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**DUAL ENROLLMENT AS A FACTOR FOR WOMEN TRANSITIONING INTO  
STEM MAJORS IN MONTANA TWO-YEAR COLLEGES**

By

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Dissertation

presented in partial fulfillment of the requirements  
for the degree of

Doctor of Education  
in Curriculum and Instruction

The University of Montana  
Missoula, MT

June, 2013

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Jakes, Penny, Ed.D., Spring, 2013

Curriculum and Instruction

Dual enrollment as a factor for women transitioning into STEM majors in Montana two-year colleges.

Chairperson: Dr. Sandra Williams

The purpose of this non-experimental, descriptive, quantitative study was to describe the impact high school dual enrollment coursework has had on initial enrollment of women with STEM majors in Montana two-year colleges. The study was designed to find whether or not differences existed for access (initial enrollment), persistence (to third semester), and success (associate's degree, certificate, or transfer to a four-year institution within 150% of program length).

The literature review highlighted the need for studies to address the issue of few women in science, technology, engineering, and mathematics (STEM) occupations. One goal of dual enrollment in Montana is to ease transitions from high school to college, including underrepresented populations such as women in STEM fields. The scope of this study was to collect, organize, and interpret data to describe the effect of that effort for women enrolling in STEM majors at two-year colleges in Montana.

Baseline information established the demographics of young women who participated in dual enrollment in Montana high schools during 2007-2009. Data analysis described results using attributes of gender, dual enrollment, access, persistence, and success for those enrolled in STEM fields. Results indicated more young women than young men take advantage of dual enrollment in high school and more women than men with dual-enrollment credit initially enroll in college. More men than women major in a STEM field and more men persist and graduate within the STEM fields. Data indicated that 221 students enrolled in a Montana two-year college with DE/DC credit during 2007-2009. Of those, eight women chose STEM majors, six persisted to the third semester, and two completed.

It is recommended that a mixed-methods study be conducted to give a deeper level of understanding for enrollment trends and career choice. Longitudinal studies should also be conducted as dual enrollment grows within the state of Montana. Further studies would enable educational stakeholders to make informed decisions to create meaningful change for women in STEM majors.

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## CHAPTER ONE

### The Problem

Western society depends on scientific and technological progress to build an economy and improve the standard of living (U.S. National Economic Council, 2011). Professionals are needed in the science and technology fields to be the explorers, inventors, healers, and academics—all with potential to make valuable contributions to modern society. Langdon, McKittrick, Beede, Kahn, & Doms (2011) stated that science, technology, engineering, and mathematics (STEM) workers “drive our nation’s innovation and competitiveness by generating new ideas, new companies, and new industries” (p. 1). Hossain and Robinson (2012) add that the STEM fields include some of the “most versatile and important careers in the contemporary world” (p. 1). Richardson (2007) adds that “twenty-first century economy calls for individuals to take charge and be creative with ideas and information...which requires higher-order critical thinking, evaluation, assessment and not just simply recall” (p. 239).

Careers in science and technology come with much responsibility, but also garner higher pay. This creates a higher standard of living and often results in more respect in United States society. Over the past 10 years, growth in STEM careers was three times faster than other fields. STEM workers are less likely to experience joblessness and play a key role in the sustained growth and stability of the United States economy (Langdon et al., 2011, p. 1).

Employment forecasts confirm that opportunities for workers with post-secondary credentials are increasing. The Carl D. Perkins Act of 2006 identified 16 career and technical education clusters to improve programs and assist students (Carnevale, Smith, & Melton, 2011). Within these clusters, the fastest growing sectors are STEM related with employment projected to increase by 15.3 million, or 10.1%, during the years 2008-2018. “Projections

show an aging and more racially and ethnically diverse labor force in which occupations where a post-secondary degree or award is usually required are expected to account for one-third of total job openings” (U.S. Bureau of Labor Statistics, 2009, p. 1).

For decades women have been underrepresented in STEM careers (Besecke & Reilly, 2006). A 2011 report by the Economics and Statistics Administration of the U.S. Department of Commerce documents the following nationwide statistics:

- Although women comprise 48% of the U.S. workforce, they hold just 24% of STEM jobs. In engineering, it is less than 15%.
- Women with STEM jobs earned 33% more than comparable jobs women held in non-STEM jobs, but less than men. The gender wage gap is smaller in STEM.
- Women hold a disproportionately low share of undergraduate degrees, particularly in engineering.
- Women with a STEM degree are less likely than men to work in a STEM occupation. (Economics and Statistics Administration, 2011, p. 1)

The reauthorization of the Carl D. Perkins Vocational and Technical Education Act of 2006 (Perkins IV) funding is one current initiative which addresses achievement gaps in college graduation rates by improving the transition/linkages between high schools and colleges. President George W. Bush signed the Perkins IV Act into law on August 12, 2006. The Act provides an increased focus on the academic achievement of career and technical education students, strengthens the connections between secondary and post-secondary education, and improves state and local accountability (U.S. Department of Education,

2006). Fiscal year 2007 allocations for Perkins IV totaled \$1.16 billion nationwide (U.S. Department of Education, 2007). Before this increased emphasis on connections between high school and college, the predominant early-college experience was advanced placement available only to the high achievers in selected high schools. The Perkins funding provides resources to develop dual enrollment and dual credit (DE/DC) as another option to ease transitions between high school and college (U.S. Department of Education, 2007).

STEM fields are considered high-wage high-demand career options (U.S. Department of Education, 2011a). These careers are considered *nontraditional* for women as they comprise less than 25% of the total workforce (Hill, Corbett, & St. Rose, 2010). To date, efforts to encourage women to complete degrees in nontraditional STEM majors, such as computer science or engineering, have not been effective (National Science Foundation, 2011). Richardson (2007) found that providing college-level courses through DE/DC results in a flexible and creative approach to encourage higher-order thinking skills and a desire to continue education past high school. In this way society can encourage progress in preparing students for careers and lifelong learning in STEM fields, which are currently in high demand.

### **Statement of the Problem**

Approximately 80% of women students enrolled in a STEM related major do not complete their college degrees (Peterson, 2008, p. xiv). Of the remaining 20% of women who stay in school, get their degree, and start a career in a nontraditional STEM career, studies show more than half quit their jobs within the first 10 years (Hill et al., 2010, p. 19). Thus, a very small percentage of women remain in a STEM field for their working careers.

According to the National Center for Educational Statistics (NCES) women accounted for 62.1% of all associate's degrees in 2008-2009 (National Center for Educational Statistics,

2011b). Of the 489,184 associate's degrees for all majors attained by women in 2008-2009, the breakdown for STEM fields includes (Table A-40-1):

- 1,608 in biological and biomedical sciences,
- 5,709 in engineering,
- 7,453 in computer and information sciences, and
- 1,497 in physical sciences and science technologies.

These total 16,267 or 4% of total associate's degrees. In this case, NCES looked back 10 years using a baseline from 1998-1999. Although statistics reveal an overall increase in numbers of women for all majors, data show a 24% decrease in engineering and a 27% decrease in computer and information sciences from 1999 to 2009. Physical sciences and biological sciences each saw increases. However, the overall result is a 15% decrease in women achieving two-year degrees in STEM fields (National Center for Educational Statistics, 2011b).

In 2009, 70.1% of all high school completers immediately enrolled in college the following fall (National Center for Educational Statistics, 2011b, Table A-21-1). In 2008, 29.5% of women and 41.1% of men intended to major in STEM fields (National Science Foundation, 2011, Table 2-8). Of those enrolled in engineering, 82.6% were men and 17.4% women (National Science Foundation, 2011, Table 2-10). The disparity between genders is further illustrated by the associate's degrees awarded in engineering in 2009 of which 86% were men and 14% were women (National Science Foundation, 2011, Table 4-1). Even though roughly 70% of students enroll in college, women graduating in STEM fields remains below the percentage of men graduating in STEM.

Theories for why women are underrepresented in STEM fields are documented in recent research, but solutions to the problem have yet to provide widespread results (Hill et al., 2010). By examining the current educational climate, researchers can identify gaps in understanding this trend. Montana has recognized the need for equality in STEM fields by stating that “Montana must do its part to help ensure the U.S. remains competitive” (Office of the Commissioner of Higher Education, 2011a). Strategies identified include the following:

- expand early-college opportunities,
- increase utilization of two-year colleges,
- increase transparency and ease of credit portability, and
- target non-traditional students.

Thus, the scope of this research was to study the access, persistence, and success of women majoring in STEM fields at two-year post-secondary institutions in Montana who had previously participated in DE/DC in high school. Adelman (2007) identified access, persistence, and success as important thresholds when studying college achievement.

### **Research Questions**

This non-experimental, descriptive, quantitative study compared Montana two-year college students who participated in DE/DC coursework while in high school with those who did not enroll in the early-college DE/DC program. The study used census data from 2007-2012 to track access, persistence, and completion—the three thresholds for college success identified by Adelman (2007). The success rates of the DE/DC and non-DE/DC students were judged by initial enrollment, persistence to third semester, and completion of a certificate/degree.

After establishing the demographics and trends of DE/DC students entering two-year education in Montana, the following questions provided the framework for this investigation:

1. Was DE/DC coursework taken in high school a factor for increasing numbers of women transitioning into initial enrollment in two-year, post-secondary education with a STEM major during the years 2007-2009?
2. Was DE/DC coursework taken in high school a factor for increasing numbers of women persisting to the third semester in two-year, post-secondary education with a STEM major during the years 2007-2009?
3. Was DE/DC coursework taken in high school a factor for increasing numbers of women succeeding in two-year, post-secondary education with a STEM major during the years 2007-2009?

### **Significance of the Study**

Addressing the problem of low-graduation rates of all students, but particularly women, in STEM majors is important to the educational field. Research shows that post-secondary education has become necessary to live and work productively in a rapidly advancing world (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006). Gender parity contributes to innovation in all fields. Gender diversity in the workplace is recognized as a positive goal for global workforce development and the educational system in the United States is committed to providing this for its citizens. Workforce equity can result in improved self-esteem, equitable salaries, and increased opportunities for women and their families. Studies show a college degree is linked to social and economic benefits that enhance the quality of life of individuals, their communities, and society of present and future generations. Higher levels of education can result in fewer demands on social services, such as welfare or



corrections, because individuals have the skills to make complex decisions about lifestyle, health care, and personal finance. Creating seamless transitions between high school and college with alignment of academic standards utilizing DE/DC provides all students in the educational system with increased academic opportunities. “STEM careers can provide women with a greater degree of economic security than most other fields, which are compelling reasons to encourage girls to take courses in science and engineering” (Hoopes, 2011, p. 1). By describing the results of DE/DC early-college initiatives, particularly in STEM majors, better and more informed decisions can be made by all stakeholders in the education field.

### **Purpose of the Study**

The purpose of this study was to describe the impact DE/DC has had on initial enrollment in a STEM major in a Montana two-year college, persistence to the third semester, and subsequent completion rates of women who previously participated in DE/DC coursework in high school. Demographics of students entering post-secondary education in Montana established a baseline from which comparisons could be made. Trends showing the longitudinal development of DE/DC in Montana were also studied.

### **Definition of Terms**

In order to clarify concepts and provide a better understanding of terms used in this study, definitions are provided. In addition, commonly used acronyms related to this study are summarized in Appendix A. Specifically, the following explanations include:

**Access:** Enrollment in college immediately following high school graduation (Wei & Carroll, 2002).

**Advanced Placement (AP):** Nationwide program offering standardized college-level courses to high school students. These courses are generally recognized to be equivalent to undergraduate courses in college. Participating colleges grant credit to students who obtain high enough scores on the exams to qualify (U.S. Department of Education, 2011a). This effort is designed to raise academic standards for a diverse group of students, but typically the advanced or high-achieving students take part in the program. It is usually found at the four-year post-secondary level and often used for students wishing to attend Ivy League and out-of-state universities. No data from this type of early-college effort was collected for this study, but was included for comparative purposes.

