips, 1996):

School leaders and teachers need to explain how an integrated curriculum improves student learning. If educators are able to explain academic and vocational integration to colleagues, students, parents and the community, they
are more likely to gain their support and cooperation. They listed five key reasons for integrating academic and vocational studies:

- Integration is how people learn in the real world.
- Integrated learning helps academic and vocational teachers expand their repertoire of teaching strategies.
- Integrated studies can cultivate a ‘yearning for learning’ among youth.
- Academic and vocational integration improves the academic achievement of more students.
- Integrated learning helps students make education and career plans.

(Bottoms & Phillips, 1996, p. 41-45)

**Purpose of the Study**

The purpose of this study was to determine if helping instructors enhance the math in a specific program (Cosmetology) at the Susquehanna County Career and Technology Center would improve the math achievement of their students as measured by the ACCUPLACER® CPT test. The National Research Center for Career and Technical Education (NRCCTE, 2006) conducted research demonstrating that when CTE teachers are given intensive professional development in enhancing the math that naturally occurs in their curriculum, students improved their math achievement. The NRC model for professional development was used to guide the cosmetology instructors at SCCTC to enhance the math that naturally occurs in Cosmetology (NRCCTE, 2006).
**Research Questions**

There were two research questions for this study:

1. Does professional development to help Cosmetology instructors enhance the math in their curriculum improve the math achievement of their students as measured by the ACCUPLACER® CPT test?

2. Does professional development to help Cosmetology instructors enhance the math in their curriculum improve the math achievement of their students significantly more than the rest of the students in the school that did not have teachers with professional development?

**Concerns of Teachers**

During interviews of teachers prior to the start of this project, several of their concerns came to light:

1. They felt that they were not trained math teachers and were not sure they would be able to teach the math in the content area.

2. They were not sure they could develop lesson plans to incorporate the math component.

3. They did not feel they had strong math skills to start with before increasing the math integration into their lessons.

4. The teachers shared their concerns that the entering students from all seven schools had a lack of math skills to start with and the teachers would have to first build a foundation.

5. They were not sure how students would react to the math in their class.
Concerns of Students

During interviews of students prior to the start of this project, several of their concerns also came to light:

1. They stated that “this is a Cosmetology class, not math”. They wanted to know why they had to do math in Cosmetology class. The value of contextual learning was explained to them and it was reinforced for them that only math that applied to their content area would be included.

2. The percentage of students with concerns regarding integrating more math into the program was quite low. In September, 2007, during the first week in interviewing students, only three students were heard to express such concerns out of 79 Cosmetology students tested at the beginning of the program. During the second week, only two additional students expressed any concerns.

3. In speaking with students throughout the 2007-2008 school year, it was found that students actually had a fear of math itself, rather than the concept of including math within the lesson that concerned them. This was verified by way of bi-monthly meetings with students.

Professional Development and Resources

In consideration of what was asked of the teachers, to integrate math into their curriculum, several opportunities in professional development were provided to ease this process and hopefully make it more successful.

1. The Cosmetology teachers, a math teacher, and the school administrator attended the Governors Math Institute presented in the summer of 2007 by The
Pennsylvania State University. The Cosmetology teachers reported back that the Institute was of enormous help to them in this new effort.

2. The Cosmetology teachers were provided with a wide array of supplies and equipment (including a laptop computer for each teacher as well as teaching tools such as flash cards, Algebra Survival guide and workbook, and other such items for distribution to students as the need arose) to help them succeed with their math integration efforts. See Appendix G (SCCTC Math Supplies & Equipment Purchased) for details.

3. The Cosmetology teachers were given the opportunity to meet every week at least three days a week between 3:00 and 3:30 P.M. to share their teaching experiences and network with each other and other teachers (a total of 57 hours). Additionally, they received a total of 35 and ½ hours of training by a professional educator-trainer and other professional development during teacher in-service days. See Appendix E for school calendar.

**Consistency and Follow-Up**

In order to ensure that the Cosmetology teachers were following the established systems and procedures during delivery of their math-integrated lessons, routine walk-through observations were conducted. At least two walk-through observation forms (Appendix F) were completed each month for all three teachers to ensure they were utilizing proper integration of math in their lesson plans.

Two informal and two formal evaluations were completed during the 2007-2008 school year. In April, 2008, each of the Cosmetology teachers wrote a brief description of their thoughts on the value of integrating math into their curriculum. These are included
in Appendix D. Additionally, all Cosmetology students were asked to write a one-page letter of their beliefs and thoughts as to the math integration in their lessons during the year. Three of these submissions were randomly selected and are attached in Appendix D.

**Limitations**

There were several limitations of this study:

1. Pre-tests were taken by most students at the end of the previous school year. New students were given the pre-test at the beginning of the 2007-8 school year.

2. Approximately 25% of the testing was done at the students’ home schools instead of the CTC, causing a small lack of consistency.

3. The CTE teachers in the SCCTC that did not participate in the math-in-CTE professional development were encouraged to consider the academics in their curricula, but were not given specific training in how to enhance the instruction of mathematics.

4. At the time of year the students took the ACCUPLACER® test, they may have felt bombarded by testing, since they had taken their 4Sight Tests, NOCTI Tests, and PSSA tests within a two-month time frame.

5. Some of the data may have been impacted by the fact that at the time of the Pre-Test, the sample included 296 students. However, by the time the Post-Test was administered near the end of the school year, 73 students were no longer in attendance at the school. (This was due to drop-outs, relocations, transfers out, home schooling, and attending Cyber School. Based on exit interviews with students there was not evidence that this change in instruction methodology
6. The ACCUPLACER® test did not match the PSSA tests in the topics of mathematics noted in this paper. This limited the usefulness of comparing PSSA math results with ACCUPLACER® results as an indication of math skill levels.

7. At the time of this research study, the math consultant utilized by SCCTC in professional development in the integration of math into the curriculum did not match the math topics covered with the math topics included on the PSSA test. This situation will be changed in future professional development.

8. Professional development in the integration of math into the curriculum was not limited specifically to the teachers of the Treatment Group (Cosmetology teachers). The Cosmetology teachers were relatively novice teachers (less than three years of teaching) while several of the teachers in other programs of study had as much as 15 to 20 years of teaching experience. Some of these arrived at SCCTC with prior training in matters such as math integration and teaching techniques. All teachers at SCCTC were provided with professional development in math integration, including development of contextual situations for their lesson plans as well as numerous devices and techniques to aid the process. Additionally, one or two teachers of other programs were actually utilizing some teaching techniques being presented in the professional development, such as “Go Find” (where students are given a topic to find, either in the textbook or online). The additional experience of the other teachers as well as their use of various integration techniques most likely contributed to an improvement in the math
achievement of their students. This would make the difference in achievement between the two groups less than would have been expected.

**Definition of Terms**

For the purpose of this study the following terms are defined:

**ACCUPLACER® Test**—The purpose of the test was to provide useful information about student academic skills in math. The results of the assessment, in conjunction with a student’s academic background, goals, and interests, are used by academic advisors and counselors to determine a student’s course selection (College Board, 2008). The arithmetic test given is designed to measure student ability to perform basic arithmetic operations and to solve problems that involve fundamental arithmetic concepts. The ACCUPLACER® online is the first and only computer-adaptive placement testing program delivered over the internet. Individual students score reports are available immediately after testing (ACCUPLACER®, 2007, p. 2).

**Arithmetic**—Performs basic computations; uses basic numerical concepts such as whole number and percentages in practical situations; makes reasonable estimates of arithmetic results without a calculator; and uses tables, graphs, diagrams, and charts to obtain or convey quantitative information (SCANs Skills, 2008, p.1).

**Mathematics**—Approaches practical problems by choosing appropriately from a variety of mathematical ideas and concepts orally and in writing; and understands the role of chance in the occurrence and prediction of events (SCANs Skills, 2008, p.1).

**CTC**—Career and Technology Center. Career and technical education (CTE) in Pennsylvania (PDE, 2008) is delivered through 85 regional technology centers, and over 300 comprehensive high schools. Of the regional technology centers, most provide CTE
courses for part of a student’s school day, but 12 centers provide comprehensive technical and academic courses. Most secondary students enrolled in CTE in Pennsylvania are in grades 10-12. The Commonwealth’s 81 Area Vocational Technical Schools (AVTSs), also called Career and Technology Centers or Technical Schools, are operated either by a school district, a group of school districts or an intermediate unit to provide career and technical education services to resident students. Sixty-six AVTSs are part-time programs where students are provided specialized instruction in career and technical fields. These students receive their basic education classes, English, social studies, math and science, in their home high schools. Many AVTSs also offer adult skill training programs. Fifteen comprehensive AVTSs are schools that offer comprehensive full-time programs where students receive both basic and career and technical education. In most cases, AVTSs that serve students from multiple school districts are governed by boards composed of school board members from participating school districts. Each board employs a director to manage the operations of the school. Each member school district pays a share of the cost in the operation of the AVTSs (PDE, 2008).

**DDIS**—Data-Driven Instructional Systems: describes the interconnected system of curriculum, pedagogy, professional development, and assessment practices that leaders build to improve student learning (Wisconsin Center for Education Research, 2008).

**JFF**—Jobs for the Future. As a nonprofit research, consulting, and advocacy organization, JFF works to strengthen our society by creating educational and economic opportunity for those who need it most. The JFF Vision is that:

- All young people make a successful transition to adulthood. By age 26, they obtain a strong high school education and an advanced educational credential.
• All adults have the education and skills they need to get and keep a job—and to advance in a family-supporting career.

• The nation has a workforce that meets the demands of a changing global economy.

Through partnerships with states and communities, national and local foundations, and other organizations, JFF accelerates opportunities for people to advance in education and careers through research, analysis, and policy development. They identify and address the challenges that prevent many people from succeeding in a family-sustaining career and develop effective models for helping youth and adults acquire the skills that employers require. JFF also provides advocacy, communications, and peer learning and influence the policies and practices driving our nation's educational and workforce development systems. (Jobs for the Future, 2008, p. 4)

NRCCTE—National Research Center for Career & Technical Education. The National Research Center for Career and Technical Education provides both descriptive and intervention-based research to improve the practice of career and technical education (CTE). Their intensive and ongoing relationships with both practitioners and policymakers at local, state, and national levels ensure that their work addresses current policy issues and needs of the field. NRCCTE strongly believes that CTE programs are an integral part of public education, and are committed to improving student achievement and vocational skills through CTE. Deriving from Perkins III legislation, NRCCTE funding is administered by the Office of Vocational and Adult Education, U.S. Department of Education. The National Research Center partners included: Primary:
PERKINS—The Carl D. Perkins Career and Technical Education Act (Perkins) was most recently reauthorized in August 2006. The purpose of Perkins is to provide individuals with the academic and technical skills needed to succeed in a knowledge- and skills-based economy. Perkins supports career and technical education that prepares its students both for postsecondary education and the careers of their choice. Federal resources help ensure that career and technical programs are academically rigorous and up-to-date with the needs of business and industry. The Federal contribution to career and technical education, about $1.3 billion annually, supports innovation and expands access to quality programs. State and local funding supports the career and technical education infrastructure and pays teachers' salaries and other operating expenses. Federal funds provide the principal source for innovation and program improvement, and help to drive state support through a "maintenance-of-effort" provision in the federal law. Perkins Basic State Grant funds are provided to states that, in turn, allocate funds by formula to secondary school districts and postsecondary institutions. States have control over the split of funds between secondary and postsecondary levels. After this decision is made, states must distribute at least 85 percent of the Basic State Grant funds to local programs using either the needs-based formula included in the law or an alternate formula that targets resources to disadvantaged schools and students. States may reserve up to ten percent for leadership activities and five percent (or $250,000, whichever is greater) for
Administrative activities. States also receive a Tech Prep grant that can be folded into Basic State Grant funds or used to provide grants to consortia of secondary and postsecondary partners that develop articulated pathways. State and local funds generally are to be used for the following types of activities:

- Serving as a catalyst for change by driving program improvement
- Developing a strong accountability system that ensures quality and results
- Strengthening the integration of academic and career and technical education
- Ensuring access to career and technical education for special populations, including students with disabilities
- Developing and improving curricula
- Purchasing equipment to ensure that the classrooms have the latest technology
- Providing career guidance and academic counseling services
- Providing professional development and technical assistance for teachers, counselors and administrators
- Supporting career and technical education student organizations

Current Perkins law allows for more state and local flexibility and raises expectations for students participating in career and technical education by holding them to the specific, valid and reliable accountability standards. States and localities are working within the updated accountability system to develop effective methods to improve programs and measure student progress and success. (Perkins: Background, 2008, p. 1)

SCCTC—Susquehanna County Career & Technology Center

Assumptions

It is assumed that all students answered the questions to the best of their ability.
Chapter 2

REVIEW OF LITERATURE

This chapter summarizes selected literature and is organized into five major components. The first encompasses the Legislation that is having such a large impact on the reforms required in the math curriculum. The second section closely examines Jobs for the Future (2005), a major research study that demonstrates how academic rigor is important for the Commonwealth of Pennsylvania and the nation in ensuring educational success and opportunity for all students, and in building a vibrant 21st Century economy. The third section analyzes literature relating to the Math-in-CTE Project. This study, completed by the National Research Center for Career and Technical Education (NRCCTE) in 2005, demonstrated that teachers using a CTE curriculum enhanced with mathematics can raise students’ math test scores (Hyslop, 2007). The Math-in-CTE Project served as the model for this research study. The fourth section of the chapter focuses on the need for modification of the content and delivery of the math curriculum. The final chapter component examines the research related to the influence or relationship between teacher participation in professional development and the subsequent impact on teaching practice and student outcomes. This final component is especially relevant to this study because the teacher participants in the study were involved in a professional development experience designed to influence the strategies and techniques used with their students in teaching math concepts.
Legislation

The Carl D. Perkins Career and Technical Education Act of 2006 and The No Child Left Behind Act of 2001 have served as the driving force behind academic rigor in our career and technical schools. These pieces of legislation are focused on improving the academic skills of CTE students and they measure success with improving achievement in academic subjects.

The purpose of the Perkins Act of 2006 is to develop more fully the academic and career and technical skills of secondary education students and postsecondary education students who elect to enroll in career and technical education programs, by:

- Building on the efforts of States and localities to develop challenging academic and technical standards and to assist students in meeting such standards, including preparation for high-skill, high-wage, or high-demand occupations in current or emerging professions;
- Promoting the development of services and activities that integrate rigorous and challenging academic and career and technical instruction, and that link secondary education and postsecondary education for participating career and technical education students;
- Increasing State and local flexibility in providing services and activities designed to develop, implement, and improve career and technical education, including tech prep education;
- Conducting and disseminating national research and disseminating information on best practices that improve career and technical education programs, services, and activities;
• Providing technical assistance that promotes leadership, initial preparation, and professional development at the State and local levels; and that improves the quality of career and technical education teachers, faculty, administrators, and counselors;

• Supporting partnerships among secondary schools, postsecondary institutions, baccalaureate degree granting institutions, area career and technical education schools, local workforce investment boards, business and industry, and intermediaries;

• Providing individuals with opportunities throughout their lifetimes to develop, in conjunction with other education and training programs, the knowledge and skills needed to keep the United States competitive. (Carl D. Perkins, 2006, pp. 5-6)

The No Child Left Behind Act of 2001 (NCLB) put emphasis on determining which educational programs and practices were proven effective through rigorous scientific research. Federal funding is targeted to support these programs and teaching methods that work to improve student learning and achievement. NCLB supports scientifically-based instruction programs in the early grades under the Reading First program and in preschool under the Early Reading First program. (NCLB, 2001)

According to Margaret Spellings,

for the first time, Career and Technical Education Programs will be held accountable for continuous improvement in performance measured by the academic proficiency of CTE students and success will be determined through
valid and reliable tests, including No Child Left Behind assessments in reading, math, and science. (Spellings, 2006, p. 1)

The legislation contains mandatory requirements, including providing professional development to strengthen academic and technical skills of students through integration. Programs must have valid and reliable measures, must show continuous improvement, and must develop and implement an improvement plan if it fails to meet at least 90% of a performance level on any indicator. If a state or local district fails to implement an improvement plan and make improvement, funds can be withheld (DiNatale, 2007).

Linda Darling-Hammond (2007), a leading education expert, discussed NCLB’s promise and problems in her article, Evaluating ‘No Child Left Behind’:

In 2002 civil rights advocates praised NCLB for its emphasis on improving education for students of color, those living in poverty, new English learners and students with disabilities. NCLB aims to raise achievement and close the achievement gap by setting annual test-score targets for subgroups of students, based on a goal of "100 percent proficiency" by 2014. These targets are tied to school sanctions that can lead to school reconstitutions or closures, as well as requirements for student transfers. In addition, NCLB requires schools to hire "highly qualified teachers" and states to develop plans to provide such teachers.

NCLB contains some major breakthroughs. First, by flagging differences in student performance by race and class, it shines a spotlight on longstanding inequalities and could trigger attention to the needs of students neglected in many schools. Second, by insisting that all students are entitled to qualified teachers, the
law has stimulated recruitment efforts in states where low-income and "minority" students have experienced a revolving door of inexperienced, untrained teachers. While recent studies have found that teacher quality is a critical influence on student achievement, teachers are the most inequitably distributed school resource. This first-time-ever recognition of students' right to qualified teachers is historically significant. This noble agenda, however, has been nearly lost in the law's problematic details. Dubbed No Child Left Untested, No School Board Left Standing and No Child's Behind Left, among other nicknames, the law has been protested by more than twenty states and dozens of school districts that have voted to resist specific provisions.