**Big Sky Pathways:** Advanced learning opportunities linking high school to college in Montana. STEM pathway courses include calculus, chemistry, economics, introduction to engineering, physics, principles of engineering, and statistics (Office of Public Instruction, 2010-2011). Students may or may not get DE/DC for these courses.

**Boys:** Term for males under the age of 12 years (APA, 2010, p. 76).

**Career barriers:** “Events or conditions, either within the person or in his or her environment that make career progress difficult” (Cardoso & Marques, 2008, p. 51). For the purposes of this study, this phrase is used in the context of an educational setting where the importance of gender and cultural stereotypes influence the academic achievement of women in nontraditional programs of study.

**Classification of Instructional Programs (CIP) codes:** Taxonomic coding scheme of instructional programs that supports the accurate tracking and reporting of fields of study and program completions activity (National Center for Educational Statistics, 2011b).

**College-level coursework:** Courses numbered *100* or above are considered college-level and those below *100* are considered developmental in the Montana University System (Office of the Commissioner of Higher Education, 2011a). Only college-level courses were considered in this study.

**Dual credit (DC):** Opportunity for high school students to take college-level coursework and receive college credit while they are enrolled in high school (Speroni, 2011). This process allows a high school junior or senior to receive simultaneous academic credit for the course from both the college and the high school. The courses are often taught by the secondary teacher on the secondary campus. These courses include both academic as well as technical courses.

**Dual enrollment (DE):** “High school students taking college courses for dual-credit or college-credit only” (U.S. Department of Education, 2011b, p. 1). Montana high school students must be at least 16 years of age and/or a high school junior. In addition, those wishing to enroll in college-level mathematics courses must meet the college entrance minimum requirements of ACTM scores of 22 or SATM scores of 520. Dual-enrollment coursework may be delivered by four different teaching models (Office of the Commissioner of Higher Education, 2011a).

**Early-college experience:** High school students taking college-level coursework while in high school. For the purposes of this study, data were limited to DE/DC as the early-college experience being studied. Early-college experience is most often implemented using DE/DC program articulations which have been worked out between secondary schools and community or technical colleges (Andrews, 2010). Secondary students can expect the following benefits:

- Experience college-level coursework while still in high school
- Gain marketable technical or vocational skills not offered by the secondary school
- Earn up to one semester, one year, or two years of college credit prior to (or immediately following) high school graduation (Andrews, 2010)

**Girls:** Term referring to females under the age of 12 years (APA, 2010, p. 76).

**Graduation timeline for a two-year program:** Graduate with an associate's degree or credential and/or transfer to a four-year program within three years of initial enrollment as a full-time, first-time student (U.S. Department of Education, 2011a). This study also included first-time, part-time enrollees. Part-time students often choose community colleges because of this flexibility and are still able to finish within the 150% of program length timeline.

**Instructional delivery:** Term used in conjunction with teaching model to indicate where the students receive the instruction and the instructor home base (Office of the Commissioner of Higher Education, 2011a).

- High school class taught by high school teacher
- High school class taught by college teacher
- College class taught by college teacher
- Distance with online college teacher

**International Baccalaureate (IB):** Educational program started by a non-profit international educational foundation headquartered in Geneva, Switzerland. "Life in the 21st century, in an interconnected, globalized world, requires critical-thinking skills and a sense of international-mindedness and Colleges and Universities are realizing the value" (International Baccalaureate Organization, 2011, p. 1). This is usually linked to four-year postsecondary

institutions and data were not included in this study unless the students also got DE/DC from a public high school in the United States.

**Jobs for the Future (JFF):** Interagency collaborative effort that identifies, develops, and promotes education and workforce strategies that expand opportunities for youth and adults (Jobs for the Future, 2009).

**Men:** Term for males 18 years of age or older (APA, 2010, p. 76).

**Nontraditional career:** Careers that are generally filled by less than 25% of one gender. Men in nursing or women in engineering are examples (Community College of Allegheny County, 2011).

**O\*NET:** Extensive database to identify and isolate the competencies needed in occupations. It was developed and is maintained by the U.S. Department of Labor, Employment and Training Division (Employment and Training Administration, 2011).

**Perkins IV:** The Carl D. Perkins Vocational and Technical Education Act of 2006 provides an increased focus on the academic achievement of career and technical education students, strengthens the connections between secondary and post-secondary education, supports innovation, expands access to quality programs, and improves state and local accountability (U.S. Department of Education, 2006). It is the principal source of federal funding to states for the improvement of secondary and post-secondary career and technical education programs. Federal resources fund innovation, program improvement, and help ensure that programs are academically rigorous meeting the needs of business and industry (Association for Career and Technical Information, 2011). This initiative provides about \$1.3 billion annually to the states, including the basic state grants (under Title I) and tech prep grants (under Title II).

**Persistence:** Enrollment pattern in which students continue to enroll in successive semesters, attain a credential or transfer upward from a two-year college to a four-year institution, and do not have a break in enrollment of more than four months in their education (Wei & Carroll, 2002).

**Rigor (rigorous):** “Challenging instruction and coursework with high expectations for all students and early, focused academic intervention for low-performing students” (Thompson & Ongaga, 2011, p. 45). This term is used throughout the literature when describing the curriculum for early-college participants.

**STEM:** Widely used acronym to mean Science, Technology, Engineering, and Mathematics. The Department of Education (2011a) identifies the STEM career cluster as “jobs in the Science, Technology, Engineering, and Mathematics fields which involve planning, managing, and providing scientific research and professional technical services (e.g., physical science, computer science, engineering) including laboratory and testing services, and research and development services” (p. 14). The National Center for Education Statistics (2011b) groups instructional programs that focus on mathematics, natural sciences, physical sciences, biological, engineering, and computer science into six STEM career field categories with identified CIP codes:

- Computer and Information Sciences CIP code range 11.0101 – 11.1004
- Engineering and Engineering Tech CIP code range 14.0101 – 15.1501
- Biological and Biomedical Sciences CIP code range 26.0101 – 26.1309
- Mathematics and Statistics CIP code range 27.0101 – 27.0502
- Physical Sciences CIP code range 40.0101 – 40.0810
- Sciences Technologies CIP code range 41.0101 – 41.0301

**Success:** Measured as persistence to a two-year degree or credential from a post-secondary public institution (Guess, 2008). In addition, the DOE considers transfer to a four-year program as a measure of success at the two-year level (U.S. Department of Education, 2011a).

**Teaching Model:** DE/DC choices available to high school students who enroll in college-level coursework in Montana (Office of the Commissioner of Higher Education, 2010):

- Model 1: Concurrent enrollment in which the college employs qualified high school faculty as adjunct faculty to teach on high school campus
- Model 2: College faculty delivering the course to a class of high school students on either high school campus or college campus
- Model 3: High school students enroll in college course and attend on college campus
- Model 4: Blending high school students into online/video college courses

**Tech Prep:** Articulated process by which students completing high school courses identified with articulation agreements may transcript the course for college credit. Tech Prep is typically a 4+2, 3+2, or a 2+2 planned sequence of study in a technical field. The sequence extends through two years of post-secondary education and culminates in an associate's degree or certificate. These agreements are reviewed and renewed on an annual basis for common course outcomes (U.S. Department of Education, 2011b). Many states are consolidating tech prep into the newer DE/DC initiative.

**Title IV Institution:** Degree-granting post-secondary institution that is eligible for Title IV federal financial aid programs, grant an associate's or higher degree, have

accreditation recognized by the U.S. Department of Education, have been in business for at least two years, and have signed a participation agreement with DOE (U.S. Department of Education, 2011c).

**Young men:** Term used for males 13-17 years of age (APA, 2010, p. 76).

**Young women:** Term used for females 13-17 years of age (APA, 2010, p. 76).

**Women:** Term used for females 18 years of age and older (APA, 2010, p. 76).

### **Delimitations**

In order to establish the scope and set the conceptual framework for this study, the following delimitations were established:

1. Participants were identified as women graduates of STEM-related programs who participated in DE/DC early-college coursework at the high school level before they enrolled in a two-year college.
2. Participants indicated a STEM field as their initial major upon college admission.
3. Participants held a credential from a two-year post-secondary Title IV institution in Montana.

### **Limitation**

Enrollment data were collected from the Montana University System Office of the Commissioner of Higher Education which included five two-year Title IV college programs in the State of Montana. In accordance with the Family Educational Rights and Privacy Act (FERPA), only summative data were evaluated and reported. Disaggregated data were only released if subgroups contained sufficient numbers so that reporting would not reveal personally identifiable information about an individual student (U.S. Department of



Education, 2011c). No individuals, high schools, or colleges were reported, thus making this census data inherently anonymous. The identified limitation was:

There are many factors contributing to persistence in college. Although this research study focused on describing college enrollment and completion patterns for women who enrolled in a two-year STEM program with early-college credit, it is recognized that other unidentified factors may influence the access, persistence, and success of college women in STEM majors.

### **Summary**

The Economics and Statistics Administration (ESA) division of the U.S. Department of Commerce reports that as of 2011 “women are still vastly underrepresented in STEM despite making up nearly half of the U.S. workforce” (Economics and Statistics Administration, 2011, p. 1). ESA (2011) recognizes that this leaves an untapped opportunity to encourage and support women in STEM.

Therefore, research is needed to determine the trends of how early-college DE/DC experiences might affect access, persistence, and success of women in STEM fields. This study isolates that segment of the educational effort in Montana by researching participation in early-college courses by young women at the high school level with their subsequent transition to college.

Historically, educational reform efforts have been developed to address identified issues motivated by improving student outcomes and meeting the needs of diverse learners. These reforms are based on learning theories from psychology, sociology, and education—but often are an eclectic blend since most educators today are finding that there never will be a comprehensive one-size-fits-all approach to educating our populace. Senechal (2010, p. 9)

cautions that reform efforts often distract us from the true goal by chasing the newest thing. Speroni (2011) points out that “the recent growth of these [dual enrollment and dual credit] programs has been unprecedented” (p.1).

Results of this research project were viewed through the lens of the *Advocacy and Participatory Worldview*. Creswell (2009) explains that the *Advocacy and Participatory Worldview* identifies “specific social issues of the day, issues such as empowerment, inequality, oppression, domination, suppression, and alienation” (p. 9). Consistent research, thorough evaluation, thoughtful revision, and timely upgrades help make reform efforts pedagogically sound while improving student success. “At its fullest and best, education prepares us to be with others and apart, to enjoy the life of the mind, to survive and prosper, to bring up new generations, to act with integrity and conscience, to pursue useful and interesting work, and to participate in civic and cultural action and thought” (Senechal, 2010, p. 5).

The organization of this study followed standard five-chapter descriptive research design. Chapter One included an introduction to the topic, statement of the problem, research questions, significance of the study, definition of terms, and limitations/delimitations of the study. Chapter Two presented a comprehensive review of related literature within the scope of the research questions. This included the impact DE/DC early-college coursework in high school may have on access, persistence, and success thresholds for women in STEM majors. It also provided background on recent federal legislation, state initiatives, and matriculation from high school to college, two-year college connections, and influences on persistence of women in STEM majors. The methodology and procedures used to gather and analyze data were presented in Chapter Three. The results of the data analysis were presented in Chapter

Four. Chapter Five contained a complete summary of the study with recommendations for further study.

## CHAPTER TWO

### Review of Related Literature

The literature review included an extensive summary of the research in the area of early-college experiences for women in science, technology, engineering, and mathematics (STEM) fields. The framework underlying the selected literature is based on the research questions relating to access, persistence, and success of women in nontraditional STEM fields for those who did or did not take dual enrollment or dual credit (DE/DC) while in high school. In order to cover the range of topics in this area, the chapter was organized into subsections as follows: standards, related federal legislation, state initiatives, gender equity, access and transition to college, community college connections, impact of early-college experience, persistence and success, factors influencing career choice, and barriers to women in STEM.

The field of education is often analyzed for its competitive edge in the global arena and that comparison is often based on the STEM fields. In 2009, the United States ranked 29 out of 109 in the world for the number of degrees in STEM fields (Else-Quest, Linn, & Hyde, 2010). Modern society and our economy are becoming more science and technology oriented, but at the same time, fewer U.S. students are studying science, technology, engineering, or mathematics (Else-Quest et al., 2010). In most developed countries, women students make up more than half of all higher education students, but the distribution across all disciplines is uneven (Mastekaasa & Smeby, 2008). Women are underrepresented in these STEM fields and many efforts are in place to encourage and assist this population in gaining their degrees.

Lederman (2011) reported:

The U.S. Department of Commerce released new data on the gender gap in science and technology fields, stressing the economic impact on women. The study noted that

women hold almost half of all jobs in the United States, but less than 25% of those in STEM fields. This trend continues even though women in STEM careers earn 33% more, on average, than do women in other fields. Plus, the data showed that of those who study STEM fields in college, women are less likely to seek out STEM jobs. Of men with a STEM degree, 40% work in science and technology fields, while only 26% of comparable women do so. (p. 1)

### **Standards**

“In the United States, research like this is necessary because our educational system is not one system, but a disparate set of roughly 15,000 school districts...with varying degrees of focus, rigor, and coherence” (Schmidt, Cogan, & McKnight, 2010-2011, p. 13). The Schmidt et al. (2010-2011) study focused on equal opportunity to learn mathematics, and the researchers found that even with national efforts to standardize outcomes and curriculum, local districts often write their own standards, write their own curriculum, and mandate textbook choice. Therefore, these researchers suggested that perhaps the schools are not the “equalizers we would like them to be” (Schmidt et al., 2010-2011, p. 13). Further, because of the vast differences in schools, as well as the variables that contribute to student achievement and learning, trying to evaluate success at a local level with a national standard is not looking at the whole story. The whole story must consider all those factors beyond the control of students, and unfortunately, “socioeconomic status typically has a greater impact on achievement than schooling” (p. 15). This is also interrelated with parents’ educational levels. “The implication of our conceptual model is that by adopting focused, rigorous, coherent, and common content-coverage frameworks, the United States could minimize the impact of socioeconomic status” (p. 16). Although this study went on to discuss the Common Core State

Standards for Mathematics (Common Core State Standards Initiative, 2010), the findings are relevant input to the early-college DE/DC effort as well.

Saltarelli (2008) conducted a regional study similar to this research project in that the researcher evaluated the effect early-college credits had on higher education achievement. Results showed that many high school graduates are entering college with credits earned while enrolled in high school. In addition, the research examined the value of early-college credit in easing students' transition from high school to college, as well as the value of early-college credit in enhancing students' persistence rates. The Saltarelli (2008) research did not take into effect gender differences, STEM majors, nor was it conducted at the two-year post-secondary level. However, the results are worth noting because the statistical analysis showed early-college experiences “do indeed indicate that students who earn early-college credit are more successful in higher education than students who do not, in the areas of achievement, persistence, and time to graduation” (p. 83). One interesting facet of the study was that instead of looking at the transition from high school to college, it looked at the transition from community colleges to four-year colleges and recommended that the four-year institutions recruit directly to the high school students (Saltarelli, 2008).

Hutton (2009) also conducted a quantitative study that looked at graduation rates of women in STEM at two-year institutions. Although it was conducted at only one institution with additional variables not under consideration in this study, the study concluded that “a significantly greater proportion of women in other majors [in comparison to STEM majors] persisted to graduation” (p. 96).

Speroni (2011) also did a limited-scope study and pointed out that at the time of the study there were no nationwide statistics available on the growth of DE/DC. The research

concluded that fast-tracking students through the educational system could actually be discouraging students who are not emotionally or academically ready for college. In fact “despite the prevalence of DE/DC programs, there is little quantitative evidence of their effectiveness” (Speroni, 2011, p. 34).

### **Related Federal Legislation**

Title IX enacted in 1972 was one effort to ensure the civil rights and equality of women in educational institutions receiving federal funding. Compliance reviews by the U.S. Department of Education and Office for Civil Rights resulting from the 1972 Act were designed to ensure gender equity in education (U.S. Department of Education, n.d.).

Perkins IV was reauthorized in 2006 to provide funding and support for early-college experiences for high school students (U.S. Department of Education, 2006). With yearly allocations of \$1.16 billion nationwide, perhaps this can become a resource for encouraging young women in high school to enter the STEM pipeline and persist to a college degree (U.S. Department of Education, 2007).

Title III Part E of the Higher Education Act (HEA) includes the Minority Science and Engineering Improvement Program (MSEIP). MSEIP supports the Federal Government’s efforts to “improve and expand the scientific and technological capacity of the United States, to support its technological and economic competitiveness, and to address barriers that have led to the underrepresentation of minority students, particularly girls, in STEM fields” (U.S. Department of Education Agency Report, 2010, p. 18). From this program, one goal of MSEIP is to increase the number of women who are prepared to enter STEM fields, which in turn should increase the number of women who graduate with undergraduate and graduate degrees. In order to meet this goal, MSEIP supports efforts to include pre-college programs

and tutoring to increase skills in preparing for STEM fields (U.S. Department of Education Agency Report, 2010).

The largest U.S. competitive education grant program, *The Race to the Top Program*, is a \$4.35 billion fund created under the American Recovery and Reinvestment Act of 2009 (ARRA), (U.S. Department of Education Agency Report, 2010). “It is designed to provide incentives to states to implement large-scale, system-changing reforms that result in improved student achievement, narrowed achievement gaps, and increased graduation and college enrollment rates” (p. 17). Programs such as these indicate the importance society is placing on equity and women in science and technology because states receive “competitive preference for creating high-quality plans to offer rigorous courses in STEM; work with STEM-capable community partners; and prepare more students for advanced study and careers in STEM, including addressing any barriers to these careers for underrepresented groups such as women” (U.S. Department of Education Agency Report, 2010, p. 17).

Access to college is an important component toward attaining degrees and has become a topic of several efforts. The New America Foundation included *A College Access Contract* in its policy early in 2007 (Adelman, 2007), and the American Council on Education opened its annual meeting with the theme of *The Access Imperative*. By March of 2007 over three dozen pieces of proposed legislation affecting access to college were introduced at the federal level; two examples are *Graduate for a Better Future Act* and the *America COMPETES Act* (Adelman, 2007).

After accessing college, students participate in the college experience and persist toward a credential. Persistence is measured by students returning for their second year and acquiring credits toward the degree. The new *Academic Competitiveness Grant* was created by Congress in 2006 as a supplement to the basic Pell Grant for low-income or



underrepresented students who complete an academically intense high school curriculum, but as Adelman (2007) suggests, “it is one thing to offer challenging courses and quite another for students to enroll in them and do the work of learning” (p. 49).

“Dual-enrollment programs, often reserved for advanced students, are now seen as one way to provide an accessible and affordable bridge to post-secondary education for a broader range of students.” Research on the outcomes of such programs has been limited in scope and exists for only a few states (Geise, 2011, p. 1).

### **State Initiatives**

DE/DC is but one of several efforts to improve educational achievement. The Common Core State Competencies Initiatives (CCSCI) of 2010 for lower grades may negate the need for early-college in the future. In the meantime, there are a variety of implementations of DE/DC efforts. States identified smooth transitions for students from high school to college as well as a mechanism for tracking results as two major problems (Hoffman, Vargas, Venezia, & Miller, 2007). To minimize difficulties with transitions between educational levels, two basic remedies were identified:

- the curriculum must be aligned, and
- data collection and reporting systems must be in place which can follow students. (Hoffman et al., 2007)

Arizona implemented a National Science Foundation (NSF) project entitled *Prime the Pipeline Project (P<sup>3</sup>): Putting Knowledge to Work*. This project is through Arizona State University and is designed to strengthen the STEM pipeline from high school to college by engaging students, teachers, graduate students, mentors, scientists, and industry representatives through work on long-term projects or problems. Surveys of high school

graduates confirmed “58% were interested in majoring in one of the STEM careers; more than 50% took advanced placement coursework in math and science; and 100% were continuing on for post-secondary degrees” (Greenes, Wolfe, Weight, Cavanagh, & Zehring, 2011, p. 37).

In 1984 Florida was the first state in the nation to create an integrated data system (*Florida Education and Training Placement Information System*) long before the current need for longitudinal educational statistics. This interagency data system collects data on current students within the educational system, but is also able to track former students in a variety of ways—welfare recipients, prisoner releases, GEDs, adult education/retraining, and military training. As reported by Hoffman et al., (2007), this ability to track students helped the state integrate grades 9-20 and provided valuable information on how well students performed at the next level based on their status when they completed each educational level (Hoffman et al., 2007).

Maine implemented early-college high schools at 10 sites with 14 post-secondary institutions and more than 40 high schools in 2006. In addition, Maine proposed legislation that would “require each high school to provide all students with free, college-level courses that also fulfill high school graduation requirements” (Hoffman et al., 2007, p. 197).

Montana’s implementation of the Perkins IV Act called *Big Sky Pathways* was introduced in 2008. It is guiding “advanced learning opportunities with high school to college career linkages in identified career clusters,” one of which is the technology sector (Office of Public Instruction, 2010-2011, p. 1). The Office of Public Instruction (OPI) has established equivalent high-school courses needed to meet Montana graduation requirements with cluster pathway courses at the college level. Pathway courses are designed to prepare students for the rigor of the college curriculum (Office of Public Instruction, 2010-2011). The statewide

partnership between the Montana University System (MUS) and the Office of Public Instruction (OPI) is building educational pathways with the goals of:

- helping students make smooth transitions from high school to work or college,
- enhancing academic momentum,
- decreasing remediation rates,
- increasing persistence, and
- increasing graduation rates. (Office of Public Instruction, 2010-2011)

Montana has four different instructional delivery models that are implemented to provide opportunities in a variety of situations to meet student needs (Office of the Commissioner of Higher Education, 2010). The report by OCHE identified advantages of each:

- High school class taught by high school teacher
  - Students on same schedule with other classes
  - Get instruction from faculty they know
  - Course taught in a year instead of a semester
  - No need for students to travel
- High school class taught by college teacher
  - Community members can also take the course for college credit
  - Quality of instruction from college faculty
  - Maintain high school classroom on high school schedule
- College class taught by college teacher
  - College environment
  - Mixed classroom with college students
  - True college experience

- Rigor and challenges of a college class
- Motivating factor for success in college coursework
- Distance education with online college teacher
  - No limitations by what is offered at high school
  - Follows high school calendar
  - Interactions with other college students
  - Builds confidence when successful
  - Requires more self-discipline from individual students (Office of the Commissioner of Higher Education, 2010)

The *MUS Strategic Plan* includes additional system initiatives directly related to this study (Office of the Commissioner of Higher Education, 2011a):

- Two-Year College Initiative: Increase access and participation at two-year colleges with online access, dual enrollment, customized programming, and promoting a two-year college as an entry point to immediate careers or four-year degrees. Reported results include:
  - In 2010 Montana reported that 58% of its high school graduates immediately enroll in college the following fall. This was slightly up from the 1994 rate of 55% (p. 1.1.1).
  - Freshmen retention rates continuing to second year at the two-year institutions were 56% in 2010, with 40% of those graduating. Again, the percentage was up slightly from the 52% retention and 37% graduation in 2007 (pp. 1.1.2, 1.1.3).