One state and a national teachers association have brought lawsuits against the federal government based on the unfunded costs and dysfunctional side effects of the law. Critics claim that the law's focus on complicated tallies of multiple-choice-test scores has “dumbed down” the curriculum, fostered a "drill and kill" approach to teaching, mistakenly labeled successful schools as failing, driven teachers and middle-class students out of public schools and harmed special education students and English-language learners through inappropriate assessments and efforts to push out low-scoring students in order to boost scores. Indeed, recent analyses have found that rapid gains in education outcomes stimulated by reforms in the 1990s have stalled under NCLB, with math increases slowing and reading on the decline. (Darling-Hammond, May 2007, pp. 1-3)

Debra Bragg and William Reger IV (2000 in their article *Toward a More Unified Education: Academic and Vocational Integration in Illinois Community Colleges*,
discussed the need for closing the gap between academic and vocational education that was made worse by some early legislation. Specifically they noted:

The need for integrating academic and vocational education arises not only out of the complex issues facing American public education amid present-day economic changes, but also out of the philosophical and legislative debates of the past. Though educational philosopher John Dewey argued for "education through occupations" rather than "education for occupations," (Bragg & Reger, 2000, pp. 2-3), the Smith-Hughes Act of 1917, following a German model, divorced vocational from academic education with serious consequences. The predominant intent of the Smith-Hughes Act was to promote secondary vocational education, especially in agriculture, industry, and the trades, by forcing state boards of education through funding incentives to create separate vocational programs in public schools. The two separate strands of education have remained within the curriculum of comprehensive high schools throughout the 20th Century.

Twenty years after passage of the Vocational Education Act of 1963, the National Commission on Excellence in Education (1983), in A Nation at Risk, declared that the failures of public education, deriving in part from the weakening of the public school curriculum, demanded a return to basic academic foundations, to the almost total neglect of vocational education (Frantz, Strickland, & Elson, 1987). Claiming that public schools would be improved by focusing nearly entirely on traditional academics, A Nation at Risk and subsequent school reforms advocated a diminished role for vocational education in the comprehensive high school. The Office of Vocational and Adult Education,
U.S. Department of Education countered with a strong statement in support of vocational education emanating from the National Center for Research in Vocational Education at The Ohio State University. This report, titled *The Unfinished Agenda* (National Commission on Secondary Vocational Education, 1984), recommended that students receive a "balanced mix of academic and vocational experience in their high school curriculum" (p. 12). Lacking the political clout of *A Nation at Risk*, recommendations from The Unfinished Agenda had limited impact in the short term. Over the long term they became central to federal vocational legislation of the 1990s, including concepts that developed into subsequent reforms such as tech prep. (Bragg & Reger, 2000, pp. 2-3)

*Jobs for the Future*

According to Jobs for the Future (2005), academic rigor is important for the Commonwealth of Pennsylvania and the nation in ensuring educational success and opportunity for all its students, and in building a vibrant responsive 21st Century economy. As the expectations and requirements for CTE programs have risen in recent decades, the end goal for CTE participants has changed significantly. Across the United States, CTE programs are being asked to prepare students for postsecondary education or career employment, CTE is no longer just for the non-college-bound; it is an alternative route to decent employment and further learning for its participants. This new “bar” for quality has placed great stress on local programs and schools—and on state governments that oversee vocational education at the high school level (Jobs for the Future, 2005).
One of the most fundamental tasks of public education is to ensure that students graduate with a diploma that prepares them for future education, work and citizenship. For the 2005-2006 school year, an estimated 1.2 million U.S. students, most of them members of minority groups, failed to graduate with their peers. That is about 30 percent of the class of 2006. The cumulative costs to the public from the nation’s dropouts are in the billions, for both lost taxes and spending on social programs.

Young people who fail to earn a high school diploma do so at enormous cost to themselves and to society. The following data presents two major costs involved of an inadequate education:

1. Over a lifetime, an 18-year old who does not complete high school earns about $260,000 less than an individual with a high school diploma, and contributes about $60,000 less in federal and state income taxes. The combined income and tax losses aggregated over one cohort of 18-year-olds who do not complete high school is about $192 billion, or 1.6 percent of the gross domestic product.

2. Adults who lack a high school diploma are at greater risk of being on public assistance. If all those receiving assistance who are high school dropouts instead had a high school diploma, the result would be a total cost savings for federal welfare spending, food stamps, and public housing of $7.9 billion to $10.8 billion a year. (Losen, 2006, p. 7)

Michael Rose (2008) pointed out in his article, *Intelligence, Knowledge, and the Hand/Brain Divide*, that the academic/vocational divide that persists in the U.S. schools today is not simply a matter of curriculum. It is an expression of beliefs about intelligence and the social order that continue to limit the options of large numbers of young people.
Rose found the following:

During the twentieth century it was found that “voc ed” was not doing a very good job of preparing students for industry. One of the principal reasons was an unimaginative and restricted curriculum. In addition, there was a mismatch between the curriculum and the workplace, and the workplace itself was constantly changing. Such concerns have been at the heart of call for reforms.

A broad range of reforms were undertaken, including the Carl D. Perkins Vocational Education and Applied Technology Act of 1990 (reauthorized in 2006). What makes this legislation particularly relevant is its stress on amending existing programs or creating new ones to better integrate academic and vocational education, thus providing a richer range of options for careers or for further training or education. The Perkins Act was unusual in its emphasis on both academic and occupational competency for a broad range of American high-schoolers.

In a few cases, a visionary faculty has used these reforms as an occasion to re-imagine the very structure of high school itself and with it the academic/vocational divide. These educators develop curricula that merge rather than reinforce disciplines, that find rich educational content in the occupational world, that blend learning and doing through projects, public presentations, and portfolios of creative and scholarly work.

There is a need to reassess long-standing and seemingly self-evident distinctions between levels and kinds of knowledge. There is a tendency -- in the school and in the culture at large -- to view all knowledge and skill associated
with physical work as rudimentary, even primitive, "neck-down" activity. The traditional, and weighty, separations between "pure" and "applied" knowledge, between "skill" and "concept," between "theoretical" and "practical," tend to neatly segment a more complex reality.

Young people at a key developmental juncture have to form their sense of self and their conception of their intelligence within the tensions and restrictions of the academic/vocational divide. They must define themselves, either in compliance or rejection, within these institutional dynamics. One of the results is that some kids -- no matter how sharp they may be in other aspects of their lives -- come to think of themselves as intellectually inferior, not too bright, a dummy. This can even be the case, as I've witnessed innumerable times, when people dismiss book smarts, mock academic pursuits, and develop identities in opposition to school success. Even as they shun the academic domain, they identify intelligence with it and trap themselves within the very terms they reject.

A number of vocationally oriented students receive mediocre educations. Some are considerably unprepared, and their under-preparation is related to their social class background: poor schools, limited resources, hard times. They tend not to do well in their academic courses, and their performance supports the school's belief that they cannot handle intellectually challenging material. This belief is often reinforced in other ways by the students themselves, by the many indications they give that they just don't like school -- and don't trust it, either. The challenge for teachers here is to be clear-headed in separating out a student's poor performance or detachment or defensiveness from intellectual possibility.
Without such bedrock beliefs and commitments, we will never truly bridge the academic/vocational divide. We will continue to take good ideas and dumb them down, for the beliefs about intelligence and the social order that underlie a curriculum are as important as the content of the curriculum itself. It is at this point that democratic principles and educational practice become one, an act of intellectual and civic realization. Those teachers and administrators who work at the breach between the academic and the vocational are engaged in a kind of applied political philosophy. By making the schoolhouse more democratic, they honor the fundamental intelligence of a broad range of human activity and challenge the culture's assumptions about hand and brain. (Rose, 2008, pp. 632-639)

**Math-in-CTE Research Project**

Hyslop (2007) wrote that one of the most prominent research studies related to the integration of academic and career and technical education was completed by the National Research Center for Career and Technical Education (NRCCTE) in 2005. According to the NRCCTE, the study demonstrated that teachers using a CTE curriculum enhanced with mathematics can raise student’s math test scores (Hyslop, 2007, pp. 40-43).

Mary J. Kisner (1999) discussed in *The ABC’s of a High-Quality Educational Experience: A Workbook for Teachers* a balance in instructional strategies:

The students of today will need experience with a variety of learning strategies to be successful as the workers of tomorrow. They will face situations where they will have to learn information on the job from co-workers and resource materials.
They will have to solve problems and make decisions based on that information. Your choice of instructional strategies can prepare students to face these situations. These instructional strategies can be grouped into three categories: presentation strategies, action strategies, and interaction strategies.

Your instructional time should be a balanced mix of these strategies. Presentation strategies are the most familiar form of instructional strategy. They may involve a lecture, a demonstration, or an interview before the group. Presentation strategies are used when the major objective is to convey information. The student is usually passive and responsibility for learning remains with the teacher. Successful presenters are lively, enthusiastic and organized. Good eye contact and a voice that varies in tone are important. Students may need assistance in learning how to be a good listener and organizing information from a verbal presentation.

Action strategies may include case studies, simulations, laboratory exercises, and individual projects. These strategies involve students physically as well as intellectually. The responsibility for learning now shifts from the teacher to the student. By careful preplanning of activities, control of the learning process remains in the hands of the teacher. Teachers who are successful with these strategies are skilled with group facilitation skills. The focus is on what students are doing, not on what the teacher is doing. Interaction strategies, including brainstorming, discussions, and committees rely heavily on discussion and group sharing among group members.
While the teacher will conceptualize the topic and anticipate possible
directions that student discussions might take, the teacher relinquishes direct
control over the learning activity. The teacher must be a good listener and
observer. Interaction strategies serve primarily as a means of processing
information presented in some other way. You may not be comfortable with some
of these instructional strategies, but learning how to involve students in the many
ways to learn is helpful to everyone. Discover your most comfortable style for
instruction and then begin incorporating other strategies into your teaching. You
will be helping your students be successful in the future. (Kisner, 1999, p. 9)

The National Dissemination Center for Career and Technical Education presented
the results of their research of the Math-in-CTE model developed by NRCCTE (Stone,
Alfeld, Pearson, Lewis, & Jensen, 2006). In their presentation, they emphasized the
importance of contextual learning. They noted that:

The contextual mathematics approach requires that students become more
actively engaged as learners and that educators change the way in which they
deliver content in order to produce enhanced thinking about and use of
mathematics concepts. According to this perspective, educators play a major role
in helping students find meaning in their education and make connections
between what they are learning in the classroom and ways in which that
knowledge can be applied in the real world.

The use of authentic situations serves to “anchor” the symbolic and
abstract math in situations that are familiar and real to students, which services to
help them make sense of the content. The National Science Foundation has
funded several contextual mathematics projects at the high school level, one of which is Core-Plus. Core-Plus has been found to increase students’ conceptual understanding and problem solving in applied contexts; however students in Core-Plus do not score any higher than students in the traditional math curriculum on a placement test used at a major university.” (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006, p. 9)

The report went on to disclose that the development of the pedagogical framework (the seven elements) was only one aspect of the model. The experimental intervention also required the creation of a process through which the CTE teachers could learn to develop and teach the math-enhanced lessons. The process included partnering CTE teachers with math teachers, building curriculum maps that intersect math concepts with CTE curricula, providing professional development for the teacher-teams, and implementing the math-enhanced lessons. (Stone et al., 2006, p. 14)

Additionally, the report noted that at the professional development workshops, CTE-math teacher-teams were given basic foundational curriculum maps to use as a basis for further revision and identifying the math concepts common to their courses, and subsequently, to use as a basis for selecting and developing the math-enhanced lessons within their specific labor market preparation (SLMP). These example curriculum maps aligned math concepts (e.g., algebra, geometry, and trigonometry) with existing high school CTE curricula for their specific SLMP. For example, the use of proportions and ratios is critical to the preparation of medicines in health occupations. The revised
curriculum maps were then used to identify and select the math concepts around which they would develop math-enhanced CTE lessons. (Stone et al., 2006, p. 21)

Finally, as part of the post-tests of the study, students were randomly assigned to one of three groups corresponding to the three postmeasures of math ability: the TerraNoval CTBS Basic Battery test (CTB/McGraw-Hill, 1997b) was used as a traditional measure of mathematical ability; the WorkKeys® Applied Mathematics Assessment (ACT, 2005), a measure of mathematics often used in the workforces, serviced as the measure of mathematics skills in applied contexts, and the ACCUPLACER® Elementary Algebra test (College, Board, 1998), a standardized college mathematics placement test used by many colleges and universities around the country, was used as a measure of potential postsecondary remediation requirements. The ACCUPLACER® test is now generally given on the computer, allowing students to jump to more difficult questions when easier questions are answered correctly, decreasing the amount of time needed to assess a wide variety of mathematical understanding. (Stone et al., 2006, p. 26)

The goal of the adopting a Math-In-CTE project at SCCTC was not to add more math into the CTE curriculum or award academic credit (as in the interdisciplinary courses), but rather to provide professional development to the instructors so they can emphasize the math that was already present in the curriculum and ensure students can transfer this knowledge. During professional development in the research study, CTE instructors were partnered with a math instructor and together they explored the CTE curriculum. Places where math naturally occurred were identified by each team of instructors. Then the team developed specific lessons to focus on those math concepts
within the context of the CTE curriculum. Each lesson plan followed a sequence of instructional steps that built a bridge from the CTE curriculum to the math concepts and back to the CTE curriculum (Hyslop, 2007). NRCCTE provided a model of an enhanced Math-in-CTE lesson. It included the “7 elements”:

1. Introduce the CTE lesson.
2. Assess students’ “math awareness” as it relates to the CTE lesson.
3. Work through the math examples embedded in the CTE lesson.
5. Work through traditional math examples.
6. Students demonstrate their understanding.
7. Formal assessment. (NRCCTE, 2006) (See the sample lesson plan template in Appendix A.)

Carl Vogel (2008), in his article, *Algebra: Changing the Equation*, noted that:

when U.S. Secretary of Education Margaret Spellings announced in March, 2008 the final report of the National Mathematics Advisory Panel, created by President Bush in 2006 to address concerns that many students lack essential skills to become engineers and scientists, she highlighted the importance of algebra. ‘The panel’s research showed that if students do well in algebra, then they are more likely to succeed in college and be ready for better career opportunities in the global economy of the 21st century,’ Spellings stated. The panel advised that all school districts provide access to algebra for all prepared students—including more as early as eighth grade. (Vogel, 2008, p. 34).
Development of an Engaging Math Curriculum

This section examines first the need for examining the way math is taught by specifically examining the mandate from selected driving forces in the initiative to reform math education. This section then examines selected initiatives to enhance the teaching of math.

Driving forces in reforming math education. For some time various business, educational and political leaders have called for an examination and modification regarding what mathematical and science concepts are taught and how those concepts are taught in our public schools. One needs only to examine the rhetoric associated with the implementation of No Child Left Behind (NCLB) guidelines at the local school district level to realize the influence these political and business leaders have had on the business of education at the local level.

The national business and political leaders are specifically concerned the personnel in our public education system will not be able to adequately stimulate and foster students’ interests in math and science—an area of weakness that they contend has contributed to the growing influence of Asian countries, most notably India and China, in the fields of engineering and technology. John J. Castellani, President of The Business Roundtable, stated, “The critical situation in American innovation threatens to undermine our standard of living at home and our leadership in the world. We cannot wait for another Sputnik to propel our energy forward in this area” (Honawar, 2005, p. 2). Congressman Vernon J. Ehlers (U.S. Representative R-Michigan) voiced a similar concern, “There is a crisis, and it is getting steadily worse....If we aren’t able to educate our children, they won’t get decent jobs, and I am not just talking about scientists and
engineers” (Honawar, 2005, p. 8). Bill Gates, Chairman of Microsoft Corporation, further reinforced these perspectives when he commented, “When I compare our high schools to what I see when I’m traveling abroad, I am terrified for our workforce of tomorrow” (Honawar, 2005, p. 9).

Thus from a variety of stakeholders our public educational system has been challenged to enhance the mathematical and scientific competence of our youth. Unfortunately, they fail to mention that this is not the sole fault or responsibility of a single entity, namely our educational system. Not only have influential leaders challenged us to improve the education system, but the youth themselves have voiced their opinions regarding our educational system (Honawar, 2005, p. 12).

According to a study by Viadero (2005) regarding math hurdles faced by high school students:

If teachers are going to be successful in teaching math, they have to be open to students using different ways of solving math problems. Curriculum experts believe students need to solve problems in a variety of ways, as well as preparing them for higher level math. Researchers and school officials have debated for years the most effective way to teach math. Educators from around the nation are looking for ideas on how to blend career and technical training with demanding academics. If schools are not delivering the academic and technical skills that business and industry need, they are doing a disservice to the students and the community. Researchers from the United Negro College Fund went to West Virginia in 2006 and asked 62 high school dropouts in the Federal Job Corps program a simple, open-ended question. “What was it about school,” they wanted
to know, “what caused you to quit?” With surprising consistency, a majority of their participants, most of whom were African-American or Hispanic, gave the same answer: “Math” (Viadero, 2005, pp. 10-12).