- At-risk and disadvantaged student enrollment in the MUS was 10.7% in 2011, up from 6.8% in 2005 (p. 1.4.1). This compares to 32% of top performing students enrolling in the MUS in 2011 (p. 1.4.2).
- The number of students taking advantage of early college enrollment has almost doubled from a total of 376 in 2004-2005 to 720 in 2010-2011 (p. 1.4.3).
- There was a 9% increase from 2000-2001 to 2009-2010 of associate's degrees awarded, and a 9% decrease in that same time span of certificates (p. 2.1.4).
- MUS Transferability Initiative: Improve course transfer between university system units and develop a centralized data system. Common course numbering for undergraduate courses ensures a direct transfer—9,000 courses in 60 disciplines have been identified as of December 2011.
- Access to Success (A2S): Collaboration with other states to increase participation and success of low income and/or minority students.
- Gaining Early Awareness & Readiness for Undergraduate Programs (GEAR-UP): Encourage and support students to set high expectations, stay in school, and take college-prep coursework. A federal grant supports this effort.
- Faculty & Staff Recruitment and Retention Efforts: Involve faculty and staff in comparative analysis to develop recommendations (Office of the Commissioner of Higher Education, 2011a).

Additionally, *College!Now*, a parallel two-year college initiative to the MUS Strategic Plan, has as two of its goals to expand DE/DC and improve two-year to four-year transfer

capabilities. The National Center for Education Statistics (NCES) indicates a 4.8% decrease of women graduates in STEM fields from 2000 to 2008 (2011b, Table 6) in Montana. This transparent matriculation to the next level is an identified solution to low graduation rates in STEM (Office of the Commissioner of Higher Education, 2011b).

New Jersey's early-college programs are designed for participants who are in grades 10-12 to take college credit on a college campus or at their high schools. The *Pre-College Academy* teaches students in customized classes taught by high school faculty recognized for excellence. Another option is called *The 12<sup>th</sup> Grade Options Program*. These teachers are adjunct faculty from the cooperating college teaching on the high school campus (Kimmel, Carpinelli, Cano, & Perna, 2012). Kimmel et al. (2012) reported that the "pre-college students who participated in these programs significantly surpassed the graduation rates of their peers" (p. 7).

Oregon promotes their *Degree Partnership Program (DPP)*, which is designed to enable students to complete a university degree more quickly and more affordably. Previously named *Dual Enrollment*, this program allows students to be concurrently admitted and enrolled at Oregon State University and any community college (Oregon State University, 2012). At the high school level, dual credit is available for students who wish to start post-secondary education early. An interagency agreement between the Oregon Department of Education and Department of Community Colleges and Workforce Development provides staffing and leadership for 17 community college career and technical education programs. The agreement ensures equity, continuity, cooperation, and accountability across the education-to-workforce continuum. Dual-credit programs are within the scope of these two cooperating departments (Oregon Department of Education, 2010, p. 1). In a study of Oregon

2007-2008 students, dual-credit students had a higher college participation rate than high school graduates overall. In addition, dual-credit students continued to the second year at a higher rate than freshmen who entered college without dual credit. Students receiving dual credit in Oregon are taught in the high school by high school faculty. No difference was found in performance in upper division coursework when the prerequisite was delivered as dual-credit in high school versus delivery of the prerequisite in college. Dual-credit enrollment in Oregon nearly doubled between 2008 and 2010 with 15% of 2010 high school seniors participating in college-level coursework (Oregon Department of Education, 2010).

Rhode Island created a new *performance-based diploma* system that allows students to use college courses as a demonstration of high school proficiency in six designated areas of core learning. There is a fee of \$50 per credit that is causing some inequity in their dual-enrollment opportunities (Hoffman et al., 2007). However, there are over 100 different courses available for high school students that enroll in college degree programs. Like many other states, Rhode Island initially thought of dual enrollment as a program for the gifted, and now sees its potential as a bridge to college for all high school students (Hoffman et al., 2007).

Syracuse University is possibly the pioneer in dual-credit programs starting in the 1970s with their *Project Advance* program which initially encompassed five states. Syracuse reports success and growth of the program with 92% of the teachers reporting their jobs as being more challenging through teaching dual-credit courses (Andrews, 2010).

Texas, as with most states, kept K-12 separate from higher education until recent efforts toward P-16. They adopted *Closing the Gaps by 2015* to facilitate educational collaboration and reform. In addition to the *Closing the Gaps by 2015* goals, Texas developed

a process for longitudinal data tracking for the entire P-16 pipeline with databases integrated into a user-friendly, interagency, longitudinal database to track student progress into the workforce. To track achievement of goals, an accountability system requires all institutions to annually report their progress toward the goals. Texas has had widespread success with dual-enrollment because high schools do not lose funding for students getting college credit simultaneously. Teachers receive a stipend as an incentive to teach the college-level coursework. However, like Rhode Island, they are mainly serving advanced or economically advantaged students because post-secondary institutions can charge tuition (Hoffman et al., 2007).

Utah has extensive dual-credit opportunities in collaboration with community colleges. They are unique in that they offer an incentive for high school students who receive an associate's degree along with a high school diploma; these students are eligible for scholarships worth 75% of upper-division college tuition (Hoffman et al., 2007). Florida, Illinois, and Kentucky have similar incentives for early-college experiences.

Virginia's *Early College Scholars* program allows students who pursue an *advanced study diploma* to earn one semester of free college credits. In addition, students who begin industry certification in high school may complete the work without cost after they graduate (Hoffman et al., 2007, p. 197).

Washington State couples high school reforms with early scholarships in their *Washington State Achievers* program. In addition, Washington State's *Running Start* is a concurrent enrollment program where qualified high school juniors may take college classes at a local community or four-year college. However, after the initial implementation in 2006, growth has fallen off because the high schools lose money when students attend college



classes. The funding structure in Washington is not unique; this financial reality has slowed progress in other states as well (Hoffman et al., 2007).

Public policy can enhance the conditions conducive to participation, but it cannot determine the extent to which students take advantage of these conditions, according to Adelman (2007). Title IX ensures equal opportunity and with the added opportunities provided by provisions in the Perkins IV legislation, the number of women getting degrees in STEM should be moving toward parity with men. Many studies have been done to evaluate Title IX, but because of the short time period since Perkins IV, little data has been available to evaluate its effectiveness.

### **Gender Equity**

The number of women in science and engineering fields has grown but men continue to outnumber women, especially at the upper levels of these professions. “In an era when women are increasingly prominent in medicine, law, and business, why are so few women becoming scientists and engineers?” (Hill, Corbett, & St. Rose, 2010, p. ix)?

In elementary, middle, and high school, girls and boys take math and science courses in roughly equal numbers and both are prepared to pursue science and engineering majors in college. Yet, fewer women than men pursue these majors. Hill et al. (2010) report the effects of “societal beliefs and the learning environment on girls’ achievements and interest in science and math (p. xiv).”

With gender equity laws in place and new linkages between high school and college, the question remains—why are there so few women scientists and engineers (Hill et al., 2010)? A 2010 National Science Foundation publication entitled, *Why So Few? Women in Science, Technology, and Math*, identifies “environmental and social barriers—including

stereotypes, gender bias, and the climate of science and engineering departments in colleges and universities that continue to block women's participation and progress in science, technology, engineering, and math" (Hill et al., 2010, p. 1). In another report (Hegewisch, 2010) states:

Occupational gender segregation is a strong feature of the U.S. labor market. While some occupations have become increasingly integrated over time, others remain highly dominated by either men or women. Our analysis of trends in overall gender segregation shows that, after a considerable move towards more integrated occupations in the 1970s and 1980s, progress has completely stalled since the mid-1990s. Occupational segregation is a concern to policy makers for two reasons: (1) it is inefficient economically, preventing able people from moving into occupations where they could perform well and that would satisfy them more than the ones open to them; and (2) occupational segregation is a major cause for the persistent wage gap. Our analysis confirms that average earnings tend to be lower the higher the percentage of women working in an occupation, and that this relationship is strongest for the most highly skilled occupations. (p. 1)

### **Access and Transition to College**

Access to schooling is generally moving toward gender parity; in fact, in some cases the number of women enrolled exceeds male enrollments (Stromquist, 2007). However, what is not changing is the concentration of women in typically feminine fields and "overrepresentation of men in fields perceived as masculine such as science and technology" (p. 163). This remains a challenge in spite of the potential contributions of women in these fields. Leon (2010) suggests that there may be biases or "cultural mismatch between women's

expectations and the reality of the work environment” (p. 2). Tinto (2008) suggests that underrepresented students are still not successful in our education system because the “open door to American higher education has become a revolving door” (p. 1). Further, Tinto (2008) supports strengthening pre-college preparation to address the deeper roots of this trend. This preparation would include helping students make the social as well as academic transition to college. Stromquist (2007) suggests that in addition to enrollment in school, other important indicators of access are completion, achievement, and matriculation to higher levels of education.

A study done for the State of Kentucky shows that dual-enrollment improves not only high school graduation rates, but improves the post-secondary transition rate (Simms, 2010). The study did not filter for STEM careers or gender differences, but did document the value of these efforts for matriculation from high school to college.

Smith (2007) found a relationship between dual-credit programs and educational aspirations. The study made a distinction about where the students took the classes. Students taking dual-credit courses on a college campus were more likely to attend college, whereas those who took the dual-credit coursework at a high school had no improvement in educational aspirations.