Wenglinsky (2002) attempted to examine the relationship between what teachers do in the classroom practices and the concerns of the students regarding math. In How school matters: the link between teacher classroom practices and student academic performance, Wenglinsky found that:

Teacher classroom practices have a significant effect on student achievement. Additionally, high-quality professional development focusing on higher-order thinking skills and diversity issues does appear to strongly influence classroom practice. Teacher quality and classroom practices can have an effect on student achievement equal to or exceeding that of socioeconomic status.

Five aspects of teacher quality affect student achievement: a teacher’s major, professional development in higher-order thinking skills, diversity training, use of hands-on learning in classrooms, and focusing on higher-order thinking skills. (Wenglinsky, 2002, pp. 1-3)

Gewertz (2006) arrived at several important conclusions that impact math achievement:

They found that other high school dropouts interviewed for a study were far more likely to say they left school because they were unmotivated, not challenged enough, or overwhelmed by troubles outside of school than because they were failing academically. Key changes could have boosted their chances of staying in school, said the former students, who were between the ages of 16 and 25 when
interviewed for the study. The most commonly cited reasons were teachers who expected more of them, schools that helped them more when they struggled, and classes that were more engaging. The report’s authors emphasized that their aim was to explore young people’s reasons for leaving school at a time of heightened interest in the issue, and to spark a national response that would help more such students finish high school. “The very people most affected by this crisis, the young people, are telling us that this problem can be solved,” said John M. Bridgeland, who directed the White House Domestic Policy Council under President Bush and is now the president and chief executive office of Civic Enterprises, the Washington-based public-policy-development group that conducted the study. (Gewertz, 2006, p. 1)

Peter D. Hart Research Associates, an opinion-research company, conducted four focus groups with dropouts in Philadelphia and Baltimore in 2006 (Gewertz, 2006):

In the following two months, researchers interviewed 467 dropouts from 25 large cities, small towns, suburbs, and rural areas. The sample was not nationally representative. Only 35 percent of the former students interviewed cited academic failure as a major factor in dropping out. More than six in 10 said they had grades of C or better. Seven in 10 said they believed they could have graduated if they had tried hard enough. The dropouts who reported the greatest academic struggles were the ones most likely to say that their schools hadn’t done enough to help them with those difficulties, the report says. Large proportions of all the former students interviewed, 70 percent to 80 percent, said they wanted better teachers and more interesting classes, including the opportunity for more “real world”
learning opportunities. Former students often cited a lack of motivation and of interesting classes as reasons they eventually disappeared from school. Sixty-nine percent said they were not motivated or inspired to work hard. Nearly half said their classes were not interesting. Two-thirds said they would have worked harder if they had been challenged to do so. “They just let you pass, with anything you got,” said one focus group participant. (Gewertz, 2006, p. 1)

Adam Gamoran, Andrew Porter, and John Smithson (1997) in their paper *Upgrading High School Mathematics Instruction: Improving Learning Opportunities for Low-Achieving, Low-Income Youth*, found that, “by orienting math learning toward higher-order thinking and problem-solving skills, providing students with more rigorous content coverage found in college-preparatory math classes, those students learn more” (Gamoran, Porter, & Smithson, 1997, p. 333). Their study found that, “low-achieving high school students are capable of learning much more than is typically demanded of them. The key is to provide a serious, meaningful curriculum: ‘hard content for all students’” (Gamoran et al., p. 336).

*Educational System Initiatives.* For a sustained period of time key educational reformers have attempted to formulate plans that local school personnel could use in enhancing the way content is taught and what content is taught. Dewey (1916) provided one of the seminal philosophical foundations for the restructuring of American education, and his philosophical influence remains strong today in the research related to teacher instructional effectiveness and educational reform movements.
Barak Rosenshine (1996) wrote in his *Advances in Research on Instruction*, about the importance of teachers helping students develop a well-connected body of accessible knowledge. He wrote that:

It is easier to assimilate new information and easier to use prior knowledge for problem solving, when one has more connections and interconnections, stronger ties between the connections, and a better organized knowledge structure. When the knowledge structure on a particular topic is large and well-connected, new information is more readily acquired and prior knowledge is more readily available for use. Having a well-connected network means that any one piece of information can serve to help retrieve the entire pattern. Having strong connections and a richness of relationships enables one to retrieve more pieces of the pattern. When information is "meaningful" to students, they have more points in their knowledge structures to which they can attach new information. Education is a process of developing, enlarging, expanding, and refining our students' knowledge structures.

To summarize, well-connected and elaborate knowledge structures are important because (a) they allow for easier retrieval of old material, (b) they permit more information to be carried in a single chunk, and (c) they facilitate the understanding and integration of new information. There are three important instructional implications that follow from this research: (a) the need to help students develop background knowledge, (b) the importance of student processing, and (c) the importance of organizers. (Rosenshine, 1996, p.1)
Honawar (2005) used Rosenshine and Stevens’ (1986) research on teaching methods and concluded that across a number of studies, when effective teachers taught well-structured skills and expository material, the teachers used the following procedures:

- Begin a lesson with a short review of previous learning.
- Begin a lesson with a short statement of goals.
- Present new material in small steps, providing for student practice after each step.
- Give clear and detailed instructions and explanations.
- Provide a high level of active practice for all students.
- Ask a large number of questions, check for student understanding, and obtain responses from all students.
- Guide students during initial practice.
- Provide systematic feedback and corrections.
- Provide explicit instruction and practice for seatwork exercises and, where necessary, monitor students during seatwork.

Statistics show that double-dosing on math has a positive effect on learning, but schools must also be committed to finding innovative ways to keep those subject areas interesting. (Honawar, 2005, p. 13)

William Daggett (2007), of the International Center for Leadership in Education in his article, *The Three R’s* explains how rigor, relevance, and relationships are keys to success:

As educators, we are constantly challenged to prepare students for successful futures. But in an ever-evolving global economy that is driven by rapid
technological changes, who can say what the future will look like? It’s true that we can’t anticipate every technical skill students will have to master, but we do know they will need to develop critical-thinking, creative, and analytical skills to solve problems we cannot yet imagine. The future requires that we create rigorous and relevant curricula now to help our students learn how to adapt to new situations—to know what to do when they do not know what to do. (Daggett, 2007, p.72)

Daggett goes on to state that:

schools must rigorously determine curricula and teaching practices, not just student scores. We need to look at not just what students know, but whether or not they are learning to apply new knowledge in a myriad of ways. Researchers at the International Center for Leadership in Education have developed a plan to examine curricula, instruction, and assessment to ensure that rigor and relevance are addressed. This Rigor/Relevance Framework (see below) is a necessary tool for assessing the teaching of deeper learning…What works for the Rigor/Relevance Framework is that it provides a structure that enables schools to ask the right questions about curriculum: Is it going deep enough? Is it asking students to be flexible thinkers, take risks, analyze real-world problems, and propose creative solutions?” Daggett concludes that “it is no longer sufficient to merely address the minimum academic needs and requirements of our students. By focusing on the new three R’s—we can set the stage for our students’ future success. (Daggett, 2007, p. 72)
Pennsylvania is no different from other states and has its own growing pains. Some schools have been better equipped and better able to improve student outcomes; others have had more difficulty. The demands are significant on both the academic and technical fronts. Students should leave high school able to perform academically like all the students in Pennsylvania’s schools. Moreover, the technical preparation must also be of high quality, responsive to employer needs, and adequate to meet employer expectations in the local labor market. How well are Pennsylvania’s CTE programs doing? Much improvement is needed if CTE is to play its rightful role as an important
contributor to the economic strength of the state and the economic advancement of its residents (Jobs for the Future, 2005).

In *Student perceptions of school culture and achievement: testing the invariance of a model*, Marcoulides, Heck, and Papanastasiou (2004) wrote about how student perceptions of school culture affect student achievement:

In one part of their study, they specifically focused on students’ beliefs and attitudes about learning mathematics in school. The study had the following results: First, the strongest direct effect on student achievement outcomes was through students’ own attitudes. It was found that less positive attitudes about mathematics were associated with lower student achievement. Student attitudes about learning mathematics were negatively related to classroom teaching processes; that is, the types of instructional activities students reported that teachers used in the classroom (i.e. focusing primarily on problems related to everyday life, checking and discussing homework) were negatively related to their attitudes about math. This may suggest that students with stronger positive attitudes about math may want to receive math content in more depth during class periods, as opposed to focusing time on understanding through using everyday problems and spending time checking homework. Those more basic teacher classroom processes may be directed primarily at students with lower attitudes and achievement in math. (Marcoulides et al., 2004, pp 3-6) (See Figure 2.2)
Another consideration in the integration of math into the curriculum is the anxiety students feel about learning math. Gary Scarpello (2005), in his dissertation *The Effect of Mathematics Anxiety on the Course and Career Choice of High School Vocational-Technical Education Students* wrote that:

Mathematics anxiety may be a critical factor in the educational and vocational choices students make and may influence whether or not they achieve their educational or career goals. One educator states "When otherwise capable students avoid the study of mathematics, their options regarding careers are reduced, eroding the country's resource base in science and technology". The amount of mathematics taken in high school and college determines a student's range of career options. To have a broad range of career options, students need to be adequately prepared in mathematics or they will be blocked from many occupations. If high school students do not take algebra for example, they will be
limiting their career options because algebra is a prerequisite for many other mathematics or science courses. Mathematics anxiety influences both directly and indirectly the choice of major based on the amount of mathematics required. Entering college students who are severely mathematics anxious may enroll in majors that require minimal courses in mathematics such as majors in the humanities, the arts, and social sciences rather than enrolling in more mathematically oriented majors such as the sciences or engineering. Studies have shown that the higher the level of mathematics anxiety, the more likely is the student to avoid mathematics-related tasks, courses or careers. People who have poor mathematics attitudes are fearful of mathematics or have intense negative emotions about anything remotely dealing with mathematics. Whereas high achieving students in mathematics have low anxiety. There is an undeniable relationship between mathematics anxiety and mathematics-related performance and between mathematics anxiety and career choice. (Scarpello, 2005, pp. 3-4)

Also, in the area of student attitude and aptitudes toward math, Dr. Patricia Busk (2008), of the University of California in San Francisco, gathered numerous data. She noted the following:

Overall mathematics achievement of females at ages 9 and 13 is constant with that of males. By age 17, however, the females are not achieving at the same level in mathematics as their male counterparts.….Because attitude development is the result of contact with all social environments the child experiences, including school, the school must address the attitudes it wishes its students to embrace An attitude is defined as a "learned predisposition to react consistently in a given
manner (either positively or negatively) to certain persons, objects, or concepts. (Busk, 2008, p. 4)

Self-confidence in learning mathematics is defined in most research as how sure a student is of his or her ability to learn and to perform well in mathematics. Self-confidence is an important factor because relatively strong correlations have been found between mathematics achievement and a student's self-confidence in learning mathematics. Self-confidence is one of the most important affective variables. Students who are confident about their abilities tend to learn more, to feel better about themselves, and to be more interested in pursuing mathematical ideas than students who lack self-confidence. As well, self-confidence is one of the strongest attitudinal predictors of mathematics course selection. Self-confidence is an important construct because it has been shown to have a consistent, positive relationship with general academic achievement. (Busk, 2008, pp. 7-8)

Teachers' attitudes and effectiveness in mathematics are viewed as prime determiners of students' attitudes and performance and are significantly related to student achievement in mathematics. If girls infer that their teachers hold lower expectations for their mathematics performance, they may develop lower expectations for their own potential achievement in mathematics courses and may choose not to enroll in optional courses. Studies have suggested that boys, especially those for whom the teacher holds high expectations, get more rewards or praise for academic performance in school. This finding can be interpreted in
terms of the value children come to place on various academic domains. (Busk, 2008, p. 10)

Another factor to consider in the area of math anxiety was touched upon by Sharon Begley (2008), stating:

Can we please retire the claim that boy brains are hard-wired for math and girl brains are not? There is no denying that, at the elite levels of math, men vastly outnumber women. Women received 27 percent of the Ph.D.s in math awarded by American universities from 1993 to 2002, edging up to a woeful 29 percent in 2007. In 2005, the ratio of gifted 13 year-olds who score 700 or above on the SAT was 1.8 boys to 1 girl. This ratio had fallen from 13-to-1 boy-girl in 1983. That change cannot be explained by “hard-wiring”, but rather it reflects how powerfully social forces affect brain function. In a 2007 study, girls reminded of the girls-are-spatially-challenged stereotype did worse on a test of spatial ability than those who were not, and brain imaging showed why: they had higher activity in the anterior cingulated, the site of negative emotions such as anger and sadness, and lower activity in high-order visual areas and complex working memory areas. Scale that up to years of messages telling girls they’re intrinsically inferior and then try to argue that a hard-wired brain rather than the messages society sends explains the math gender gap. (Begley, p. 57)
Impact of professional development on teacher behavior and student performance. There have been numerous initiatives over time to enhance the effectiveness of teachers with the desired end product of such initiatives being the enhancement of student achievement often measured in terms of cognitive knowledge attainment. Powell and Beard (1982) and Brophy and Good (1986) identified approximately 3,000 investigations related to the initiatives designed to enhance teacher competence. Most recently Seidel and Shavelson (2007) have examined the literature on teacher effectiveness with special attention to the teacher’s domain/subject specific teaching strategies on students cognitive growth in that subject area. Seidel and Shavelson specifically commented that student “cognitive outcomes were most strongly influenced by domain specific student learning activities (effect size = .25)” for experimental and quasi experimental designed assessments (p. 481-483). Their conclusion is based on a review of 16 studies on teacher effectiveness conducted from 1996 to 2004. Some of these studies involved teachers participating in professional development initiatives with the goal of identifying the characteristics, strategies and behaviors used by teachers in providing effective instruction.

Bloom, as long ago as 1984, attempted to identify the factors that, in his terminology, control learning. He further attempted to develop a weighting system to identify the relative influence of the factors that influence learning. Bloom subsequently suggested that knowledge about three factors would enable a person to predict student learning outcomes. These three global factors included:

1. Cognitive knowledge that a student brings to the learning situation or the level of prerequisite skills a student brings to the learning situation.
2. Affective motivation and interest a student has for learning the material.

3. Teacher competence or the quality of instruction that is provided the student.

(Bloom, 1984, p. 5)

It is Bloom’s last factor that has provided the basis for much of the current professional development initiatives designed to enhance the teacher’s effectiveness in facilitating a learning environment that fosters student achievement. Goldenberg’s (1992) primary contention was that teacher behavior matters—what a teacher does in the classroom is the critical element in student achievement (Bloom, 1984, p. 522).

Cruickshank (1990) cites Dunkin and Biddle (1974) who utilized the Rosenshine and Furst conceptual model (see below) of factors that influence student achievement. The presage variables involve the teacher’s formative experiences, training experiences including in-service professional development experiences, and properties. The context variables refer to the student’s formative experiences as well as the student’s properties, school and community, and classroom contexts. These two sets of variables influence the process variables in the classroom, including the teacher’s classroom behavior and the student’s classroom behavior. Dunkle and Biddle contend the interactions of the presage, context and process variables lead to observable changes in student behavior in the classroom. The final stage in the model are product variables which are the immediate student effects and eventually the long-term student effects. This model provided guidance in the research study discussed in this paper (Cruickshank, 1990).
Figure 2.3. Dunkin and Biddle Conceptual Model. (Cruickshank, 1990)

Wong and Wong (2001), very well known for *The First Days of School*, noted that, “Training is one of the best ways to send a message to your teachers that you value them and want them to succeed and stay. Much worse than training people and losing them is not training them and keeping them!” (Wong & Wong, 2001, p. v). Wong and Wong also noted that an effective teacher: 1) has positive expectations for student success, 2) is an extremely good classroom manager, and 3) knows how to design lessons for student mastery (Wong & Wong, 2001, p. 9). They go on to explain that classroom management refers to all of the things that a teacher does to organize students, space, time, and materials so that instruction in content and student learning can take place (Wong & Wong, 2001, p. 84). Seidel and Shavelson (2007) imply that teacher
professional development activities for teachers need to be more subject matter or domain specific if such “training” is to have a greater influence on student outcomes.

During the past decade Linda Darling-Hammond (2007), formerly at Columbia University and now at Stanford, has specifically written regarding the importance of professional teacher development from both a pre-service and in-service education perspective. She wrote in *The Key Components of Effective Teacher Preparation: The Experts Speak* in addressing the role of professional teacher development that:

A good teacher education program, first of all, is coherent. That is, it has an idea about what good teaching is and then it organizes all of its course work, all of the clinical experiences, around that vision. So it's not just a random assortment of courses and experiences for people—the courses are very much connected to practice as well as to theory. They say, in fact, that there's nothing as practical as a good theory, and in fact there is nothing as theoretical as good practice. And good teacher education programs have students in the classroom working constantly with expert master teachers while they're also teaching students for a variety of ideas about how students learn, about how to assess their learning, about effective teaching strategies that will allow them to build a repertoire. (Darling-Hammond, 2007, p. 1)

Additionally, in Darling-Hammond’s *Thoughts on Teacher Preparation* (2001) she wrote:

What is the value of combining theory and practice? Students find that the combination of practice and course work at the same time is very important. It's hard to learn theoretical ideas in isolation, try to remember them for two years
until you get to student teaching, and then all of sudden be put in a situation
where you're supposed to implement something you've never seen in practice.
That doesn't work. That's the old model of teacher education. Now what you see
are models that really put the two together and have a strong relationship between
the university and the school so that the kind of practice that's very student-
centered, that really takes into account how students learn and how different
students learn differently, is something that can be worked on while you're also
learning about the many knowledge bases that have to come together to produce
that. We'd be much better off to invest in high-quality preparation and have very
effective career teachers in a stable teaching force than trying to be penny-wise
and pound-foolish and not invest on the front end where it's so essential to be sure
that teachers have the tools they need. (Darling-Hammond, 2001, pp. 1-3)

Please see Appendix G (Supplies Purchased by SCCTC)

Finally, Darling-Hammond (2007) in contributing to the article *The Key
Components of Effective Teacher Preparation* stated:

In the last ten years there's been a lot of research done about what makes a
difference for student achievement, and it's now clear that the single most
important determinant of what students learn is what their teachers know. Teacher
qualifications, teacher's knowledge and skills, make more difference for student
learning than any other single factor. (Darling-Hammond, 2007, pp. 1-2)

Thus, Darling-Hammond supports the conclusions of Seidel and Shavelson (2007)
that the preparation and continuing development of teachers is a critical link in the
Dunkle and Biddle framework where presage variables and process variables are directly linked to teacher pre-service and in-service professional development activities.

Clearly that means if we want to improve student learning, what we have to do is invest in teachers' learning. We have to be sure that teachers understand not only their content area, which is very important, but also, how do students learn? How do different students learn differently? How do students acquire language? How do second language learners need to be taught? How do we organize curriculum in ways that are effective? Almost every study (Seidel & Shavelson, 2007) that's done that examined these factors found significant and moderate to substantial effects on what students learn. Interestingly, well-qualified teachers make more difference for students who have struggled more. So it's the most important factor for the students who have had the most difficulty in school (Darling-Hammond, 2007).

According to Teaching Teachers: Professional Development To Improve Student Achievement (2005), by the American Educational Research Association in their Research Points: Essential Information for Education Policy:

Good teachers form the foundation of good schools, and improving teachers’ skills and knowledge is one of the most important investments of time and money that local, state, and national leaders make in education.

Our changing goals for learning, coupled with shifts in curriculum emphasis and a deeper understanding of teacher learning and student thinking, have led to new findings about the impact of teacher professional development and how best to sharpen teachers’ skills and knowledge.
What matters most is what teachers learn. Professional development should improve teachers’ knowledge of subject matter that they are teaching, and it should enhance their understanding of student thinking in that subject matter. Aligning substantive training with the curriculum and teachers’ actual work experiences also is vital.

The time teachers spend in professional development makes a difference as well, but only when the activities focus on high-quality subject-matter content. Extended opportunities to better understand student learning, curriculum materials and instruction, and subject-matter content can boost the performance of most teachers and students. (Teaching Teachers: Research Points, 2005, pp. 3-4)

See Figure 2.4.

![Aspects of Teacher Professional Development and Their Relationship to Better Instruction](image)

**Figure 2.4. Research Points Chart. (Teaching Teachers: Research Points, 2005)**

Christine Smith and Marilyn Gillespie (2007) found in their *Research on Professional Development and Teacher Change: Implications for Adult Basic Education* that:
We can help students achieve higher standards only if we also enhance the effectiveness of our teachers. The research in both K-12 and adult education demonstrates that professional development can, under the right conditions, help teachers be more effective. However, questions remain. Over the long term, we need more research that helps us understand the relationship among student achievement, professional development, and such factors as program structure, teachers’ backgrounds, and working conditions. Such information can guide decisions about the design and funding of teacher preparation and support. However, there is much we can do in the short term to promote more effective research-based approaches to teacher professional development. (Smith & Gillespie, 2007, p. 239)

Milbrey McLaughlin and Joan Talbert (2001) discussed the need for and great benefit of teacher learning communities in their book, *Professional Communities and the Work of High School Teacher*. One of their main premises was that “teachers’ different responses to contemporary students—the patterns of practice they pursue in their classroom, and the conceptions of students and principles of teaching from which they derive—fundamentally shape students’ classroom experiences” (McLaughlin & Talbert, 2001, p. 32). They went on to write that:

students’ learning experiences in high schools or departments with weak teaching cultures are akin to an instructional lottery, in which their learning opportunities depend heavily on which teachers they draw, from class to class and from year to year. Individual teachers’ preferences and beliefs about students and subject matter define students’ classroom experiences, ranging from strict adherence to
curriculum coverage and standardized testing, to “dumbed-down” content, to collective work on challenging problems and issues in a subject. (McLaughlin & Talbert, 2001, p. 64)

Another factor to consider in professional development was discussed by the authors when they discussed the need for career growth. In the case of the high school math departments they researched, they found that those teachers, “who were given the opportunity to teach new and more advanced math material felt less stagnant in their jobs and those teachers are expected to hold high standards for all of the colleagues, as well as for all of their students” (McLaughlin & Talbert, 2001, p. 81). With regard to leadership, the authors went on to say that:

leaders use a number of strategies and opportunities for teachers to work together in ways that clarify norms of practice and expectations for students. They create various structures to support conversation and exchange, both formal and informal, and enable teachers to negotiate different understandings about practice. At school and district leaders use retreats, ad hoc assignments to cross-school committees or task forces, and other means to integrate views both vertically and horizontally within the system and to keep channels of communication open. They also understand the importance of informal communication; they ensure time and opportunities for it to occur. (McLaughlin & Talbert, 2001, p. 121)

In order for this all to occur, the authors explained that:

this is fundamentally a problem of re-culturing the profession—changing the ethos of teaching from individualism to collaboration, from conservatism to innovation. Efforts too change teaching by restructuring schools or by mandating
new education standards will fail if teachers lack the vision and will to change their professional lives and practice. Further, as gatekeepers of students’ access to higher education, high school teachers are subject to expectations and pressures from parents, colleges and universities, and the public about how to prepare and allocate students into an extremely stratified higher education arena. (McLaughlin & Talbert, 2001, p. 125)

The authors continued by stating:

the character and quality of teaching found in any high school classroom on any day signals much more than the attributes, energy, and expertise of any individual teacher. The work of high school teaching takes shape in professional communities—through norms for teaching, curriculum structures and assignment policies, collegial supports, and leadership messages about good professional practice. (McLaughlin & Talbert, 2001, p. 140)

Rebecca Blink (2007), in her book *Data Driven Instructional Leadership*, stated that:

data-driven instructional design, which includes the lessons of study and how to teach them, also corresponds with systemic change and school reform. Data-driven instructional design focuses on using data to inform instruction at the classroom level. Unlike data translation, which focuses more on the district and building levels, data-driven instructional design focuses on what is happening in the classroom. As school leaders, we can create all the programs we want, but if we don’t change the way teachers teach in the classroom, all the data in the world isn’t going to make a difference. Data-driven instructional design is at the heart of
the Data-Driven Instructional System (DDIS) model. The goal of any data-driven initiative must be to change instruction at the classroom level. The classroom level is where change needs to happen—but it cannot happen without the DDIS model in place to support the efforts of teachers. (Blink, 2007, p. 8)

Blink, and her dissertation advisor, Dr. Richard Halverson, developed the following model for DDIS (Blink, 2007, p. 3), see Figure 2.5 below:

![Figure 2.5. Blink/Halverson Model for Data-Driven Instructional Systems. (Blink, 2007)](image)

Victoria Bernhardt (2005), in her article, *Data Tools for School Improvement*, discussed the need for what data tools a school needs to help schools improve. She explained that specific data tools that are available and that can be utilized:
• A **database** is a system of organized information that is easily retrievable—preferably electronically. Telephone books and dictionaries are common databases that are organized alphabetically to make information easy to find.

• **Student information systems** are databases that electronically collect and organize data concerning characteristics of the student population and school processes. Such a system makes it easy to collect and consolidate data about many factors, such as student attendance; discipline referrals; number of students of a certain gender, ethnicity, or family income; student course assignments and schedules; and specialized school programs.

• **Educational data warehouses** allow the manipulation and integration of multiple databases connected to one another through individual student and teacher identification numbers, and through class schedules that link students to teachers. An excellent educational data warehouse will link together student demographic and grading data from your student information system to standardized student test scores that might come from a testing company and to program data in a separate database. One could access these different types of data for an individual student without needing to reenter the basic student information each time. Data warehouses allow longitudinal and comprehensive data analyses with multiple variables from multiple sources.

• **Instructional management systems** help teachers align lessons to standardized learning objectives, provide instructional resources and assessments, and measure student performance on learning objectives.

(Bernhardt, 2005, p. 69)
Douglas Harris and Tim Sass (2006) presented their Teacher Training, Teacher Quality and Student Achievement study results, reporting the following data related to the effects of teacher experience and professional development on student achievement in the area of mathematics:

- Experience matters, even after controlling for unmeasured teacher characteristics.
- Positive correlations between in-service professional development and teacher effectiveness only found for middle-school math teachers.
- Limited evidence that subject content course work in education is correlated with improved teacher effectiveness in high school math. (Harris & Sass, 2006) (See Table 2.1 below.)

Table 2.1.

<table>
<thead>
<tr>
<th></th>
<th>Elementary (Grades 4-5)</th>
<th>Middle (Grades 6-8)</th>
<th>High School (Grades 9-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content In-service hours</td>
<td>-0.0013 (0.38)</td>
<td>-0.005 (0.26)</td>
<td>0.0066 (2.10)</td>
</tr>
<tr>
<td>Content In-service hours,1</td>
<td>0.0040 (1.13)</td>
<td>0.0069 (2.65)</td>
<td>0.0054 (1.45)</td>
</tr>
<tr>
<td>Content In-service hours,2</td>
<td>-0.0070 (2.00)</td>
<td>0.0050 (1.79)</td>
<td>0.0088 (2.26)</td>
</tr>
<tr>
<td>Content In-service hours,3</td>
<td>-0.0020 (0.52)</td>
<td>0.0037 (1.41)</td>
<td>0.0009 (0.22)</td>
</tr>
<tr>
<td>Other In-service hours</td>
<td>-0.0028 (0.92)</td>
<td>0.0016 (0.98)</td>
<td>0.0006 (0.22)</td>
</tr>
<tr>
<td>Other In-service hours,1</td>
<td>0.0024 (0.92)</td>
<td>0.0041 (2.77)</td>
<td>-0.0010 (0.32)</td>
</tr>
<tr>
<td>Other In-service hours,2</td>
<td>-0.0013 (0.49)</td>
<td>-0.0016 (1.16)</td>
<td>0.0023 (0.86)</td>
</tr>
<tr>
<td>Other In-service hours,3</td>
<td>-0.0015 (0.61)</td>
<td>0.0016 (1.01)</td>
<td>0.0050 (2.63)</td>
</tr>
</tbody>
</table>

Note for table: Numbers in ( ) are the $t$ values whereas the first number in a cell represents the beta value.
Another factor in student performance was the identification of a barrier to math comprehension called dyscalculia. Marcia D’Arcangelo (2001) interviewed neuropsychologist Brian Butterworth in her article, *Wired for Mathematics*.

Butterworth’s research noted that:

- dyscalculia is a condition a child is born with that affects the ability to acquire the usual arithmetical skills. Dyscalculic students may show difficulty understanding even simple number concepts and, as a consequence, will have problems learning the standard number facts and procedures. Even when dyscalculic students can produce the correct answer or the correct method, they may do so mechanically and without confidence because they lack an intuitive grasp of numbers that the rest of us possess. Dyscalculia is rather like a dyslexia for numbers—by unlike dyslexia, little is currently known about its prevalence, causes, or treatment.
- Dyscalculia often appears in conjunction with other learning difficulties—including dyslexia, dyspraxia, and attention deficit disorders—but most dyscalculic students will have cognitive and language abilities in the normal range and may indeed excel in nonmathematical subjects. (D’Arcangelo, 2001, p.16)

**Summary**

Chapter 2 presented a review of legislation and literature that impacts the formulation of a CTE curriculum that contains increased academic rigor. The Perkins Legislation, in concert with NCLB, mandates this. Jobs for the Future stresses the need for increased academic rigor to ensure the educational success and opportunity for Pennsylvania’s and the country’s students for the 21st century economy. Students drop out of school for many reasons, but often boredom, lack of motivation, and difficulty
with academic subjects are cited as some of the more common. The research indicates that students will continue to drop out unless curriculum is made more engaging and relevant. Ronsenshine and others have shown that there are effective, well-structured procedures to follow that will lead to engagement of students in their learning. The Math-in-CTE project completed by NRCCTE in 2005 demonstrated that teachers using a CTE curriculum enhanced with mathematics can raise students’ math test scores. The impact of professional development on teacher behavior and student performance was discussed and found to be crucial and very beneficial in attaining the goal of raising the level of academic achievement of CTE students.

The Math-In-CTE professional development process from the National Research Center for Career and Technical Education served as the model for this research study. This model provides a prescribed method of providing professional development for CTE instructors combined with a scripted lesson plan format to help CTE instructors discover and teach the math embedded in their programs.

The Perkins Legislation has served as the driving force behind academic rigor in our career and technical schools. This legislation is focused on improving the academic skills of CTE students and measures success with improving achievement in academic subjects. Funds are at risk in schools that do not continuously improve student achievement.

James Stigler and James Hiebert (1999) stated clearly that the United States can compete in a global economy if we build a system of gradual improvement like the one found in Japan, where clear standards for what students should learn and a means of
assessing progress is implemented. Stigler and Hiebert (1999) established the following six principles for gradual, measurable improvement:

Principle #1: Expect improvement to be continual, gradual, and incremental.

Principle #2: Maintain a constant focus on student learning goals.

Principle #3: Focusing on teaching, not teachers.

Principle #4: Make improvement in context.

Principle #5: Make improvement the work of teachers.

Principle #6: Build a system that can learn from its own experience.

(Stigler & Hiebert, 1999, p. 131)

The six principles provide a rational basis for continuing, steady school improvement that meets needs of our CTE students and the stakeholders of our CTE programs while also addressing the mandates in state and federal initiatives for school reform.
CHAPTER 3
METHODOLOGY

Introduction

An approach to helping teachers help students improve their math achievement was researched by the National Research Center for Career and Technical Education (NRCCTE, 2006). The NRC model was used to provide professional development to Cosmetology teachers at the SCCTC to examine whether such professional development could contribute to a gain in math achievement of students in that program.

Integrating math into career and technical education (CTE) programs supposedly enhances the mathematical concepts that are embedded in career and technical education content. It is a process that provides the opportunity for math and CTE teachers to work together to identify where math intersects with CTE concepts and applications. Students benefit from this team process by having math concepts taught in the same context in the math classroom and also the CTE program. Research demonstrated that this model has been shown to have a significant positive impact on student learning in mathematics with no loss to career and technical area content (Pennsylvania Department of Education, 2008).

Population

The population for this study included all students from the seven sending schools that attend the Susquehanna County Career and Technology Center. The Susquehanna County Career & Technology Center has seven sending schools from two counties (Susquehanna and Wyoming), and is comprised of eight programs of study (Automotive Technology, Building Trades I and II, Business Education/Information Technology, Food
Management/Production/Services, Health Career Technology, Cosmetology, and Cooperative Education/Diversified Occupations. Sessions at SCCTC are divided in A.M. (8:15-11:46) with students from 11th and 12th grades, and P.M. (12:12-2:16) with students from 10th grade. Additionally, Susquehanna Community School students attend for both sessions due to distance traveled (1 hour each direction). These students were in the 10th, 11th, and 12th grades and were between the ages of 15 to 20. A total of 296 students were given the pre-test in September, 2007 near the start of the school year, prior to receiving any enhanced math instruction in their program of study and prior to the Cosmetology teachers receiving any enhanced professional development in the area of math.

**Treatment**

There are eight programs of study at the SCCTC: Automotive Technology, Building Trades I (carpentry and cabinetmaking), Building Trades II (electrical, plumbing, and heating), Business Education/Information Technology, Cosmetology, Food Management/Production/Services, Health Care Technology, and Diversified Occupations/Cooperative Education.

**Group # 1 (Treatment Group)** serving as the students receiving the treatment in this study were the Cosmetology students, represented by 110 students. These students were in the 10th, 11th, and 12th grades. In consideration of what was asked of the teachers, to integrate math into their curriculum, several opportunities for cosmetology teacher professional development were provided to ease this process and hopefully make it more successful.

1. The Cosmetology teachers attended the Governors Math Institute presented in the summer of 2007 by The Pennsylvania State University (Appendix L). This Institute
was a dynamic week of professional development activity for secondary instructors. The focus of the institute was on collaborating across disciplines to help students learn mathematics while learning in CTE course. The institute brought teachers from both disciplines together for collaborations, content learning, and current instructional strategies. All three teachers reported back that the Institute was of enormous help to them in this new effort.