Similarly, McCauley (2007) found that advanced placement or dual-enrollment coursework while in high school significantly influenced post-secondary graduation rates. The study was done with data from four-year colleges or universities instead of the two-year specified in this study, but the conclusion is similar in that it is important for high schools and colleges to find incentives such as these to improve graduation rates. However, the McCauley (2007) study identified problems with DE/DC programming:

- Questions of rigor and quality of programs surfaced
- Models that did not involve courses on a college campus differed very little from high school coursework
- College courses may be compromised due to high school student enrollment as teacher adapts to lesser degrees of knowledge and maturity
- Programs are not reaching individuals who are least likely to continue on to college
- Funding calculations for states where it is enrollment based
- Pushing students away from advanced placement classrooms towards community college classrooms with fewer hours, larger class sizes, less monitoring
- Is not effective in increasing college success of underrepresented groups; race and low-income status reduces student participation. (McCauley, 2007, pp. 19-25)

To address the issue of matriculation from high school to college, some school districts have created science and math high schools, while others are using the National Science Foundation's *Talent Expansion Program* to improve enrollment and graduation rates (Else-Quest et al., 2010). Other school districts have created *Early College High Schools* as a pathway for high school reform (Kaniuka & Vickers, 2010). According to the Kaniuka and Vickers study (2010):

Disparities as defined by race and gender persist. The achievement gap remains an elusive and persistent challenge and is further complicated by the fact that

nationally little or no progress has been made in helping traditionally underrepresented students achieve college readiness. (p. 166)

An even stronger case is made by Thompson and Ongaga (2011) who feel that the “traditional American high school is seen as a fragmented, alienating system stalled by an adherence to an outmoded transmission-oriented model of teaching and learning” (p. 44). This case study proposes that because educational reform efforts have fallen short of meeting the challenges of an “increasingly diverse, technological, and economically-entwined world, early-college efforts are more thinking-oriented and student-focused” (p. 44). Adelman (2007) would agree; he suggests that educational leaders aren’t going to see any improvement of the bottom 40% of high school graduates without changing their academic preparation because:

Over the past 15 years we have created early colleges, middle-college high schools, and magnet schools by the hundreds, and now perhaps 20% of our secondary-school students are in dual-enrollment programs. But for the most part, these efforts reach students whose profiles already destine them for successful participation in college. (p. 53)

Residential STEM schools or academies for gifted high-school students were the topics for research conducted by Olszewski-Kubilius (2010). These STEM secondary schools or academies are most appropriate for talented students who are willing to leave home as sophomores and who are very serious about taking advanced courses in preparation for a STEM career. However, the research did explore other options as well since there are few specialized STEM institutions. Regardless of whether students chose STEM academies or participated in DE/DC experiences, Olszewski-Kubilius (2010) concluded that students can prepare better for STEM careers by:

Experiencing challenging academic work early and consistently, having authentic research experiences that enable them to get a true picture of the nature of scientific investigation and inquiry, and having substantial contact with STEM professionals who can offer tacit knowledge and guide them. (p. 69)

Koebler (2011) agrees that focusing on STEM should begin early. “The key is to look at all of this as a continuum...you have to start early, beginning in middle school, and if we could, we’d begin pushing STEM in kindergarten” (p. 1).

One of the problems with transitions from high school to college is misinformation and lack of guidance. “Why schools and colleges focus on raising students’ expectations while so thoroughly failing to provide clear information about realistic probabilities and incentives for school effort” is a question raised by Rosenbaum and Becker (2011, p. 14). For instance, students must take placement tests in college which determine whether or not they can take college credit classes or enroll in noncredit remedial courses. Rosenbaum and Becker (2011) point to a high school senior who almost dropped out with a C- average looking forward to college:

No one told her she has to pass a college placement test before she can take a college course, nor has she been told that she may have to pay for remedial courses for no credit. No one has told her that she probably lacks the academic preparation to do well in remedial courses, much less college courses. No one has told her that most students like her never earn a college degree. (p. 14)

Instead of hoping this student will catch up in college, Rosenbaum and Becker (2011) support collaboration between high school and college educators to create a clear path from high school graduation to college graduation by providing the following support:

1. Instead of relying on student choice, show students what content and skills they need for college and provide a curriculum leading to the mastery of that content and those skills.
2. Instead of assuming students are motivated, foster motivations by offering incentives and bolstering student confidence.
3. Instead of student-initiated guidance, keep students on track by providing frequent mandatory guidance and closely monitoring progress.
4. Instead of a student-initiated college search, manage the transition from high school to college.
5. Instead of assuming study skills, teach study skills. (Rosenbaum & Becker, 2011, p. 15)

Part of the success of early-college high schools formed through partnerships between high schools and community colleges was that they were able to do all these things. As Rosenbaum (2011) continues, “standards alone are much too vague; students need specific information about college requirements and how to reach them” (p. 15). In other words, make sure all students have the information they need to access the college of their choice.

Of all the types of early-college options for credit, “only dual-enrollment/dual-credit programs afford students direct contact with a cooperating community college or four-year institution” (Swanson, 2008, p. 182). Students in DE/DC courses experience the climate of a college course—purchasing textbooks, and receiving a college transcript at the end of each semester. College credits accumulate that may enhance persistence toward a degree (Besecke & Reilly, 2006). In addition, Swanson (2008) found that a “smaller percentage of DE/DC

students transferred from two-year to four-year colleges, while larger percentages of DE/DC students executed reverse transfers from four-year to two-year colleges” (p. 216). In addition, the study found that more dual-enrollment students earned certificates or associate’s degrees than bachelor’s degrees in relation to DE/DC non-participants and the total population (Swanson, 2008). Findings reported by Swanson (2008) indicate that dual enrollment might enhance students’ chances at achieving a two-year degree or technical training certification, but the statistics produced by the dual-enrollment variable showed very little direct influence upon either persistence or degree attainment. Surprisingly, the Swanson (2008) study did not filter for women in STEM fields.

According to Adelman (2007), there are three major thresholds for students’ post-secondary education: access, persistence, and completion. Graduating actually requires that students take a higher level of responsibility than when they matriculate from high school to college; Adelman (2007) has researched aspects of this process starting with different meanings for the term *access*:

- Threshold access—walking through the door
- Recurrent access—if leave before graduation, can return at any time
- Convenient access—entrance at a season and location of preference
- Distributional access—choice of institution or institutional type. (p. 49)

Adelman (2007) found on average 79% of graduating high school seniors enter college. The research did take into consideration ethnicity, but did not address gender differences. In addition, the findings indicated that race and ethnicity differences exist, but there is more disparity between graduates from the top third of the family-income range (91% entered post-secondary education) and those from the bottom third of family income (69% entered post-



secondary education). Of the low-income students, 67% were reading below level of simple inference, and 71% never reached Algebra 2. Contrary to other researchers who support the idea that higher mathematics skills are needed, Adelman feels that reading levels are more important. Someone reading below grade level cannot read the math textbook, biology textbook, documents on the Web, or technical manuals (Adelman, 2007).

Swanson (2008) stated that in order to ensure quality programming, systematic oversight must be designed by dual-enrollment providers and research must continue “to test and monitor the efficacy of dual-enrollment programs for students” (p. 349). DE/DC enrollment has shown potential for impacting enrollment and participation in college. In order to blur the lines between high school and college, Williams and Southers (2010) advocate for improving matriculation from high school to college with connections to a community college.

### **Community College Connections**

The National Governor’s Association (NGA) is taking a leadership position on the issue of the shortage of STEM-skilled students and workers. In a position statement published in June, 2011, NGA recognized that community colleges can play an important role in these governor-led STEM initiatives. One of the identified goals is to ensure that credits are transferrable and stackable which can build on the dual-enrollment experiences for high school students by ensuring that students can transfer STEM courses and programs from two-year to four-year colleges (Baber, 2011). Implementation of NGA STEM initiatives varies by state:

- California—embed engineering and applied skills with course pathway structure

- Colorado—articulation agreements for each program
- Florida—statewide articulation agreement
- Hawaii—STEM bridge program brings together high school students with college student peers
- Montana (and 13 other states)—STEM pathways with partnerships between high schools and community colleges. Montana has implemented four teaching models:
  - High school class taught by high school teacher
  - High school class taught by college teacher
  - College class taught by college teacher
  - Distance class with online college teacher
- North Carolina—STEM pathways with early-college high schools for at-risk and low-income students who receive an associate’s degree along with high school diploma
- Oregon—dual enrollment at post-secondary level between community colleges and four-year institutions with dual credit at high school level
- Virginia—STEM focused programs of study with established engineering standards in which students earn college credit and industry certification (Baber, 2011)

Community colleges historically serve students with a rich diversity based on age, academic ability, socioeconomic status, and educational background.

The history of the community college reflects an almost continuous effort to increase access to higher education; women, members of non-dominant groups in society, older

learners, learners with disabilities, and now younger students have often accessed higher education through the community college. As a result of this history of increasing access and inter-institutional collaboration, the community college has become known as the access point to higher education. (Williams & Southers, 2010, p. 26)

Williams and Southers (2010) did not look at specific opportunities for young women coming into STEM, but instead focused on whether the presence of high school students as young as 14 has an effect on the learning environment of adult students at the community college. While their findings concluded the faculty, staff, administration, and students supported the concept of early college in the form of dual enrollment, concerns included more discipline problems, funding and space problems, and faculty not trained to educate high school students. The diversity of the student body, however, allowed them to broaden their scope of academic service to the community (Williams & Southers, 2010).

Increasing numbers of students taking part in accelerated learning options that provide college credit while in high school has sparked a renewed interest in the community colleges. These institutions lead the way in making these options available. In fact, “98% of public two-year institutions had high school students taking courses for college credit” (Hoffman, Vargas, & Santos, 2009, p. 44). In addition, community colleges are in a position to accommodate the four ingress points for access to post-secondary education:

- Threshold access—walking through the door
- Recurrent access—if leave before graduation, can return at any time
- Convenient access—entrance at a season and location of preference

- Distributional access—choice of institution or institutional type of choice  
(Adelman, 2007, p. 47)

Most of the research to date shows that DE/DC programs have the potential to offer numerous benefits to not only students, but also colleges, high schools, and teachers. Crockett-Bell (2007) found that by exposing students to early-college experiences they “are realizing their potential, and in many cases, choosing the sponsoring colleges to make seamless transitions” (p. 4). While the Crockett-Bell (2007) research was a qualitative study within a single locality, the results were indicative of expectations for the early-college program goals:

Dual-credit programs create academic challenges for high school students and provide an opportunity for them to make a seamless transition from high school to college. The underlying goal of the program is to assist students in earning college credit(s), while saving time and money. (p. 51)

Similar to other research mentioned earlier in this review, Crockett-Bell (2007) found dissatisfaction with the process; i.e., “a major weakness of the dual credit program is the coordination between the high school and the college, which results in poor recordkeeping, mixed messages, and scheduling problems” (p. 52). In particular, there was a lack of communication between high school teachers and department chairs at the community college. The Crockett-Bell (2007) study concerned the qualifications of the high school teachers—advanced placement teachers did not necessarily have master’s degrees or degrees in the discipline they were teaching whereas dual-credit teachers were required to have additional credentials and specialized professional development. The study also did not take into account gender differences or STEM fields, but it was conducted at the community

college level and the very nature of a qualitative study produced interesting personal insights from the various stakeholders.

A study by Mattis and Sislin (2005) that focused on the community college and its role in engineering careers found that in 2005 (before the current reform efforts) community colleges were already essential to the education of engineers in the United States. This study states:

Increasing the number of engineers will first require increasing the number of engineering students, and one way to do that is to tap into the pool of students pursuing engineering science studies at community colleges, who could then transfer to four-year institutions. (Mattis & Sislin, 2005, p. 7)

Further, community colleges are an attractive source for engineering students because millions of students already attend, with projections for increased enrollments. Of their student bodies, many are women and minorities. Few students earning associate's degrees transfer to four-year engineering programs so there is tremendous potential for growth with this population (Mattis & Sislin, 2005). This transfer function of community colleges has yet to reach its potential. Recent reform efforts are aimed at increasing this opportunity and making effective use of community college campuses to achieve student and faculty diversity goals.

The community college transfer function is critical to meeting the national need for a robust, diverse engineering workforce. In fact, community college transfer may be the primary mechanism for increasing the number of students pursuing engineering degrees, particularly underrepresented minority students. Although there are many innovative and effective partnerships between community colleges and four-year

institutions, they must not only be enhanced, but also taken to scale to meet a national need. (Mattis & Sislin, 2005, p. 7)

Noted in this study, however, is the fact that “most two-year institutions do not have the resources to compile and analyze data on the effectiveness of their preparation of engineering science students for transfer to four-year engineering programs” (p. 10). Therefore, the initiatives currently in place become more important for improving opportunities for women in STEM.

The National Action Council for Minorities in Engineering recommends utilizing a variety of paths to STEM careers, including using an associate’s degree as the starting point to an engineering profession and advanced degrees. The recommendation includes helping students who have dropped out to re-enter; the community college is designed to serve those returning students. Utilizing various options for obtaining necessary skills enables women and other underrepresented students to prepare for these STEM careers and join the engineering workforce (Koebler, 2011).