2. During the 2007-2008 school year, the Cosmetology teachers received extensive math integration training and information from Dr. Mary Kisner while other teachers were receiving other in-service training. The Cosmetology teachers received a total of 35 and ½ hours of training by a professional educator-trainer and other professional development during teacher in-service days. The Cosmetology teachers were also given the opportunity to meet every week at least three days a week between 3:00 and 3:30 P.M. to share their teaching experiences and network with each other and other teachers (amounting to 57 hours). See Appendix E for school calendar.

Dr. Kisner utilized the Math-in-CTE model in working with the Cosmetology teachers on a contextual basis. The teachers brought current lesson plans to the training and re-worked these to include math as well as learning effective instructional strategies and techniques in executing the lessons. This was done on three separate occasions during the year. The teachers from other programs were involved in math integration training during those in-service periods provided by Dr. Daniel Perna. However, that training was more limited in nature and broad-based to encompass the wide array of CTE disciplines. Additionally, it should be noted that several of these teachers were “veterans”
with 15 or more years of teaching experience. As such, they were utilizing some integration of math in their curriculum prior to these in-service training sessions.

3. The Cosmetology teachers were provided with a wide array of supplies and equipment (including a laptop computer for each teacher as well as teaching tools such as flash cards, Algebra Survival guide and workbook, and other such items) to help them succeed with their math integration efforts. These tools were distributed to students in the classroom as needed. See Appendix G (SCCTC Math Supplies & Equipment Purchased) for details.

    **Group #2 (Comparison Group)** were the students in the other seven programs of study at SCCTC, comprising a total of 186 students. Teachers of these programs did not receive direct professional development in math integration.

    It should be noted that the math model was not fully implemented in this initial effort at SCCTC. The seven elements of the Math-in-CTE model were not able to be fully implemented. Specifically, the area of assessment will need more effort at SCCTC. Teachers will be trained in formulating useful, informative assessments, both informal and formal. Also, math teachers were not involved in actually aiding Cosmetology teachers in developing lesson plans for members of the Treatment Group. In the future, the math teachers will be directly involved in presented some course material to such students.

    **Research Design**

    The previous section described the treatment condition. From a research design perspective this study represented quasi-experiment research using intact groups.
Specifically, the study used the nonequivalent control group design as described by Graziano and Raulin (2007, pp. 292-295).

**Instrument**

The ACCUPLACER® Computerized Placement Test (CPT) was used to measure student achievement in math. This provided information about students, level of skill and accomplishment in mathematics. The arithmetic test given was designed to measure student ability to perform basic arithmetic operations and to solve problems that involve fundamental arithmetic concepts. The ACCUPLACER® online was the first and only computer-adaptive placement testing program delivered over the internet. Individual students score reports were available immediately after testing (ACCUPLACER®, 2007, p. 2).

**Data Collection**

Because the ACCUPLACER® CPT was delivered on the computer, it was necessary to test 20 students at a time in the computer lab. The test took approximately 30 minutes to complete.

Since 223 of the original 296 students took the pre-test and the post-test, consent letters were mailed to the homes of each of these students on July 5, 2008. (The balance of the original test takers had moved, dropped out, or transferred out of the CTE school). Students and their parents/guardians were asked to return the letters indicating their consent or rejection to include their student scores in the data analysis process by July 16, 2008. To encourage a timely return of the consent forms, the recipients were informed that all those who returned their form by the due date would be entered into a drawing for
a $50 pre-paid Visa card (the winning recipient, Control # 2145, was mailed a letter and Visa card on September 11, 2008).

By the due date, 73 letters were received back. In order to increase the response rate additional efforts were made. All non-responding students/parents were telephoned and either were spoken to personally, or a message was left. In many of these instances, the recipient asked for an additional consent form to be mailed and this was done immediately. In other instances, the initial form was completed after the phone call and returned. As a result of these efforts, an additional 44 signed consent forms were received. Of the total 117 consent forms received, 112 granted consent to be included in the research study. This represented slightly more than 50% of total test subjects. A comparison using the independent t test was made between the two groups of responders (early and later responders). No significant difference existed between the two on the pre- and post-test scores.

**Data Analysis**

The data were entered into Microsoft Access® (database software). A comparison was made between pre-test and post-test scores for the Cosmetology students. A second comparison was made between the percent of gain in scores between the Cosmetology students and the rest of the school.
Table 3.1 shows the reliability results for the math test by dimension measured for the Treatment and Comparison groups (N=112).

Table 3.1.

Reliability Results for the Math Test by Dimension measured

<table>
<thead>
<tr>
<th>Math Test Dimension</th>
<th>N</th>
<th>Number of Items</th>
<th>Cronbach Alpha Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-test</td>
<td>112</td>
<td>18</td>
<td>.76</td>
</tr>
<tr>
<td>Multiplication</td>
<td>112</td>
<td>5</td>
<td>.51</td>
</tr>
<tr>
<td>Division</td>
<td>112</td>
<td>7</td>
<td>.56</td>
</tr>
<tr>
<td>Addition</td>
<td>112</td>
<td>2</td>
<td>.28</td>
</tr>
<tr>
<td>Subtraction</td>
<td>112</td>
<td>4</td>
<td>.58</td>
</tr>
</tbody>
</table>

Based on the reliability results, only the post-test total scores has an acceptable level of reliability of .7 or higher (Isaac & Michael, 1995). Within each of the dimensions results will be examined by individual item.

Confidentiality

To maintain confidentiality of the students, a control number was assigned to each student. Data were collected and stored at Susquehanna County Career & Technology Center in a locked/password protected file. In the event of a publication for presentation resulting from the research, no personally identifiable information about the family or child will be shared.
CHAPTER 4
FINDINGS

Introduction

The purpose of the study was to investigate whether an enhanced math curriculum resulted in greater student achievement, as measured by the ACCUPLACER® CPT test, for a rural school district in Pennsylvania. The research questions included:

1) Does professional development to help Cosmetology instructors enhance the math in their curriculum improve the math achievement of their students?

2) Does professional development to help Cosmetology instructors enhance the math in their curriculum improve the math achievement of their students significantly more than the rest of the students in the school that did not have teachers with professional development? Additional findings include anecdotal evidence and records from interviews and observations.
Background of Study Participants

Table 4.1 summarizes the participant background profiles by treatment condition. (N=73) for Comparison Group and (N=39) for Treatment Group.

Table 4.1.

Participant Background Profile by Treatment Condition.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Comparison Group (N=73)</th>
<th>Treatment Group (N=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Valid %</td>
</tr>
<tr>
<td><strong>Home School</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BR</td>
<td>17</td>
<td>23.3</td>
</tr>
<tr>
<td>EL</td>
<td>35</td>
<td>47.9</td>
</tr>
<tr>
<td>LT</td>
<td>4</td>
<td>5.6</td>
</tr>
<tr>
<td>MO</td>
<td>10</td>
<td>13.7</td>
</tr>
<tr>
<td>MV</td>
<td>3</td>
<td>4.1</td>
</tr>
<tr>
<td>SU</td>
<td>3</td>
<td>4.1</td>
</tr>
<tr>
<td>TU</td>
<td>1</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Program</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto</td>
<td>23</td>
<td>31.5</td>
</tr>
<tr>
<td>BT I</td>
<td>10</td>
<td>13.7</td>
</tr>
<tr>
<td>BT II</td>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>Business Educ.</td>
<td>7</td>
<td>9.6</td>
</tr>
<tr>
<td>FM</td>
<td>11</td>
<td>15.1</td>
</tr>
<tr>
<td>HCT</td>
<td>18</td>
<td>24.7</td>
</tr>
<tr>
<td>Cos.</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Session</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AM</td>
<td>41</td>
<td>56.2</td>
</tr>
<tr>
<td>PM</td>
<td>29</td>
<td>39.7</td>
</tr>
<tr>
<td>All Day</td>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td><strong>Grade</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10th</td>
<td>27</td>
<td>37.0</td>
</tr>
<tr>
<td>11th</td>
<td>21</td>
<td>28.8</td>
</tr>
<tr>
<td>12th</td>
<td>25</td>
<td>34.2</td>
</tr>
<tr>
<td><strong>IEP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>43</td>
<td>58.9</td>
</tr>
<tr>
<td>Yes</td>
<td>30</td>
<td>41.1</td>
</tr>
</tbody>
</table>

See Key below.
Key for Table 4.1

Home Schools:
- BR= Blue Ridge
- EL= Elk Lake
- LT= Lackawanna Trail
- MO= Montrose
- MV= Mountain View
- SU= Susquehanna
- TU= Tunkhannock

Programs of Study:
- Auto= Automotive Technology
- BT I= Building Trades I (Carpentry and Cabinet Making)
- BT II= Building Trades II (Plumbing, Electrical, and Heating)
- Business Education= Business Education/Information Technology
- FM=Food Management/Production/Services
- HCT=Health Career Technology
- Cos=Cosmetology

Sessions:
- AM session meets daily 8:15-11:46 A.M.
- PM session meets daily 12:15-2:16 P.M.
- Grades:
  - 10th Grade meets in the PM session
  - 11th and 12th Grades meet in the AM session.
  - Susquehanna students attend all day due to distance traveled (1 hour each way).
Information in Table 4.2 provides background information regarding the study participants’ math and reading performance on their most recent PSSAs. For this study what is especially important is the overall performance on the PSSA math, and is used to assess whether the two groups of students differed substantially on their overall math knowledge prior to participating in the study. PSSA data were available for 33 of the 39 students in the treatment group. For the 33 students in the treatment group the average PSSA math score was 1242.85 (SD = 177.12); whereas, the comparison group students averaged 1224.54 (SD = 151.35). Thus, the two groups of students were very similar on their overall math knowledge prior to participating in the study as assessed by their PSSA math scores. Therefore, there is evidence that the two groups of students did not differ substantially on general overall math knowledge prior to the study as assessed by the PSSA math test.

Table 4.2.

Participant PSSA Reading and PSSA Math Profile by Treatment Condition.

<table>
<thead>
<tr>
<th>Variable by Group</th>
<th>N</th>
<th>Mean (Median)</th>
<th>Standard Deviation</th>
<th>95% CI Low-High</th>
<th>Range Low-High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PSSA Reading</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison Group</td>
<td>67</td>
<td>1224.54 (1265.00)</td>
<td>198.71</td>
<td>1176.07-1273.01</td>
<td>804-1766</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>33</td>
<td>1326.33 (1360.00)</td>
<td>237.24</td>
<td>1242.21-1410.46</td>
<td>700-1757</td>
</tr>
<tr>
<td><strong>PSSA Math</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison Group</td>
<td>67</td>
<td>1239.00 (1230.00)</td>
<td>151.35</td>
<td>1202.08-1275.92</td>
<td>956-1674</td>
</tr>
<tr>
<td>Treatment Group</td>
<td>33</td>
<td>1242.85 (1305.00)</td>
<td>177.12</td>
<td>1180.04-1305.65</td>
<td>879-1610</td>
</tr>
</tbody>
</table>

Math PSSA Test Score Interpretation: Advanced (1509 and above); Proficient (1304-1508); Basic (1167-1303); Below Basic (1166 and below).
Research Question #1

Information in Table 4.3 summarizes the performance of the students in the treatment group. The average performance on the pre-test was 73.18% (SD = 18.29%) of the items correct on the 20 item math test. The lowest individual participant score on the pre-test was 28% correct and the highest individual participant score on the pre-test was 100% of the items correct. For the post-test the average performance was 75.05% (SD 17.13%) of the items correct on the 20 item math test. The lowest individual participant score on the post-test was 33% correct and the highest individual participant score on the post-test was 100% of the items correct.

In comparing the differences from pre-test to post-test, there is a change (gain) of approximately 2% from pre-test to post-test. However, the examination of the variability in individual scores reveals that one person decreased by 22% from pre-test to post-test, and one individual increased by 33% from pre-test to post-test. The standard deviation is relatively large (15.51%) and is influenced by the relatively large decrease for some individuals and relatively large increases by other individuals.

Table 4.3.

Student Math Test Results for Students Enrolled in Courses Taught by Teachers Receiving Math Enhancement Professional Development.

<table>
<thead>
<tr>
<th>Math Test</th>
<th>N</th>
<th>Mean (Median)</th>
<th>Standard Deviation</th>
<th>95% CI</th>
<th>Range Low</th>
<th>Range High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math Pre-test (%)</td>
<td>39</td>
<td>73.18 (72.00)</td>
<td>18.29</td>
<td>67.25 – 79.11</td>
<td>28</td>
<td>100</td>
</tr>
<tr>
<td>Math Post-test (5)</td>
<td>39</td>
<td>75.05 (72.00)</td>
<td>17.13</td>
<td>69.50 – 80.61</td>
<td>33</td>
<td>100</td>
</tr>
<tr>
<td>Math Test Change Score from Pre-test to Post-test</td>
<td>39</td>
<td>1.87 (0.00)</td>
<td>15.51</td>
<td>-3.16 – 6.90</td>
<td>-22</td>
<td>33</td>
</tr>
</tbody>
</table>
Figure 4.1 displays the percentage math domain items correct (N=39) by reviewing pre-test and post-tests in addition, subtraction, division & multiplication.

Multiplication had the largest gain.

On the pre-test students did the best in addition, then multiplication and subtraction, and last in division. The rank order was the same for the pre-test and post-test.

Figure 4.1. Percentage of Math Domain Items Correct (N=39).
Research Question #2

Changes From Pre-Test To Post-Test Compared By Group

Independent \( t \) tests were used to determine whether statistically significant differences existed on both the math pre-test and the post-test between the two groups of students (Table 4.4). The 39 students in the treatment group were slightly lower (mean = 73.18\%) than the comparison group (mean = 77.55\%). However, this difference was not statistically different (\( t = 1.31, \) df = 1/110, \( p=.193 \)). From a research study design perspective this is an important finding because it indicates that prior to the study the students were equivalent as measured by the math knowledge pre-test.

The post-test results in Table 4.4 reveal that the average math post-test score was 75.05\% for the treatment group (SD = 17.14) and 79.29 (SD = 15.02) for the comparison group. The difference between the two groups on the post-test was not statistically significant (\( t=1.35, \) df=1/110, \( p=.179 \)).
The last analysis summarized in Table 4.4 examines whether the difference between the pre-test and post-test scores for the two groups differed. The results indicate that although the student scores for both groups increased slightly from pre-test to post-test (1.87% = treatment group and 1.74 for comparison group) there was no significant difference in the amount of change between the two groups.

Table 4.4.

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
<th>Independent test Value**</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test Math Score (% Correct)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Group</td>
<td>39</td>
<td>73.18</td>
<td>18.29</td>
<td>28</td>
<td>100</td>
<td>1.31</td>
</tr>
<tr>
<td>Comparison Group</td>
<td>73</td>
<td>77.55</td>
<td>15.96</td>
<td>39</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Post-test Math Score (% Correct)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Group</td>
<td>39</td>
<td>75.05</td>
<td>17.14</td>
<td>33</td>
<td>100</td>
<td>1.35</td>
</tr>
<tr>
<td>Comparison Group</td>
<td>73</td>
<td>79.29</td>
<td>15.02</td>
<td>39</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Gain Score from Pre-test to Post-test (Change in %)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Group</td>
<td>39</td>
<td>1.87</td>
<td>15.50</td>
<td>-22</td>
<td>33</td>
<td>.04</td>
</tr>
<tr>
<td>Comparison Group</td>
<td>73</td>
<td>1.74</td>
<td>15.57</td>
<td>-55</td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
(t = .04, df = 110, p = .966).
* Gain or change score was calculated as Post-test Score – Pre-test Score.
** The equal variance assumption for the t test was met using Levene’s test for equal variance.
The following figures display the performance of the treatment and comparison groups on general types of math questions, such as multiplication, addition, division, multiplication and subtraction. The figures indicate specific question numbers (A1 would be the first question on the pre-test). To facilitate understanding of the figures, the following is a list of specific math categories that each question falls under:

| Multiplication/Division-Whole Numbers: |  
|---------------------------------------|---|
| #1                                   |  
| #2                                   |  
| #3                                   |  
| Addition/Subtraction-Decimals:       |  
| #4                                   |  
| #5                                   |  
| #6                                   |  
| Multiplication/Division-Decimals:     |  
| #7                                   |  
| #8                                   |  
| #9                                   |  
| Addition/Subtraction-Fractions:      |  
| #10                                  |  
| #11                                  |  
| #12                                  |  
| Multiplication-Fractions:            |  
| #13                                  |  
| #14                                  |  
| #15                                  |  
| Division-Fractions:                  |  
| #16                                  |  
| #17                                  |  
| #18                                  |  

Figure 4.2 presents the percentage of correct answers from the Treatment Group (N=39) by reviewing the pre-test and post-test in multiplication items.

Figure 4.2. Treatment Group Percent Correct Responses for Multiplication Items.
Figure 4.3 clarifies the Comparison Group (N=73) percent correct responses by detailing the pre-test and post-test in multiplication items.

Figure 4.3. Comparison Group Percent Correct Responses for Multiplication Items.
Figure 4.4 presents the percentage of correct responses by the Treatment Group (N=39) by summarizing the pre-test and post-test in division items.

Figure 4.4. Treatment Group Percent Correct Responses for Division Items.
Figure 4.5 clarifies the percent of correct responses by the Comparison Group (N=73) by summarizing the pre-test and post-test in division items.

Figure 4.5. Comparison Group Percent Correct Responses for Division Items.
Figure 4.6 shows the percent of correct responses by the Treatment Group (N=39) by summarizing the pre-test and post-test in subtraction items.

Figure 4.6. Treatment Group Percent Correct Responses for Subtraction Items.
Figure 4.7 clarifies the percent of correct responses by the Comparison Group (N=73) by summarizing the pre-test and post-test in subtraction items.

Figure 4.7. Comparison Group Percent Correct Responses for Subtraction Items.
Figure 4.8 displays the percent of correct responses by the Treatment Group (N=39) by summarizing the pre-test and post-test in addition items.

Figure 4.8. Treatment Group Percent Correct Responses for Addition Items.
Figure 4.9 clarifies the percent of correct responses by the Treatment Group (N=39) by summarizing the pre-test and post-test in addition items.

Figure 4.9. Comparison Group Percent Correct Responses for Addition Items.
CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study was intended to provide career and technical education (CTE) professionals important information about the rigorous legislative requirements imposed by The No Child Left Behind Act of 2001 (NCLB 2001) and the 2006 reauthorization of the Carl D. Perkins Career and Technical Education Act (Perkins:Background, 2008) along with detailed presentations of research on how student achievement can be improved to meet those requirements. Specifically, the study first examined whether professional development of a selected group of professionals (Cosmetology teachers) to help enhance the math in their curriculum improved the math achievement of their students as measured by the ACCUPLACER® CPT test. Secondly, the study examined whether professional development to help Cosmetology instructors enhance the math in their curriculum improved the math achievement of their students (as measured by the ACCUPLACER® CPT test) significantly more than the rest of the students in the school that did not have teachers with professional development?

Summary of Study Procedures

With the passage of NCLB and the reauthorization of Perkins in 2006, the responsibility for including academic subject material, including math, was increased greatly on CTE professionals. In addition to remaining proficient and current in their content area, they were not being pressed to merge math and literacy competencies into their programs. The literature review for this study examined the specific legislative changes impacting CTE; summarized the information available on the academic rigor needed in Pennsylvania and the rest of the United States to ensure educational success.
and opportunity for all students in the building of a vibrant responsive 21st Century economy (Jobs for the Future, 2005); synthesized research data to determine applicable and effective methods and tools in the area of professional development and for creating an engaging math curriculum which would help CTE professionals improve student achievement; and established a baseline for use in determining progress in CTE students’ academic learning, specifically in the area of math.

The study empirically tested the possibility that enhancing the embedded mathematics in the Cosmetology curriculum would result in greater academic student achievement as measured by the ACCUPLACER® CPT test. This information should provide valuable information for CTE programs in obtaining and being accountable for Perkins funds. The study should also help to designate the remediation teaching that needs to be provided to help ensure success for our students. The study examined the following questions:

1. Does professional development to help Cosmetology instructors enhance the math in their curriculum improve the math achievement of their students as measured by the ACCUPLACER® CPT test? (Treatment Group)

2. Does professional development to help Cosmetology instructors enhance the math in their curriculum improve the math achievement of their students significantly more than the rest of the students in the school that did not have teachers with professional development?

The research questions tested the difference between the math achievement of Cosmetology students (treatment group) with enhanced math embedded into their
curriculum and the rest of the students (comparison group). This represented a quasi-experimental research design as the students already existed in intact classroom settings.

The total population for this study included all students from the seven sending schools that attend the Susquehanna County Career and Technology Center. The Susquehanna County Career & Technology Center has seven sending schools from two counties (Susquehanna and Wyoming), and is comprised of eight programs of study (Automotive Technology, Building Trades I and II, Business Education/Information Technology, Food Management/Production/Services, Health Career Technology, Cosmetology, and Cooperative Education/Diversified Occupations. Sessions are divided in A.M. (8:15-11:46) with students from 11\textsuperscript{th} and 12\textsuperscript{th} grades, and P.M. (12:12-2:16) with students from 10\textsuperscript{th} grade. Additionally, Susquehanna Community School students attend for both sessions due to distance traveled (1 hour each direction). These students were in the 10\textsuperscript{th}, 11\textsuperscript{th}, and 12\textsuperscript{th} grades and were between the ages of 15 to 20.

A total of 296 students were given the test in September, 2007 near the start of the school year, prior to receiving any enhanced math in their program of study and prior to the Cosmetology teachers receiving any enhanced professional development in the area of math (Pre-Test). In the Spring of 2008, 223 of those students were given a post-test (the remaining testers had moved away, dropped out, or transferred out of the CTC). After several attempts at obtaining consent for use in the study from all guardians and parents of students, a total of 112 granted consent, representing 50.2% of total study subjects.
Summary of Background Literature

A review of literature in five major areas of interest was conducted. These were Legislation, Jobs for the Future, Math-in-CTE Project, Development of an Engaging Math Curriculum, and Impact of Professional Development on Teacher Behavior and Student Performance.

Legislation

The first included a detailed analysis of the increasing academic requirement mandated by legislation, such as NCLB and Perkins, as reauthorized in 2006, has served as one of the driving forces behind academic rigor in our career and technical schools. Perkins specifically requires CTE schools to develop and integrate challenging academic and technical standards, conduct and disseminate research on best practices that improve career and technical education programs, services, and activities, provide professional development in order to improve the quality of CTE teachers, and support partnerships among secondary schools, postsecondary institutions, local workforce investment boards, and business and industry. NCLB (2001) puts emphasis on determining which educational programs and practices have proven effective through rigorous scientific research. Federal funding is targeted to support these programs and teaching methods that work to improve student learning and achievement. This leads to the conclusion that CTE must conduct research studies similar to this study in order to continue to justify government funding for CTE programs of study.
Jobs for the Future

The second area of literature reviewed was in the area of Jobs for the Future (2005). This study indicated that academic rigor is important for the Commonwealth of Pennsylvania and the national in ensuring educational success and opportunity for all its students, and in building a vibrant responsive 21st Century economy. CTE programs are being asked to prepare students for postsecondary education or career employment, CTE is no longer for the non-college bound; it is an alternative route to decent employment and further learning for its participants (Jobs for the Future, 2005). This further demonstrates the need for increasing the integration of math and other academic subject matter into the CTE curriculum in a rigorous, relevant way that relates to the program of study curriculum.

Math-in-CTE Research Project.

The third area of literature studied was the Math-in-CTE Project, which served as the model for this research study. Hyslop (2007) wrote that this study, conducted by the National Research Center for Career and Technical Education (NRCCTE) in 2005 was one of the most prominent studies related to the integration of academic and career and technical education. According to the study, teachers using a CTE curriculum enhanced with mathematics can raise students’ math test scores. The NRCCTE model for Math-in-CTE includes the following 7 elements:

1. Introduce the CTE lesson.
2. Assess students’ “Math Awareness” as it relates to the CTE lesson.
3. Work through the math examples embedded in the CTE lesson.
5. Work through traditional math examples.
6. Students demonstrate their understanding.
7. Formal assessment.

The National Dissemination Center for Career and Technical Education found in their research of the NRCCTE Math-in-CTE model that the contextual mathematics approach requires that students become more actively engaged as learners and that educators change the way in which they deliver content to produce enhanced thinking about and use of mathematics concepts. The use of authentic situations serves to anchor the symbolic and abstract math in situations that are familiar and real to students, which service to help them make sense of the content. Their report also noted that in addition to the 7 elements noted above, it was necessary to create a process through which the CTE teachers could learn to develop and teach the math-enhanced lessons. The process included partnering CTE teachers with math teachers, building curriculum maps that intersect math concepts with CTE curricula, providing professional development for the teacher teams, and implementing the math-enhanced lessons (Stone et al., 2006, p. 14). It should be noted that this was the plan followed in this research study.

Development of an Engaging Math Curriculum.

The fourth area of the literature focused on the need for Development of an Engaging Math Curriculum. This encompassed modification of the content and delivery of the math curriculum and on the influence or relationship between teacher participation in professional development and the subsequent impact on teaching practice and student outcomes. This latter component was especially relevant to this study because the teacher
participants in the study were involved in a professional development experience designed to influence the strategies and techniques used with their students in teaching math concepts. Readings were analyzed that discussed the need for examining the way math is taught; specifically examining the mandate from selected driving forces in the initiative to reform math education. Readings were also analyzed that explored selected initiatives to enhance the teaching of math.

For some time various business, educational and political leaders have called for an examination and modification regarding what mathematical and science concepts are taught and how those concepts are taught in our public schools. One needs only to examine the rhetoric associated with the implementation of No Child Left Behind (NCLB) guidelines at the local school district level to realize the influence these political and business leaders have had on the business of education at the local level.

Honawar (2005) noted the concerns of the state of our math curriculum, including John J. Castellani, President of the Business Roundtable, who stated “the critical situation in American innovation threatens to undermine our standard of living at home and our leadership in the world. We cannot wait for another Sputnik to propel our energy forward in this area”, and Congressman Vernon J. Ehlers (R-Michigan) who voiced a similar concern: “There is a crisis, and it is getting steadily worse. If we aren’t able to educate our children, they won’t get decent jobs, and I am not just talking about scientists and engineers”. Even Bill Gates, Chairman of Microsoft Corporation, reinforced these concerns when he stated “When I compare our high schools to what I see when I’m traveling abroad, I am terrified for our workforce of tomorrow”. Not only have these
leaders challenged us to improve the education system, but the youth themselves have voiced their opinions regarding our educational system.

Viadero (2005) found that regarding math hurdles faced by high school students, if teachers are going to be successful in teaching math, they have to be open to students using different ways of solving math problems. Videro also noted that researchers from the United Negro College Fund found that the most prevalent reason for high school students dropping out, the majority of which were African-American or Hispanic, was Math. Wenglinsky (2002) found that teacher classroom practices have a significant effect on student achievement. Gewertz (March 2006) found that of those students who dropped out of high school, most said that they were unmotivated and not challenged enough or were overwhelmed by troubles outside of school rather than the expected cause they were failing academically. Such students said they needed teachers who expected more of them, schools that helped them more when they struggled, and classes that were more engaging.

Barak Rosenshine (1996) explained that students assimilate new information and use prior knowledge in problem solving when there are more interconnections, stronger ties between the connections, and a better organized knowledge structure. The emphasis here is on contextual learning. In this study, the Cosmetology teachers were given specific training in integrating math in to their existing curriculum, making it relevant to the material being taught in that lesson or unit. This served the purpose of using research presented by Honawar (2005) where he found that statistics show that double-dosing on math has a positive effect on learning, but schools must also be committed to finding innovative ways to keep those subject areas interesting.
William Daggett (2007) explained how “The Three R’s” (rigor, relevance, and relationships) are key “to help our students learn how to adapt to new situations—to know what to do when they do not know what to do” (Daggett, 2007, p. 72).

Impact of Professional Development on Teacher Behavior and Student Performance

The final area of literature reviewed was in the realm of professional development. In order to make the improvements in the CTE curriculum that were required by legislation, found to be critical in the Jobs for the Future study, proven to be effective by the Math-in-CTE model, and clamored for by political and national leaders, the most important ingredient was the incremental professional development needed by the CTE teachers. These professionals, who were hired for their expertise in the field of teaching, were now being required to become proficient at integrating math into their CTE curriculum in a meaningful and effective manner.

Powell and Beard (1984) identified approximately 3,000 investigations related to the initiatives designed to enhance teacher competence. Bloom (1984) suggested that knowledge about three factors would enable a person to predict student learning outcomes. These factors included:

- Cognitive knowledge that a student brings to the learning situation or the level of prerequisite skills a student brings to the learning situation.
- Affective motivation and interest a student has for learning the material.
- Teacher competence or the quality of instruction that is provided the student.

Cruickshank (1990) cited the Dunkin and Biddle conceptual model (1974) of factors that influence student achievement. These included presage variables (involve the
teacher’s formative experiences, training experiences including in-service professional development.

Linda Darling-Hammond (2007) wrote that it is now clear that the single most important determinant of what students learn is what their teachers know. Teacher qualification, teachers’ knowledge and skills, make more difference for student learning than any other single factor. Thus Darling-Hammond supports the conclusions of Seidel and Shavelson (2007) that the preparation and continuing development of teachers is a critical link in the Dunkle and Buddle framework where presage variables and process variables are directly linked to teacher pre-service and in-service professional development activities.

In regard to quantifying the impact of professional development, Rebecca Blink (2007), in her book, “Data Driven Instructional Leadership”, made the case that data is needed to determine what changes are needed and whether those changes had the necessary impact on teacher professional development. The data-driven instructional system (DDIS) supports the teachers in their efforts to make the needed changes at the classroom level. Additionally, Victoria Bernhardt (2005) thoroughly describes and explains the data tools a school needs to help their programs improve. These included databases, student information systems, educational data warehouses, and instructional management systems.

**Research Study Conclusions**

**PSSA Academic Math Background of the Students** – Participants of the study did not differ in their general math knowledge prior to the start of the study.
PSSA math data were obtained for 33 of the 39 students in the Treatment Group. The Treatment Group average PSSA math score was 1242.85 (SD=177.12); whereas the Comparison Group students averaged 1224.54 (SD=151.35). Thus, the two groups of students were statistically similar (t =.113, df=98, p =.910) on their overall math knowledge prior to participating in the study as assessed by their PSSA math scores. Therefore, there is evidence that the two groups of students did not differ substantially on general overall math knowledge prior to the study (Table 4.2 in Chapter 4).

Differences in Pre- and Post-test ACCUPLACER® CPT test—Students in the treatment group and in the comparison group did not differ statistically on the ACCUPLACER® CPT pretest at the very start of the study. At the conclusion of the study students in the treatment group and in the comparison group did not differ statistically on the ACCUPLACER® CPT post-test.

Independent t tests were used to determine whether statistically significant differences existed on both the ACCUPLACER® CPT math pre-test and the post-test between the two groups of students (Table 4.4 in Chapter 4). The 39 students in the treatment group were slightly lower (mean = 73.18% correct) than the comparison group (mean = 77.55% correct) on the pre-test. However, this difference was not statistically different (t = 1.31, df = 1/110, p=.193). From a research study design perspective this is an important finding because it indicates that prior to the study the students were statistically equivalent as measured by the ACCUPLACER® CPT math knowledge pre-test.

The post-test results in Table 4.4 (Chapter 4) reveal that the average math post-test score was 75.05% correct for the treatment group (SD = 17.14) and 79.29 correct (SD
= 15.02) for the comparison group. The difference between the two groups on the post-test was not statistically significant (t=1.35, df=1/110, p =.179).

Change in ACCUPLACER® CPT test from Pre- to Post-test—There was not a significant difference in the amount of change in ACCUPLACER® CPT test scores from the pre-test to the post-test.

The last analysis summarized in. Table 4.4 (Chapter 4) indicated that although the student scores for both groups increased slightly from pre-test to post-test (1.87% for Treatment Group and 1.74% for Comparison Group) there was no statistically significant difference in the amount of change between the two groups (t=.04, df=1/110, p=.966).

Discussion

Although there was no significant improvement in the test scores for the Treatment Group, compared to the Control Group, the SCCTC teachers in Cosmetology truly have integrated math in their contextual lessons and students appear to have a better understanding of their course work with the math. Initially, the teachers had a fear of teaching math in their content area; they did not feel they were as proficient in math as they needed to be. The Cosmetology teachers felt supported by the additional professional development they were provided with and had some base to work from once they began integrating math into their program of study. One of the teachers in Cosmetology commented that,

*by incorporating math into my CTE lessons, students were able to refresh math skills they learned in the past and may have forgotten. I use daily worksheets on math lessons for bell work each day...I feel students were unaware of how the math they learn in school related to their chosen career path. By using fun hands-*
on activities students are learning that the math they learn in school is important to them in Cosmetology.

Another Cosmetology teacher stated that,

*I asked math teachers for ideas and worksheets and incorporated these into my lessons. I was surprised at how much math is used daily in Cosmetology...At first students questioned why we were discussing math terms and concepts in Cosmetology. They didn’t see how math relates to Cosmetology. Soon students began to open up about areas of math that were confusing to them. Peer tutoring became very popular. Students began to make the connection about how math relates to Cosmetology. Students even began bringing in work from their own math classes and sharing it in our class...I feel more confident as a teacher after a year of incorporating math and I feel that my students have benefited as well. I will continue to incorporate math by using group discussion and hands-on activities.*

A third Cosmetology teacher went further, noting that,

*I feel now that I can help other teachers in our school who want to incorporate Math into their CTE lessons. I will encourage them to use strategies that I have tried and know work in my classroom. I would strongly recommend the other teachers to attend the Governor’s Institute for Math-in-CTE. (See Appendix D for testimonial letters from Cosmetology teachers.)*

In addition, the students are more accepting of the need to include math in their program of study at the CTC. They are finding the relevance of math as a result of the context in which it is being taught in their CTE classes. The walk-through observations as well as
formal and informal evaluations, demonstrated the teachers have a greater comfort level with teaching the integrated material and just as with most things in life, the more practice with this, the better they will become.