### **Impact of Early-College Experience**

One purpose of early-college experience is to get high school students interested in college before they graduate from high school. The results of a descriptive analysis done by Maltese (2008) demonstrated that most students who went on to complete majors in STEM completed at least three or four years of STEM courses during high school and enrolled in advanced high school mathematics and science courses at higher rates. There are several opportunities for high school students to get college credit while attending high school:

- Tech Prep
- Advanced Placement

- Dual credit
- Dual enrollment
- Early-college high schools
- International baccalaureate (Maltese, 2008)

The oversight of these programs is provided by state departments of education, which in turn report to the U.S. Department of Education. The foundation of all these efforts is based on the theory that presenting high school students with college-level coursework will not only engage their interest in the field but will encourage them to continue their education after high school graduation (Maltese, 2008).

According to U.S. Department of Labor projections, by 2014 women will account for 47% of the total labor force. Total employment is projected to grow 13% by 2014 with the fastest employment gains within professional and science-related occupations. This occupational group is made up mostly of occupations that require post-secondary education or training. These fields include computers and networking systems, data communication analysts, computer software engineers, and environmental engineers. Of the top 12 hot jobs (strongest outlook and highest earnings) seven are STEM career fields (U.S. Department of Labor, 2011). In contrast to the fast-growing fields needing college preparation, jobs with the largest numerical growth tend to be in fields needing only on-the-job training. These jobs are service oriented, office support, food preparation and serving, building and grounds maintenance, and transportation or materials moving. The median weekly earnings continue to show a gender gap: \$585 for women and \$722 for men, even though the number of women in the workforce is almost equal to that of men. The discrepancy in pay follows the

underrepresentation of women in the higher salaried STEM careers (U.S. Department of Labor, 2011).

Since the Perkins IV reauthorization in 2006, most U.S. public high schools have dual-credit and dual-enrollment courses. The U.S. Department of Education supports early college efforts with Title IV monies (Diament, 2011). Even with this support, Harris (2011) found that:

The problem has been an emphasis on equal opportunity, not equal outcomes. Equal outcome campaigns, the goal of comparable worth, have had inconsistent effects for women. Earnings disparities between men and women serve as the principal measure of gender inequity. Hence, wages determine economic well-being and how fairly and equitably wages are distributed is a predictable gauge of status and constitutes a factor in the division of labor decisions that men and women make; other factors include less credentialing by women, discrimination that penalizes women for pursuing nontraditional roles, and early socialization choices that force them into gendered roles.

(p. 123)

Hugo (2001) found that dual enrollment can build closer links between high schools and colleges. DE/DC strengthens the ties between the P-16 sectors and leads to more partnerships and stronger collaborations. Even though this article was written over 10 years ago, it is reflective of the current effort. Findings indicate that DE/DC programs provide an opportunity for students to learn about colleges, improve their study skills, experience the process of attending college, and inspire students to excel (Hugo, 2001).



In the eight years since Hugo's article, Mead (2009) found that high school students are enrolling in higher education at record rates as a result of seamless educational opportunities such as DE/DC. Providing high school student's wider access to more rigorous academic and technical courses, saving time and college costs, and enhanced college admission and retention are advantages of the early-college experience. Mead (2009) showed a significant difference in the success of the dual-credit students when compared to the success of the non-dual-credit students; however, there was no significant difference when controlling for gender. One recommendation for future research was to replicate the study on a wider scale including a qualitative component to fully understand the benefits and identify ways to improve the program (Mead, 2009).

Increasing high school graduation rates while encouraging post-secondary education is the topic of a Hoffman, Vargas, and Santos (2009) study devoted to options for creating pathways from high school through college. Findings suggest that an emerging body of research is supporting the early-college efforts of providing college-level work in high school as one promising way to prepare a wide range of young people for college success. If designed well, this experience has potential to:

- increase the pool of historically underserved students,
- provide realistic information about knowledge and skills needed for success,
- improve motivation through high expectations,
- promise of free courses,
- decrease cost by compressing the years to degree, and

- create standards, assessments, curriculum, and transitions (Hoffman et al., 2009, p. 44)

McComas (2010) focused on concurrently enrolled students in the community college system in Iowa:

Degree completion rates were highest for white women enrolled in college parallel programs and for white men enrolled in career and technical programs; degree completion rates were lowest for men, non-white students enrolled in arts and sciences programs. (p. 11)

Results of this study indicated that even with early-college experiences, the sciences are still male dominated with men comprising 70% of the career and technical programs.

While the Hugo (2001) study and the Mead (2009) study both found that early-college experiences were improving success in college, others did not agree. The Hugo research study was completed five years before government intervention. The concept of DE/DC was not created with the reauthorization of Perkins IV, but was not widely available to underrepresented students. Implementing change within institutions like educational systems takes time. Hugo (2001) was included in this review to provide a historical reference that early college is not a new concept. What is new is the funding supporting the efforts and the new, widespread implementation as a result. Hugo (2001) and Mead (2009) findings disprove the generalization that early college is *good for all*.

Tinberg and Nadeau (2011) agree that while some early-college courses have a positive effect on some students enrolling in college, there is no evidence of these courses enhancing learning outcomes. The researchers question the oversight given to the curriculum

that supposedly matches the course taught at the college level. This raises doubts about the effectiveness of improving student readiness for higher education (Tinberg & Nadeau, 2011).

Duffy (2009) found “no significant differences existed in student college persistence and performance outcomes among the respective [dual credit vs. no dual credit] student groups, the only pre-entry attribute that showed a significant relationship in every regression model was the composite ACT, high school GPA, and high school rank” (p. 8). Although there was no difference in persistence and performance, it was found that dual-credit students persist and perform equally as well in college as their non-dual credit peers (Duffy, 2009). Even though this study included statistics for a four-year college and data from years prior to 2006, it was included in this literature review as a historical reference.

When looking at early-college coursework and college graduation rates, Smallwood (2006) found that early college certainly helps, but he believes the single best predictor of college performance in science courses was students’ mathematical proficiency. Hill et al. (2010) report that women “who take calculus in high school are three times more likely than girls who do not to major in a scientific or engineering field in college” (p. 92). Another benefit of taking higher-level DE/DC science and math courses while in high school is that it increases career options (Smallwood, 2006).

While researching mathematical abilities, Hill et al. (2010) found “a large gender difference in cognitive abilities in the area of spatial skills, with boys and men consistently out-performing girls and women” (p. xv). Spatial skills are believed to be important for success in engineering and other scientific fields. In fact, Sorby and Baartmans (2000) received NSF funding to develop a pre-graphics course for freshman engineering majors. It was based on Piagetian theory with spatial ability developed in three distinct stages:

topological spatial visualization, projective/perspective representation, and finally combine projective ability with the concept of measurement (Sorby & Baartmans, 2000). The course was developed to “provide the prerequisite spatial skills needed by students to succeed in engineering” (p. 301). The course was assessed in a longitudinal study that documented its success, without filtering for gender or other pre-college characteristics. More research comparing spatial skill development between genders is an area that might provide insights as it relates to success of women in the science fields (Hill et al., 2010).

Else-Quest, Linn, and Hyde (2010) conducted an international study and found globally there is no significant difference in mathematics ability between girls and boys. These findings suggest more complicated issues contribute to the reason women are not graduating at the same rate as men in STEM fields. Results from the Riegle-Crumb and King (2010) study also found no evidence that mathematics attitudes or aptitudes contribute to disparities between genders in choosing a STEM career.

Smallwood (2006) found mathematical proficiency, regardless of gender, is a predictor of college success. Early-college courses provide advanced mathematics instruction to high school students. Therefore, by taking advantage of DE/DC coursework, both young men and young girls build college-level math skills and should succeed equally well in STEM college majors (Smallwood, 2006).

### **Persistence and Success**

An NCES report of 2009 college graduates in STEM-related majors shows a significant difference in the percentage of graduates in engineering between genders with 10% of men graduating compared to 2% of women; in computer science 24% of men graduate compared to 14% of women (National Center for Education Statistics, 2011a). This

report analyzed nationwide data to find trends in the differences among graduates with results suggesting that a challenging curriculum in high school was a factor for college completion (National Center for Education Statistics, 2011a).

Precollege characteristics have been extensively studied and reported in the literature as it relates to persistence and success in post-secondary education. In addition to gender, race, and socioeconomic status, other topics suggested as possible predictors for college success include number of hours studying in high school, academic ability, leadership ability, and meaningful philosophy of life (Astin & Lee, 2003). Environmental events, disposition, motivation, expectations, and aspirations as well as prior education experiences, enrichment activities during summers, extra-curricular activities, and parent educational level are also frequent topics for studying college success. The NCES (2011b) found that STEM degree attainment is related to parents' education levels, strong academic preparation in high school, and type of institution in which they first enroll. Ormrod (2012) found that past behaviors prior to college are not necessarily predictors for future behavior at the post-secondary level, and research by Konings, Brand-Gruwal, van Merriënboer, and Broers (2008) found:

Expectations bias perceptions by directing students' attention to choices that are consistent with the expectations. Expectations bias students' interpretation of events to favor consistency with expectations. Bias influences subsequent behavior in a manner consistent with expectations (p. 535).

In other words, students create what they expect in a self-fulfilling prophecy. Astin and Lee (2003) agree that expectations are always in flux and when precollege characteristics are combined with new experiences on campus the outcome becomes a determining factor in persistence and success. Kuh, Kinzie, Buckley, Bridges, & Hayek (2006) also found that

among variables studied as potential success factors, only expectations for college could predict success. In addition to the research on precollege expectations, studies have found additional elements leading to persistence.

Santovec (2011) found that getting into college with a STEM major was an important “transition space in the STEM pipeline,” but persistence is often affected by the second transition space in which women discover more appealing majors after enrolling in college (p. 25). The reasons postsecondary students change majors once they reach college is the topic of a report by Griffith (2010) which found that “persistence in one of these [STEM] majors is much lower for women and minorities, suggesting that this may be a leaky joint in the STEM pipeline for these two groups of students” (p. 911). Griffith (2010) found that 9.3% of students that start in STEM remain in a STEM field at graduation with no identified pattern to the fields they were switching into or from.

Santovec (2011) suggests that a “sense of fit with the college environment was a key to persistence” (p. 25). The Griffith (2010) analysis showed that differences in preparation and the educational experiences once women arrived on campus explained much of the differences in persistence. A college with a focus on undergraduate education is also a positive factor for persistence to a degree. However, the researcher acknowledged that it is still not well understood what factors affect persistence or where the focus should be placed in order to improve persistence (Griffith, 2010).

One strategy for looking at persistence factors is to study why students change majors. Studies show that this attrition is not due to skill or competence because women in STEM majors have equivalent grades to men (Solomon, 2012). The most frequently identified reasons cited by women leaving STEM majors include:

- losing interest in the field,
- feeling discouraged because of academic failure or negative encounters with faculty or peers,
- experiencing poor teaching, and
- experiencing difficulty applying learning/theory to practice. (Santovec, 2011, p. 25)

To address attrition in STEM majors, Solomon (2012) suggests that altering pedagogical methods may make classes more accessible for women and reduce the feeling of *tokenism*. Interactive classes, hands-on work, real-world applications, potential social impact, group work, women TAs, examples of women and minorities making a difference in their field, and personal interaction with professors could encourage women to remain in a STEM major (Solomon, 2012).