The research in the literature reviewed also provided some insight into possible factors contributing in the math scores not increasing significantly. Marcoulides, Heck, and Papanastasiou (2004) noted that the strongest direct effect on student achievement outcomes was through students’ own attitudes rather than on students’ academic achievement. They found that less positive attitudes about mathematics were associated with lower student achievement. Many of the Cosmetology students had a low self-image with regard to their math skills. Also, as Patricia Busk (2008) noted in her study, by age 17, females are not achieving at the same level in mathematics as their male counterparts. The main cause for this seems to be low self-confidence in math. Since all but one of the Cosmetology students in the group were female, it appears that this played a large role in why the post-test scores showed so little improvement. In addition, for this study, no specific breakout was conducted which examined whether there was an interactive effect for students on an IEP versus those not on an IEP. It is possible such an examination would provide more specific results, especially when one considers that this study used a quasi-experimental design without the ability to randomly assign students to either the Treatment or Comparison Group.

Additionally, since all three Cosmetology teachers were female, it appears that the same research applies to them. They were very apprehensive about teaching math since they felt their skills in that area were severely lacking. They were provided with remedial training as well as incremental professional development as suggested by the study
Teaching Teachers: Professional Development to Improve Student Achievement, by the American Educational Research Association (Teaching Teachers, 2005). That study found that what matters most is what teachers learn. Professional development should improve teachers’ knowledge of subject matter that they are teaching, and it should enhance their understanding of student thinking in that subject matter. Aligning substantive training with the curriculum and teachers’ actual work experiences also is vital. The Cosmetology teachers were new to this math-enrichment program this year. It is clear from the research that teachers need to grow into the integration of math in their curriculum. I believe each year the teachers will develop the ability to teach the math in their content area with greater ease and comfort.

There is evidence in the research reported by Harris and Sass (2006) that the immediate/short term direct “payoff” from teachers’ participation in in-service education is minimal when that payoff is measured by academic achievement on mathematics cognitive tests. For high school students in grades 9-12 the standardized beta values (see page 58 in Chapter 2) are very small (beta values are = .008). Thus when measured in the short term changes in cognitive math performance for this study are similar to the Harris and Sass results reported for Florida high school teachers. The results of their study support the research of Marcoulides, Heck, and Papanastasiou (2004).

Next year’s testing for the NOCTI and PSSA will be a good indicator of how well on a long-term level the enhancement has worked. Classrooms now have math charts available and posters displayed, serving as reinforcement of math into their content area.
**Recommendations**

There are six recommendations:

1. **Pre-Admission Testing:** Recommend that students be tested for their math skills before being accepted into SCCTC. Low scoring by itself would not eliminate a student from enrollment, but the results would provide the school with the ability to assess the students’ needs before entering. Age and maturity of the student may play a role in the scores. Students must also be continually reminded of the need for math in all aspects of their learning and they should not feel that math is out of place in their CTE program of study.

2. **Timing of Testing:** All new students in the program this year, including tenth graders should be tested in the Fall of 2009. All students, grades 10-12 should be tested in the Spring (2010) and these scores compared to the prior scores (Fall, 2009 for tenth graders and Spring, 2008 for 11th and 12th graders).

3. **PSSA Results:** Continue to collect PSSA Math and Reading scores as these are a good indicator of how well a student may do.

4. **Highly Qualified Teachers:** Continue to hire the highly qualified teachers who will institute differentiated instruction, address all learning styles, and have a desire to teach contextual learning.

5. **Math Teacher:** Hire a math teacher in the CTC with the specific mission of helping the teachers with development and use of assessments and with alignment of their curriculum. This teacher would work with the CTC teachers to tailor their lesson plans in line with the professional development they receive.
6. **Professional Development:** Continuously provide professional development for staff and provide resources, equipment, and supplies in order to accept all students that have the ability to benefit. The Cosmetology teachers were initially very hesitant about teaching math in their program, but once they attended the Governor’s Institute, obtained additional training in math integration from a specialist in the field, received supplemental resources such as laptops and math teaching tools, and implemented their new math-integrated lesson plans, they were much more comfortable. In another year, their proficiency should be much higher. Some specific professional development items to be addressed would include:

   a. Professional development needs to be presented on an ongoing basis, all year long, not just in a quick one or two day in-service at the start of a school year.
   b. Teachers need specific training in the design and use of formal and informal assessments.
   c. Monitor teacher progress with regard to integration of math in their lessons.
   d. Provide teachers with extra support if needed during the school year. If we hired them as teachers, they are certainly worth the investment!
   e. Ensure that teachers stay current with global economic trends and developments as they relate to careers and needs in their field of study.
   f. Ensure that teachers maintain close contact with members of their Occupational Advisory Committees.
g. Show teachers how to work with industry contacts so they can obtain guidance from them about changing employment needs and business developments that will impact the graduating students. This will help them tie technical and academic skills together.

h. Most important of all, teachers not only need training, but also the time to focus and process the new knowledge and skills the training has provided them.

This all must take place if we are to compete in a global society where our students can gain successful employment and make a sustainable wage in our economy.

**Suggested Changes for Future Efforts**

In future efforts in this area, we would make the following changes to improve our chances for a more successful outcome:

1. Test students entering the Career & Technology Center during the summer, possibly during the mandatory student orientation. This would reduce the negative impact of students being bombarded with standardized tests during the first two months of school.

2. Have students tested in larger groups simultaneously. This would reduce the amount of anxiety among those students awaiting the administration of their test. It would also reduce the amount of interruptions in the various shops.

3. Have more examination proctors present in the testing rooms to allow for more individualized assistance of students as they accomplish the multi-step process necessary to log into the test administration site.
4. Test students to determine their basic attitudes toward math. This would allow for development by the teachers of a plan to influence these student attitudes and perceptions of the students’ ability to “do math” within the context of their CTE career cluster. Many students are under the impression that academic subject material will not be included in the CTE program of study. They are then surprised when the math integration starts to be implemented. Students have fears that they will not do well in their CTE program of study if they need to “do math” as part of it. If their attitudes and perceptions can be positively influenced by the CTE teachers during the year, then student math scores would have a better likelihood of improving by year-end. Research by Hyde, Fennema, and Lamon (1990) clearly stated that “if females, on the average, experience higher levels of math anxiety than males, this may interfere with their learning of mathematics and their performance on mathematics tests and discourage them from taking elective mathematics courses” (Hyde, Fennema, & Lamon, 1990, p. 301). A useful tool in establishing students’ attitudes toward math is the Fennema-Sherman scales. These are confidence in learning mathematics, mathematics anxiety, usefulness of mathematics, mathematics as a male domain (the extent to which mathematics is stereotyped as being masculine), attitude toward success in mathematics, effectant motivation in mathematics, mother’s attitude (reported by the student, as are the following two scales), father’s attitude, and teacher’s attitude…One other important scale to consider is the Mathematics Anxiety Rating Scale (MARS). It is a 98-item scale that taps math anxiety in both
everyday situations and academic situations, including examinations. (Hyde et al., 1990, p. 302)

Hyde et al. (1990) went on to note that

the largest effect sizes for mother’s attitude, father’s attitude, and teacher’s attitude occur in the high school years, essentially this means that during high school boys report more favorable attitudes on the part of adults toward their mathematics performance than girls. The peak in the gender difference in stereotyping mathematics as a male domain also occurs in the high school years. (Hyde et al., 1990, p. 306)

The Cosmetology teachers at SCCTC are highly motivated and will try to reach and teach all students. They work cooperatively together and are open to ideas and suggestions. An example of this is the way they are fully participating in this year’s professional development effort, the integration of literacy into the curriculum. One of the tools being utilized is Dr. Mark Forget’s (2004) *MAX Teaching* which contains a wealth of tools and techniques that help increase the amount of literacy included in the CTE curriculum. These Cosmetology teachers have embraced these concepts and have already implemented many of the techniques into this year’s lessons.
**APPENDIX A** Math-in-CTE lesson plan template and rubric

![Math-in-CTE lesson plan template and rubric](image_url)
<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Students write down the information from the lesson and then do a self-assessment. Think: How many rooms are in a house? How many rooms are in a house?</td>
</tr>
<tr>
<td>2.</td>
<td>Students will write down the information from the lesson and then do a self-assessment. Think: How many rooms are in a house?</td>
</tr>
<tr>
<td>3.</td>
<td>Before we solve this problem we need to know the formula.</td>
</tr>
<tr>
<td>4.</td>
<td>Demonstrate manipulation of the formula for area to determine</td>
</tr>
<tr>
<td>5.</td>
<td>Demonstrate manipulation of the formula for length to determine</td>
</tr>
<tr>
<td>6.</td>
<td>Determine the area of a rectangle or a square.</td>
</tr>
<tr>
<td>7.</td>
<td>Given the minimum area requirement for the floor area of the salon is 180 square feet, what would be the minimum length of a salon be if the width is 12 feet?</td>
</tr>
<tr>
<td>8.</td>
<td>Given the minimum area requirement for the floor area of the salon is 180 square feet, what would be the minimum length of a salon be if the width is 12 feet?</td>
</tr>
<tr>
<td>9.</td>
<td>Area = length x width</td>
</tr>
<tr>
<td>10.</td>
<td>Length = area / width</td>
</tr>
<tr>
<td>11.</td>
<td>Width = area / length</td>
</tr>
<tr>
<td>12.</td>
<td>Work through the Math example embedded in the CTE lesson.</td>
</tr>
</tbody>
</table>

**Tools that you will need are the graph paper, pencil, ruler.**

- You should have used graph paper in your previous math lessons.

**Assessment**

- How many rooms are in a house? How many rooms are in a house?
<table>
<thead>
<tr>
<th>QUESTION #</th>
<th>MATHEMATICAL FORMULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The length of a salon is 18 feet. Solve for the width.</td>
<td>[ \frac{180}{\text{length}} ]</td>
</tr>
<tr>
<td>2. The width of a building is 9 square feet. Solve for the length.</td>
<td>[ \sqrt{9 \times \text{width}} ]</td>
</tr>
<tr>
<td>3. The width of the salon is 13 feet. What must the length be?</td>
<td>[ \frac{13 \times \text{inches}}{180 \text{ inches}} ]</td>
</tr>
</tbody>
</table>

Given the salon requires a minimum area of 180 square feet, solve for:

- **4. Work through additional contextual multi-CITE examples.**

**Dimension of the salon are 15 feet by 12 feet.**

- **Manipulate the formula again to solve for the unknown.**

**180 square feet = length \times 12 feet**

Check off 'Header and Footer' under VIEW to type your lesson title here.
1. Solve these word problems:

3. \(L = 16\) inches, \(W = 7\) inches
2. \(L = 12\) feet, \(W = 12\) feet
1. \(L = 20\) feet, \(W = 10\) feet

2. Calculate the areas of the following:

5. Work through the following examples:

\[
\frac{\pi}{\text{area of circle}} = \left(\frac{22}{7}\right) \times \left(\frac{\pi}{4}\right) = \frac{\pi}{\left(\frac{22}{7}\right)} \times \left(\frac{\pi}{4}\right) = \frac{\pi}{88} \times \left(\frac{\pi}{4}\right)
\]

4. Solve the following equation:

\[
\frac{\pi}{\text{area of circle}} = \left(\frac{22}{7}\right) \times \left(\frac{\pi}{4}\right) = \frac{\pi}{88} \times \left(\frac{\pi}{4}\right)
\]

Click on "Header and Footer," under "VIEW" to open your lesson title here.
Formal assessment:

(To meet the minimum requirement of 180 square feet, the formula will provide the room length = length x width. Share their project assessment and evaluate each others results. Students will show each other their planning and design. Students will develop design and illustrate the floor plan for their future home. Students demonstrate their understanding.)

4. Area of a circle: $\pi r^2$ 

$\frac{4}{3\pi}$ square feet

Area of the floor is: $3.14(20)^2 = 3.14 \times 400 = 1256$ square feet

The area of the larger circle is the smaller area. A local home has two steps, one with a diameter of 4 feet and a circle with a diameter of 4 feet and one with a diameter of 20 feet.
Example: square, rectangle, circle.

1. Different geometric shapes they could choose for the design.
2. Determination of the actual cost is not being assessed. In other words, the actual cost is not being assessed. However, the assessment is not according to the dimensions in the table below.

- Square
- Rectangle
- Circle

3. Check if the dimensions chosen for the square or rectangle are consistent with the actual cost.

- Minimum of 180 square feet.
- Ensure length and width dimensions multiplied can equal a multiple of 180 square feet.

• 180 square feet
• 90 square feet
• 80 square feet

Answers to the assessment:

- 12.5 inches
- 20 feet
- 16 feet

How do you think the shape of your selection would affect the cost of building your school? Why?

- Square: Area = 125 square feet, sides = 10 inches. 
- Rectangle: Area = 480 square feet, length = 25 feet, width = 16 feet. 
- Circle: Area = 12.5 square feet.

I. Calculate the length of the missing dimension.

2. Design a school using graph paper that meets the given requirements for area (minimum area of a school is 180 square feet).
<table>
<thead>
<tr>
<th>School</th>
<th>Position</th>
<th>Name</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center</td>
<td>Director</td>
<td>Alice Davis</td>
<td>Administrator</td>
</tr>
<tr>
<td>Center</td>
<td>Teacher</td>
<td>Jane Smith</td>
<td>Counseling Teacher</td>
</tr>
<tr>
<td>School</td>
<td>Student</td>
<td>John Doe</td>
<td>Student</td>
</tr>
</tbody>
</table>

**Reference**

*Middle Grade Textbook, 2004*

**Math Standards Addressed**

- Use of notebook during class
- Needs less. Read student

**Check on Teacher and Parent under ANSI to type your lesson here.**
APPENDIX B

ACCUPLACER® TEST

ACCUPLACER®

ARITHMETIC SUPPLEMENTARY SKILLS

HIGH SCHOOL LEVEL TEST.

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APPENDIX C
FALL TEST RESULTS

TOTAL # STUDENTS TESTED- 296

ARITHMETIC SUPPLEMENTARY SKILLS

Copyrighted Material

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Mrs. Davis,

By attending the Governors Institute for Math, it helped me to realize the importance of integrating math into CTE lessons. After attending the institute I realized the need to make students see how important math is on a daily basis in the real world.

By incorporating math into my CTE lessons, students were able to refresh math skills they learned in the past and may have forgotten. I use daily worksheets on math lessons for bell work each day. I displayed posters and math tools in my room to reinforce the use of math in Cosmetology. I was surprised at how much math is really used in cosmetology.

I feel students were unaware of how the math they learn in school related to their chosen career path. By using fun hands-on activities students are learning that the math they learn in school is important to them in Cosmetology.

I really feel that the students are benefiting from the incorporation of math in my lessons and I will continue to use these strategies and share them with other teachers.

Thank You,
Amy Bush
Cosmetology Instructor
Dear Mrs. Davis,

Thank you for allowing me the opportunity to attend the Governors Institute for Math. It helped me to realize the importance of integrating math into CTE, it is vital to students’ learning and achievement. After attending the institute I realize the need to make students aware that math is not just a pass or fail class. Math is a necessity for daily life and job skills.

By integrating math into my daily lessons, students can refresh on basic math skills and learn new math skills while working hands-on in a field they have chosen and are interested in. I added lessons to my basic curriculum at the beginning of the year following the lesson plan template from the Governors Institute. I asked math teachers for ideas and worksheets and incorporated these into my lessons. I was surprised at how much math is used daily in cosmetology.

At first students questioned why we were discussing math terms and concepts in cosmetology. They didn’t see how math relates to cosmetology. Soon students began to open up about areas of math that were confusing to them. Peer tutoring became very popular. Students began to make the connection about how math relates to cosmetology. Some students even began bringing in work from their own math classes and sharing it in our class.

I feel more confident as a teacher after a year of incorporating math and I feel that my students have benefited as well. I will continue to incorporate math by using group discussion and hands-on activities.

Thank You,
Kim Cosklo
Cosmetology Instructor
April 18, 2008

Mrs. Davis,

After going to the Governor’s Institute for Math in CTE last summer I realized how important Math is in every CTE curriculum. I also have realized how much I use Math in my CTE lessons everyday and didn’t realize it. After integrating Math into my CTE lessons I believe I have helped each student refresh their Math skills and have helped some students strongly improve their Math skills. The way we use Math in Cosmetology is slightly different than how a Math teacher might teach a lesson, but I learned how to work with other Math teachers so we will use the same Math terms and teaching strategies to help the students. Our students in Cosmetology use Math in our practical/hands-on skills. We use measurement in haircutting, chemical formulas, ratios, receptionist duties such as scheduling appointments and making change for customers. Incorporating Math skills in CTE lessons has helped my students be more prepared for real-world on the job skills that they will use and need everyday. Incorporating Math in every lesson should be done in every CTE course and curriculum.

I feel now that I can help other teachers in our school who want to incorporate Math into their CTE lessons. I will encourage them to use strategies that I have tried and know work in my classroom. I would strongly recommend the others teachers to attend the Governor’s Institute for Math –in-CTE.

Thank You!

Susan Birtch

[Signature]
Math had helped me by measuring things. It helped me by doing some math that I haven't done in a long time. It is important to do math in cosmetology. We have to measure hair cutting and measure hair color. We even count how much things we need to have or do. This is why it is important to know how to do math in cosmetology. We use math in our everyday life.
Math has helped me by measuring things. It helped me with learning things from a while back. Math is important because you need it in your everyday life. Some of the things you need Math for is cooking, building a house. Plus in cosmetology we measure how much hair we are going to cut off. We measure hair color in cosmetology.
How much math has helped me. 16th in CS is a good thing because with out nowing math you will not be able to get your right measure part for your hair cut and Sectoning. Also you will need to be able to use math to get through with paying them money and give them the right change back. I think it is good to teach math in CS.
APPENDIX F
SCCTC Walk-through Observation Form

Susquehanna County Career and Technology Center
Walk-Through Observation Form

Teacher: __________________________ Date: ____________

Subject/Class: ___________ Time: _______ Beginning _______ Middle _______ End

Physical Setting:
___ Student work displayed
___ Room clean and neat
___ Instructional posters on walls

Curriculum Objective: Clear and evident to students what they are expected to
learn and why.
___ Evident: Posted on board/screen and/or revisited throughout lesson
___ Objective(s) linked to mastery of standard(s) and essential questions
___ Not evident

Instruction:
___ Lecture
___ Teacher/Student Discussion
___ Cooperative Group Activity
___ Silent Reading
___ Writing
___ Performing
___ Teacher Demonstration
___ Student/Student Discussion
___ Student Technology Use
___ Independent Seat Work
___ Viewing
___ Experimenting

Level of Student Engagement:
___ Active
___ Passive
___ Off Task
___ Instructional strategies actively engage all students
___ Students involved in knowledge acquisition (awareness, comprehension and application
in one discipline)
___ Student involved in knowledge application (awareness, comprehension and application
across disciplines or real-world predictable and/or unpredictable situations)
___ Student involved in assimilation (analysis, synthesis and evaluation in one discipline)
___ Students involved in knowledge adaptation (analysis, synthesis and evaluation applied
across disciplines or real-world predictable and/or unpredictable situations)

Assessment:
___ Assessment embedded in instruction
___ Questioning strategies target understanding
___ Questioning strategies target rote memorization/recall
___ Formal assessments are aligned to the academic standards

Notes:
________________________________________________________________________
________________________________________________________________________
## APPENDIX G
### SCCTC Math Supplies & Equipment Purchased

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Total Cost</th>
<th>Unit Price</th>
<th>Quantity</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock Stand Set</td>
<td>$3.96</td>
<td>$3.96</td>
<td>1</td>
<td>$3.96</td>
</tr>
<tr>
<td>Clock Set</td>
<td>$1.80</td>
<td>$1.80</td>
<td>1</td>
<td>$1.80</td>
</tr>
<tr>
<td>Dry Erase Markers</td>
<td>$0.99</td>
<td>$0.99</td>
<td>3</td>
<td>$2.97</td>
</tr>
<tr>
<td>Dry Erase Pencils</td>
<td>$0.50</td>
<td>$0.50</td>
<td>3</td>
<td>$1.50</td>
</tr>
<tr>
<td>Student Whiteboards</td>
<td>$35.95</td>
<td>$35.95</td>
<td>2</td>
<td>$71.90</td>
</tr>
<tr>
<td>Metric Ruler</td>
<td>$0.75</td>
<td>$0.75</td>
<td>25</td>
<td>$18.75</td>
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**Total:** $30.00

**Grand Total:** $197.20

**Shipping:** $5.97

**TOTAL:** $203.17

**Number of Items:** 12

**Total Cost:** $153.86

**Subtotal:** $153.86

**Tax:** $17.80

**Total:** $171.66

**Shipping:** $5.00

**TOTAL:** $176.66

**TOTAL:** $3488.57
APPENDIX H  Recruitment Letter

To: All students enrolled in Susquehanna County Career & Technology for the 2007-2008 School Year.
Re: Requesting your participation in a Penn State Research Study described below.
From: Alice M. Davis, Principal Investigator

Title of Project: Math Integration-Comparison of Beginning of the Year to the End of the Year Results

Principal Investigator: Alice M. Davis, Graduate Student
RR #1 Box 47
Meshoppen, PA 18630
(570)965-2068(Home) (570)278-9229, ext. 783 (Work);
alice.davis@elklakeschool.org

Advisor: Dr. Richard A. Walter, PH.D.
301 Keller Building
The Pennsylvania State University
University Park, PA 16802
(814) 865-2133; raw18@psu.edu

1. Purpose of the Study: The purpose of this research study is to determine the impact that very specific math instruction will have on future math performance by the student. This intense, directed math instruction will be provided to students that demonstrate a need as determined by test results obtained from a diagnostic math test (ACCUPLACER®).

2. Procedures to be followed: Student test results from ACCUPLACER® math tests taken in August 2007 and May 2008 will be included (without any identification of student) in research data.

3. Benefits: The student might learn more about himself or herself from participating in this study. The student might have a better understanding of his or her strengths and weaknesses in the subject of math by participating in this study. The student might learn how improving math skills in areas requiring improvement will help in developing further skills in their program of study. This research might provide a better understanding for teachers and teacher aides in developing their programs and including an emphasis on math in their programs. This information could help plan programs and make student services better. This information might assist students in attaining higher test scores on standardized tests they are required to take in their high school careers.

4. Duration: Testing is complete. No time required except in signing the consent form to follow.
5. **Statement of Confidentiality:** Participation in this research will remain confidential. The data will be stored and secured at Susquehanna County Career & Technology Center in a locked/password protected file. In the event of a publication or presentation resulting from the research, no personally identifiable information about your family or child will be shared. The following may review and copy records related to this research: The Office for Human Research Protections in the U.S. Department of Health and Human Services, Penn State University’s Social Science Institutional Review Board and Penn State University’s Office for Research Protections.

6. **Payment for participation:** Upon return of signed consent form by July 16, 2008, the student’s name will be entered into a drawing to receive a $50 pre-paid Visa card.

7. **Voluntary Participation:** Participation in this study is voluntary. Please note that the testing itself was a requirement of the school district and has been completed.

8. **Required Consent:** Parental consent (will be required of all participants since all participating students are minors. A separate Consent Form is provided to parents/guardians.
Title of Project: Math Integration-Comparison of Beginning of the Year to the End of the Year Results

Principal Investigator: Alice M. Davis, Graduate Student
Susquehanna County Career & Technology Center
P.O. Box 100
Dimock, PA 18816
(570) 278-9229, ext. 783; alice.davis@elklakeschool.org

Advisor: Dr. Richard A. Walter, PH.D.
301 Keller Building
The Pennsylvania State University
University Park, PA 16802
(814) 865-2133; raw18@psu.edu

1. Purpose of the Study: The purpose of this research study is to determine the impact that very specific math instruction will have on future math performance by the student. This intense, directed math instruction will be provided to students that demonstrate a need as determined by test results obtained from a diagnostic math test (Accuplacer).

2. Procedures to be followed: Your child’s test results from Accuplacer math tests taken in August 2007 and May 2008 will be included (without any identification of your child) in research data.

3. Discomforts and Risks: There are no risks in participating in this research beyond those experienced in everyday life.

4. Benefits: Your child might learn more about himself or herself from participating in this study. Your child might have a better understanding of his or her strengths and weaknesses in the subject of math by participating in this study. Your child might learn how improving math skills in areas requiring improvement will help in developing further skills in their program of study. This research might provide a better understanding for teachers and teacher aides in developing their programs and including an emphasis on math in their programs. This information could help plan programs and make student services better. This information might assist students in attaining higher test scores on standardized tests they are required to take in their high school careers.

5. Duration: Testing is complete. No time required except in signing this consent form.
6. **Statement of Confidentiality:** Your child’s participation in this research will remain confidential. The data will be stored and secured at Susquehanna County Career & Technology Center in a locked/password protected file. In the event of a publication or presentation resulting from the research, no personally identifiable information about your family or child will be shared. The following may review and copy records related to this research: The Office for Human Research Protections in the U.S. Department of Health and Human Services, Penn State University’s Social Science Institutional Review Board and Penn State University’s Office for Research Protections.

7. **Right to Ask Questions:** You or your child can ask questions about this research. Please contact Alice M. Davis at (570) 278-9229 ext. 783 with questions. You or your child can also call this number to discuss complaints or if you or your child feels harmed by this research. If you or your child has questions about your rights as a research participant contact Penn State University’s Office for Research Protections at (814) 865-1775.

**PLEASE TURN PAGE OVER AND COMPLETE FORM ON BACK.**

8. **Payment for participation:** Upon return of your consent form by July 16, 2008, your family’s name will be entered into a drawing to receive a $50 pre-paid Visa card.

9. **Voluntary Participation:** Your decision to include your child’s test results in this study is voluntary. Please note that the testing itself was a requirement of the school district and has been completed. You can stop or withdraw your participation at any time. You do not have to answer any questions you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would otherwise receive.

**INSTRUCTIONS FOR COMPLETING FORM AND RETURNING TO RESEARCHER:**

**PLEASE NOTE:** Your consent to including your child’s test results will benefit many parties. You will be helping the school to grow and to academically prepare your child, and other children in future classes, for their future endeavors and careers. You will also be allowing the school to better prepare teachers to serve students better in their areas of instruction. This will allow for improvement in professional development programs for teachers and will help the school to help your students succeed in their SCCTC program and their academic classes.

If you and your child agree to the information described above and want to participate in the research, please check the first box below and print your child’s first and last name below and sign two copies of the parental consent forms provided in this mailing. You must be 18 years of age or older to consent for your child to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below. Then, please return one signed copy to Alice M. Davis in the stamped, self-addressed return envelope. You may keep the second copy of this consent form for your records.

☐ I agree to allow the math test results from the Accuplacer tests given in August, 2007 and May, 2008, to be released to the principal investigator of this study (Alice M. Davis) for the purpose of determining whether the integration of math into my child’s program of study results in the achievement of higher math scores on future tests.
☐ I DO NOT agree to allow the math test results from the Accuplacer tests given in August, 2007 and May, 2008, to be released to the principal investigator of this study (Alice M. Davis).

______________________________________________________________________________
Print First and Last Name of Your Child

______________________________________________________________________________
CONSENT: Parent or Guardian Signature _____________________ Date

______________________________________________________________________________
ASSENT: Age 13 and Older Child’s Signature _____________________ Date

______________________________________________________________________________
Person Obtaining Consent – Researcher _____________________ Date
Alice M. Davis
Date: July 3, 2008
From: Andrea R. Seisler, IRB Administrator
To: Alice M. Davis
Subject: Results of Review of Proposal - Expedited (IRB #28719)
Approval Expiration Date: June 17, 2009
“Math Integration-Comparison of Beginning of the Year to the End of the Year Test Results”

The Social Science Institutional Review Board (IRB) has reviewed and approved your proposal for use of human participants in your research. By accepting this decision, you agree to obtain prior approval from the IRB for any changes to your study. Unanticipated participant events that are encountered during the conduct of this research must be reported in a timely fashion.

COMMENT: Please use the attached recruitment script. The recruitment script submitted was not formatted for a letter.

Enclosed is/are the dated, IRB-approved informed consent(s) to be used when recruiting participants for this research. Participants must receive a copy of the approved informed consent form to keep for their records.

If signed consent is obtained, the principal investigator is expected to maintain the original signed consent forms along with the IRB research records for this research at least three (3) years after termination of IRB approval. For projects that involve protected health information (PHI) and are regulated by HIPAA, records are to be maintained for six (6) years. The principal investigator must determine and adhere to additional requirements established by the FDA and any outside sponsors.

If this study will extend beyond the above noted approval expiration date, the principal investigator must submit a completed Continuing Progress Report to the Office for Research Protections (ORP) to request renewed approval for this research.

On behalf of the IRB and the University, thank you for your efforts to conduct your research in compliance with the federal regulations that have been established for the protection of human participants.

Please Note: The ORP encourages you to subscribe to the ORP listserv for protocol and research-related information. Send a blank email to: L-ORP-Research-L-subscribe-request@lists.psu.edu

ARS/ars
Enclosure
cc: Richard A. Walter
February 17, 2009

Mr. Joshua Rogers
RR 1 Box 66A
Springville, PA 18844

Re: You Won the $50.00 Gift Card!

Dear Josh:

Enclosed please find a $50.00 American Express Gift Card won by you when your name was the winner drawn from among those students who returned their signed letters back to me for my research study. This card can be used the same as cash at any business taking American Express, such as gas stations.

Thank you again for your prompt response in sending your consent letter back.

Sincerely,
Introduction to Institute

The PA Governor’s Institutes for Educators are a series of professional development courses that aim to help the Commonwealth’s teachers stay create challenging learning environments for Pennsylvania’s children. Governor’s Institutes are offered in 18 different topic areas.

Each of the institutes provides an intellectually rigorous program of study that will improve academic classrooms and thereby assist educators in improving their students’ academic achievement.

The typical program activity requires teachers’ involvement in 45 hours of face-to-face sessions, followed by application and dissemination of what they learn when they return to school in the fall. In return for their effort, teachers may earn two graduate credits. The costs of materials, speakers, lodging, meals, and the two graduate credits are paid by the Pennsylvania Department of Education.

The Governor’s Institute for Integrating Mathematics in Career and Technical Education Programs

The Governor’s Institute for Integrating Mathematics in Career and Technical Education Programs (GI for Math-in-CTE) is a dynamic week of professional development activity for secondary instructors. The focus of the institute is collaborating across disciplines to help students learn Mathematics while learning in Career and Technical Education courses.

As school districts aim to reach Adequate Yearly Progress in Mathematics, teachers are searching for strategies to help students learn math. CTE instructors and administrators recognize that their real-world, career-oriented programs allow students to learn and reinforce math skills in relevant context. The GI for Math-in-CTE brings teachers from both disciplines together for collaboration, content learning, and current instruction strategies.
Specifically, the teachers will practice

- A research-proven process to link CTE lesson content to Mathematics standards and concepts as they appear on standardized tests, such as the PSSA.
- Current strategies to improve student achievement in Mathematics.
- Instructional and assessment techniques to accommodate students with special needs. You are the right person for this institute if one or more of the following statements describe you:
  - Your school is not meeting state and federal requirements for Adequate Yearly Progress in Mathematics.
  - Your students need to perform Mathematics on-the-job.
  - Your students use Math to perform technical tasks, but do not perform well in Math classes.

This institute is being implemented by The Pennsylvania State University Professional Personnel Development Center in Career and Technical Education and is administered by the PDE Bureau of Career and Technical Education.

Expectations

This institute will feature:

- A research-proven technique to help students learn Mathematics in a technical work-like environment.
- Curriculum sharing and networking with educators from other schools.
- Shared planning time.
- Productive and fun days.

At the conclusion of this institute, participants will:

- Produce a database of Math-enhanced CTE lessons.
- Be able to link technical content to Mathematics standards.
- Collaborate with instructors from other schools and disciplines.
- Develop a plan to continue enhancing CTE lessons with math during the academic year.

During the school year following the institute, participants will:

- Continue enhancing CTE lessons with math during the academic year.
- Share what they learned with colleagues at their school or professional conferences.

Participants will be expected to complete assignments at quality worthy of at least a “B” grade. Attendance at all sessions, July 30-August 3, is required.

Monday, 7/30 Tuesday, 7/31 Wednesday, 8/1 Thursday, 8/2 Friday, 8/3

7:15 Breakfast & check-out
8:30 Continental Model to Colleagues
8:45 Breakfast
9:00 Break
9:30 Methods of Math
Most sessions will be small groups of approximately 25 teachers per room and will allow time for participants to apply the content to the institute assignments.
REFERENCES


Losen, D. (2006, June 22). Costs of not graduating tallied by researchers: The cumulative costs to the public from the nation’s dropouts are in the billions, for both lost taxes and spending on social programs. *Education Week, 25*, 7.


Alice M. Davis
570-278-9229
alice.davis@elklakeschool.org

VITA

EDUCATION

Penn State University
Doctor of Philosophy in Workforce Education and Development
2009

Penn State University
Vocational Administrative Director Program
1998

University of Scranton
Supervisor’s Certificate in School Guidance Services
1993

University of Scranton
Master of Science in Secondary School Administration
1991

University of Scranton
Master of Science in Counselor Education
1987

College Misericordia
Bachelor in Elementary Education
1986
Keystone College
Associate Degree in Liberal Arts
1980

EXPERIENCE

Susquehanna County Career & Technology Center
Administrative Director
1998-Present

Susquehanna County Career & Technology Center
Guidance/Placement Director
1988-Present

Susquehanna County Career & Technology Center
Coordinator/Liaison
1985-1988

Elk Lake School District
Secretary
1978-1985

Elk Lake School District
Classroom Aide
1977-1978

MEMBERSHIPS/ACTIVITIES

- Pennsylvania Association of Career & Technical Administrators, Incoming President (2009)
- Pennsylvania Association for CTE Commercial and Education Exhibits Committee, Chairperson
- Endless Mountains Counselors Association, President
- Skills/USA, Advisor
- Association for Career & Technical Education, Member
- Pennsylvania School Counselors Association, Member
- Association for Supervision & Curriculum Development, Member
- Northern Tier Industry Education Consortium, Member
- Northern Tier Tech Prep Consortium Advisory Board, Member
- Keystone College Advisory, Member
- Tyler Home Health Board, Member
- United Way of Susquehanna County, Board Member
- Susquehanna County Community Foundation, Board Member
- Phi Delta Kappa International, Member

HONORS

- PA High School Counselor of the Year for 1998—selected by the PA School Counselors Association
- Northeast Woman of the Week—March 20, 1988
- Selected for “Who’s Who Among Students in American Universities and Colleges”