What students do before and during high school affects post-secondary performance; in fact, Kuh et al., (2006) suggests that grade school experience is also important because students begin to drop out of college in grade school. Persistence is one of the goals of the DE/DC efforts, but a Grefenstette-Moon (2011) dissertation focusing on high school patterns and predictability of persistence to a degree showed early-college coursework added very little predictive value for persistence to the second year of college, regardless of major.

### **Factors Influencing Career Choice**

Another goal of the early-college experience is to assist students in choosing a career. Stromquist (2007) recognized career choice as a function of societal and cultural experiences as well as academic experience. These life experiences contribute to a student's career choice (Stromquist, 2007), but does DE/DC coursework also have an impact? The literature review

found few studies capable of answering this question, although several did provide related background information.

The Geise (2011) study found that 27% of students taking early-college coursework enrolled in STEM majors, while the same percentage, 27%, of those who did not take early college enrolled in STEM majors. Additionally, of those who did enroll in college, “male students were 3.8 times more likely than women to major in math, science, or engineering” (p. 75).

Leon (2010) studied career success factors and found that individual, cultural/societal, and corporate influences were factors contributing to the success of women in aerospace engineering. The research found that many factors overlapped as a person grew up, attended school, attended college, and joined the workforce. Basically, Leon (2010) found several individual characteristics that were relevant to working in the engineering field:

- Confidence
- Persistence
- Self-efficacy
- Leadership
- Assertiveness
- Positive attitude
- Goal orientation
- Communication skills
- Propensity to take risks
- Mathematics/science efficacy
- Desire for independence (p. 117)



These traits can be attributed to success in education as well. Self-confidence in core skills was the topic of a mixed methods, longitudinal, study which found that:

Increasing the pool of women and minority STEM students requires producing students that graduate from high school with strong quantitative measures of academic ability and the self-confidence in their core skills that comes from successful completion of rigorous classes. (Nicholls, Wolfe, Besterfield-Sacre, Shuman, & Larпкиattaworn, 2007, p. 42)

Leon (2010) found that family support, economic level of family, inspirational teachers, quality of school environment, outreach programs, enrichment activities, sports, and role models in the field influenced student choices for college majors and subsequent careers. In addition, the study indicated the importance of advanced mathematics and science in high school as essential for success in engineering (Leon, 2010, p. 116).

Individual experiences, personal characteristics, and cultural values create a diverse student population entering STEM fields. Within this diversity, DE/DC in mathematics and science may be one shared element for those who choose STEM fields. Not all research agrees, however, that DE/DC has an influence on career choice.

A recent dissertation by Touchstone (2010) found that career goals and choice of postsecondary institution were not significantly impacted by involvement in DE/DC coursework, even though 93% of those who participated in DE/DC classes felt the experience was positive. Further, DE/DC appears to positively affect student self-confidence and perceptions of being able to succeed at the post-secondary level. These results indicate DE/DC can improve transitions from high school to college. A student's career decision may be based on a complex interaction of gender, ethnicity, socioeconomic status, role models,

influential teachers, counselors, grades, parents/siblings, personal interests, institutional appeal, peer group, perceptions of working in that field, and pay, with pay being a strong motivation in some cases (Touchstone, 2010).

Pay is not the only reason that workers choose an occupation. People with strong STEM competencies are “high-performing students and workers who have a broad range of educational and career choices” (Carnevale, Smith, & Melton, 2011, p. 3). Identified core skills associated with STEM include:

- Mathematics
- Science
- Critical thinking
- Active learning
- Complex problem solving
- Operations analysis
- Technology design
- Equipment selection
- Programming
- Quality control analysis
- Operations monitoring
- Operation and control
- Equipment maintenance
- Troubleshooting
- Repairing
- Systems analysis/evaluation (Carnevale et al., 2011)

STEM workers are able to transition into other occupations which share these competencies. The Occupational Information Network (O\*NET) was able to isolate the competencies needed in particular occupations and has found that the demand for the STEM competencies creates a growing demand for STEM talent. In addition to the cognitive abilities, additional personal attributes of work interest and work values have an impact (Carnevale et al., 2011).

The idea that girls might not be interested in choosing STEM careers is proposed by Corbett (2011) in a recent report to the *Collaborative Learning Space for Science*. This report found that fewer young women than young men express an interest in pursuing science or engineering. In fact, of those who indicated an interest in an engineering career, 24% were young men and 5% were young women (Hill et al., 2010). Further, AAUW (2010) studies show that often young women who excel in mathematics do not pursue STEM careers.

Interest in an occupation is influenced by several factors which include:

- a belief in one's ability to succeed in that occupation,
- culturally prescribed gender roles, and
- personal values (Hill et al., 2010).

Hill et al. (2010), as well as Carnevale et al. (2011), suggest that girls develop beliefs as early as middle school that they cannot pursue particular occupations because they perceive them as inappropriate for their gender. In addition, Hill et al. (2010) found that women prefer an occupation with a clear social purpose and "since most people do not view STEM occupations as directly benefiting society or individuals, these fields often do not appeal to women who place a high value on making a social contribution" (p. 22). Biomedical and environmental engineering, however, are STEM fields showing success in attracting more women; perhaps because these disciplines have a clear, social purpose (Hill et al., 2010).

Mastekaasa and Smeby (2008) found that students who chose a gender-traditional career field did so as the result of an early interest in that field. Besecke and Reilly (2006) also found that early experiences encouraged women to pursue a career path regarded as contrary to traditional gender roles for women. Research findings from both the Mastekaasa (2008) and Hill et al. (2010) studies confirmed that women are more likely to drop out of a nontraditional career choice than they are in a traditional career choice.

Besecke and Reilly (2006) identified factors influencing women's initial career choices. There are many well-known factors such as parental support and educational level, peer groups, teachers, exposure to career paths, counselors, and individual interests, but when looking at enrollment in STEM careers, "the role of early enriching experiences and mentoring relationships resulted in a positive influence on women's selection and success in STEM" (p. 4). Three key factors which influence women's initial career choice of a scientific field were identified by the Besecke and Reilly (2006) study:

- Girls should be given early opportunities to develop exposure to and confidence in their abilities in science-related activities.
- Misconceptions of the activities involved in science and science careers should be cleared up.
- Scientists should not be stereotyped.
- Classrooms should provide hands-on experiments, role models and mentors, special encouragement, and opportunities to meet scientists and see the interactive process of scientific explorations and discovery (p. 6).

This may suggest that the DE/DC early-college experiences would be encouraging for high school girls.

Bryant (2011) found in his study that “even the girls who are succeeding in the mathematics classroom are not happy to be there and very few see themselves entering a math or science career in the future” (p. 4). The Bryant study was done in 2011, but, did not take into consideration DE/DC early-college efforts. Bryant (2001) points out prior solutions focused on changing girls’ attitudes so they are more compatible with mathematics, but “changing the girls, without changing the environment that created the girls’ dislike [of math] to begin with, will never become an effective long-term solution” (p. 4).

### **Barriers to Women in STEM**

Between 1960 and 2000 there was a sizeable increase in women working in STEM fields, growing from 1% of engineers in 1960 to 11% in 2000. Of the working women, 52% quit their STEM career before 10 years had passed (Hill et al., 2010). A retention study conducted by The Society of Women Engineers (Eng, 2008) found that in spite of similar educational achievements, fewer women than men stay in the engineering field. Reasons for job satisfaction identified as *personal challenge* and *interesting work* were similar for both women and men. However, women and men who leave the engineering field are doing so for different reasons. “Men place more emphasis on salary and career advancement while women are more likely to cite a need for more family-friendly work environment” (Eng, 2008, p. 1).

According to the National Association of Colleges and Employers (2010), the 10 best-paid degrees in the class of 2010 were in engineering, computer science, or information science degrees. The pay gap between men and women in STEM fields tends to be smaller than in the population as a whole where women earn, on average, 77% of what men earn in comparable positions. Even though women earn less than men, women in STEM tend to earn more than women in other fields (Hoopes, 2011).

Besecke and Reilly (2006) discovered that perceptions of working in the sciences create barriers for women because a common misconception is that science is for men. This perception is perpetuated by the relatively small group of current scientists who have their traditions and rules—the old boys’ network. Taken to the extreme, this is referred to as the pollution theory where males discriminate on the basis that “women will pollute the prestige of traditional male fields” (Harris, 2011, p. 4). These gender stereotypes can prompt bias in evaluative judgments of women in male-dominated environments, even when these women have proved themselves to be successful and demonstrated their competence (Heilman & Wallen, 2004).

When choosing a STEM career, women need to see that science involves a great deal of interaction and is not simply about collecting data. Other perceptions that may surface include the opinion that it is easier for men to be taken seriously and that science is an isolated, demanding, and inflexible career (Besecke & Reilly, 2006). Some of this comes from the 50+ hour work-week mentality. Workplace environment is important to women; those in STEM careers report feelings of isolation, an unsupportive work environment, extreme work schedules, and unclear rules about advancement (Hill et al., 2010). Leon (2010) also found that workplace environment was a factor for women in engineering. Specifically, a positive corporate environment was created by the company that provided outreach, favored diversity, treated men and women equally for promotions and pay, and created flexible time/place work options (Leon, 2010). There are numerous studies verifying barriers to women in STEM fields, but efforts to solve the problem have not changed the outcome.

Santovec (2011) found that STEM students face different challenges than their college peers. Identified barriers that continue to limit college women's success in STEM fields include:

- selective and competitive admissions criteria for admission to the major,
- unwelcoming climate,
- locked in, highly structured curricula with little opportunity for electives or co-curricular involvement,
- evidence that STEM faculty intentionally try to weed out students early using difficult assignments and harsh grading practices, and
- defining or perceiving men as *good* computer scientists, engineers, or mathematicians encourages gender discrimination and bias against women.

(Santovec, 2011, p. 24)

A new NSF effort, in conjunction with the White House Jobs Bill, is designed specifically to mitigate barriers for women by increasing workplace flexibility in the STEM fields. Because of the agreement of many research findings over the last 20 years identifying barriers for women in a scientific field, Mastekaasa and Smeby (2008) suggest that “instead of asking why women drop out of male-dominated programs, one should ask why they are so strongly attracted to the female-dominated ones” (p. 200).

Stromquist (2007) uses the mechanisms of oppression and feminist theory to identify forces that shape the apparent free choices that women and men make through their lives. While education is considered a source of “cultural capital, employment, and social mobility...educational institutions are conservative settings that reflect the values and rules of patriarchal society” (p. 153).

According to Stromquist (2007), initiating proactive strategies in early grades that introduces patriarchy, sexism, and racism issues is essential. Schools should create spaces within classrooms for young girls to be included in situations of equal exchange. Recommendations “underscore the need for holistic probing of the educational system with a multidisciplinary analysis” (p. 155). Cardoso and Marques (2008) also suggest integrating issues of equal opportunities into the school system early in the lower grades and provide teachers in-service training and support to minimize barriers for those entering nontraditional fields. “Interventions should be available before the negative beliefs and perceptions of career barriers are structured” (p. 58).

There has been extensive research into the contributing factors for why so few women graduate in the STEM fields. Bryant (2011) equates the history of women’s roles in mathematics as a parallel to the history of the women’s movement.

### **Summary**

Although the DE/DC effort has grown since funding became available with the Carl Perkins Act of 2006, the literature review found few studies directly related. However, the literature review produced an abundance of background material in the form of women’s issues, challenges for encouraging women to choose STEM careers, legislation, barriers to women in STEM, precollege characteristics of college freshmen, and statewide/nationwide statistics that create the DE/DC landscape. For those studies that did look directly at DE/DC, results were mixed regarding whether or not there was a relationship to college access, persistence, and success.

Modern society and our economy are becoming more science and technology oriented, yet few U.S. students are studying science, technology, engineering, or mathematics (Else-



Quest, Linn, & Hyde, 2010). Of those working in STEM, women are underrepresented in these fields and many efforts are in place to encourage and assist women in gaining their degrees. Early-college coursework, in the form of DE/DC, is one effort to mitigate this achievement gap. Since Perkins IV funding was enacted in 2006, it has received considerable attention, additional funding, and promotion. The National Science Foundation and White House Jobs Bill are designed to improve workplace conditions over the next 10 years. There are good employment projections for STEM fields. If current efforts improve conditions from middle school exposure, high school DE/DC early-college coursework, successful college experience, and improved working conditions, women may benefit from new career opportunities.

The literature review was done in accordance with criteria established by Boote and Beile (2005) for literature reviews. As a result of this review, historical research on educational initiatives was found, as well as a significant amount of research on women's issues. There is little research on the effectiveness of DE/DC early-college efforts as it relates to success rates of women in STEM fields at two-year institutions. Appendix B contains a *map* of the literature review.

For the purposes of this non-experimental, descriptive, quantitative study comparing the success rates of women majoring in two-year post-secondary STEM careers who did not participate in DE/DC early-college courses, with success rates of women who had at least one DE/DC course, can provide insight on whether or not funding DE/DC efforts is yielding the desired results. Further, comparison with men in the same DE/DC or non-DE/DC categories provides a baseline for comparison.

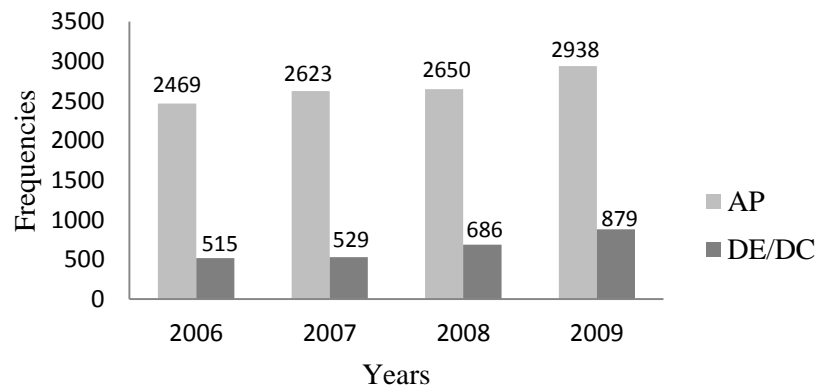
## CHAPTER THREE

### Methodology

With the reauthorization of the Perkins IV Act in 2006, increased efforts have been put into place to encourage and assist in creating opportunities for more women to gain degrees in science, technology, engineering, and mathematics (STEM) career fields. Since modern society and our economy are becoming more science and technology oriented, it is important that women, who are historically underrepresented in these fields, get assistance in gaining their STEM degrees (Hill, Corbett, & St. Rose, 2010). One effort designed to assist women transitioning to college STEM programs is early-college coursework, specifically in the form of dual enrollment and dual credit (DE/DC).

DE/DC is not a new concept in the field of education in the U.S. In Montana, some schools had a version of DE/DC starting in 2001 with the Tech Prep effort. Previous to 2001, high schools offered advanced placement (AP). Perkins IV, enacted in 2006 and implemented in 2007, resulted in an increased effort to create seamless transitions from high school to college and to increase participation of all students in post-secondary education. As a result, Perkins IV changed the scope of Tech Prep and AP efforts. The Tech Prep option was incorporated into the DE/DC effort in Montana resulting in dual enrollment becoming the newer option available to high school students. It is still in development in Montana, whereas it is widely recognized in other states who implemented the concept earlier. In contrast, the other early-college option, advanced placement (AP), has been well established since the 1950s and is widely recognized nationally (Office of the Commissioner of Higher Education, 2011a).

Dual enrollment is locally significant as it is a direct result of articulation agreements between a high school and a cooperating two-year college. Students receive college credit on a college transcript when it is successfully completed. In contrast, AP is awarded at the discretion of the college after the student passes an exam. On a scale of one (no recommendation) to five (extremely well qualified), 11.7% of Montana high school seniors scored a *three* (qualified) or higher on at least one AP exam. This is lower than the national average of 16.9% (National Center for Education Statistics, 2011a). For the purposes of comparison, the numbers of students participating in advanced placement (AP) continues to outpace those participating in the DE/DC opportunity for early-college credit. Both early-college options have grown in participation counts during the timeline of 2006-2009. Figure 1 diagrams the AP and DE/DC counts for Montana students.



*Figure 1.* Montana high school student participation in advanced placement and DE/DC. (National Center for Education Statistics, 2011a)

This study compared Montana women who participated in DE/DC coursework while in high school with those who did not enroll in the early-college credit. The study used census data from 2007-2012 to evaluate access, persistence, and completion—the three thresholds for

college success identified by Adelman (2007). The success rates of the DE/DC and non-DE/DC students were evaluated by initial enrollment (access), retention (persistence) to third semester, and completion (success) of a certificate/degree within three years of enrollment or transfer to a four-year program. The scope of this study was to determine whether completing DE/DC early-college coursework in high school contributed to access, persistence, and success of women at two-year post-secondary institutions in Montana.

### **Review of Related Literature**

The literature review produced few studies that were directly related. In fact, no studies were found that could provide answers to the research questions in this study. Therefore, the literature review included a wide range of studies that provided background information for creating the conceptual framework of this research.

Because nationwide longitudinal data were not readily available, the majority of studies on this topic were done at local levels. Even though few studies filtered for gender or for college major, the research methods and outcomes were reflective of the current status of dual enrollment. One such study by Swanson (2008) was representative of locally designed studies and concludes “the impact of dual-enrollment programs on students in the high school and college setting remains largely untested and unknown” (p. 147).

Available data indicated a need for analyzing participation in DE/DC coursework as it related to women in STEM majors. Demographics for the population identified in this study were established as baseline information. Frequencies provided by the National Center for Educational Statistics (NCES) showed national totals and longitudinal trends of enrollment and graduation data. These data were used to establish a framework for describing demographics of all students in Montana with comparisons to regional rural states as well as

national data. The rural states adjacent to Montana chosen for comparison were Idaho, North Dakota, South Dakota, and Wyoming. After establishing demographics for all students, differences between women and men in Montana who participated in DE/DC were evaluated. The analysis of frequencies, percentages, and trends provided results that were descriptive of access, persistence, and success in two-year STEM programs. Specifically, this research was designed to determine whether or not participation in dual enrollment in high school had an effect on transition from high school to college and persistence to graduation for Montana women in STEM programs.

### **Research Questions**

After establishing the baseline demographics and trends of DE/DC students entering two-year education in Montana, the following questions provided the framework for this investigation:

1. Was DE/DC coursework taken in high school a factor for increasing numbers of women transitioning into initial enrollment in two-year, post-secondary education with a STEM major during the years 2007-2009?
2. Was DE/DC coursework taken in high school a factor for increasing numbers of women persisting to the third semester in two-year, post-secondary education with a STEM major during the years 2007-2009?
3. Was DE/DC coursework taken in high school a factor for increasing numbers of women succeeding in two-year, post-secondary education with a STEM major during the years 2007-2009?

## Research Design

The research design of this non-experimental, descriptive, quantitative study was to analyze data from five Montana colleges. Data for this study were obtained through the Office of the Commissioner of Higher Education (OCHE) data warehouse to determine enrollment trends. The data warehouse “integrates data from multiple sources and consolidates it into a multidimensional data set” (Han, Kamber, & Pei, 2012, p. 26). Data were summative in nature; no students were identified individually. Because no individual students were identified, the process met requirements of the Family Educational Rights and Privacy Act (FERPA). Design considerations of this descriptive analysis were guided by several researchers including Han et al. (2012), Huck (2008), Creswell (2009), Johnson (2001) and Cozby (2009).

In his writings concerning descriptive research, Johnson (2001) stated that “a substantial proportion of quantitative educational research is non-experimental because many important variables of interest are not manipulable [*sic*]” (p. 3). He suggested non-experimental research was one form of “systematic empirical inquiry and is an important methodology because it allows us to communicate effectively in an interdisciplinary research environment” (p. 3). One of the classifications of non-experimental research is descriptive, in which the primary objective is to describe and document findings of the study (p. 9). In addition, descriptive studies should be designated by their time dimension. In this study it is considered a cohort analysis using longitudinal data from 2007-2012 (Johnson, 2011).

Cozby (2009) stated that the non-experimental research method can study relationships in several ways, one of which is to examine census data. When observing the variables, the non-experimental method is a reasonable approach to studying relationships.

However, the weakness of this method is the difficulty in determining causal relationships as well as extraneous variables that may have an influence. Cozby (2009) wrote that the major goal of science is to provide an accurate description of events (p. 83). Further, the goal of much research is to describe behavior. In the field of psychology, Cozby (2009) pointed out that the work of Jean Piaget was descriptive in nature; his descriptions and interpretations led to his theory of cognitive development.

One design consideration of descriptive analysis suggested by Han et al. (2012) used data characterization to describe the population in general terms. This process summarizes the general characteristics and features of the data collected as a result of queries.

A second design consideration of descriptive analysis uses *data discrimination* to compare and contrast attributes of the population in order to provide a general comparative profile. This process can be accomplished by analyzing counts, totals, proportions, and percentages within the categories used in the study (Han et al., 2012). For educational research, these attributes are defining characteristics for each individual that existed before the study. Cozby (2009) also referred to these characteristics as attributes. These attributes determine inclusion in one or more categories for the descriptive analysis. Pre-existing characteristics do not change in the study. Attributes of the population, also considered parameters or data points, were used for queries and for categorizing the nominal level census data in this study. Both data characterization and data discrimination techniques were used to provide a general comparative profile and discover associations within the data (Han et al., 2012).

The assumption of independence (Huck, 2008) for this study was met by using census data to represent the population. Cumulative totals created a frequency description, which was

graphically illustrated with bar charts. For purposes of comparison, each student was classified into a category. Unduplicated counts resulted in a frequency distribution which described the characteristics of the population in relation to the categorical attributes. Descriptions consisted of frequencies, percentages, and proportions as appropriate output.

The descriptive variables (attributes) of the population included gender, DE/DC, access, persistence, and success. Huck (2008) suggested the use of frequency distributions and percentages to understand population characteristics relative to categorical parameters. Therefore, percentages of total within categories were calculated. Trends were analyzed within the parameters of the research questions and attributes of the population.

### **Population**

The population of this study was women who initially enrolled in STEM majors at two-year post-secondary institutions in Montana immediately after graduation from high school. This study focused on those women who had taken DE/DC while in high school.

The young women participating in DE/DC were high school juniors and seniors, ranging in age from 16 to 18 years old. Montana high school students were 51% young men and 49% young women. The high schools these young women attended were categorized by *class* which indicated the range of enrollment. The sizes of high schools in Montana by *class* designation are summarized in Table 1 (Office of the Commissioner of Higher Education, 2011a).



Table 1

*Montana high schools by (class) size (2010)*

Class	Enrollment range	Statewide Total Student Population	Number of schools in class	Percent of Total Schools	Proportion of total enrollment
AA	>826	20,760	14	8%	.467
A	340-825	10,620	21	12%	.239
B	120-339	7,708	37	21%	.174
C	<119	5,337	106	59%	.120

The 14 largest high schools (Class AA) were in the urban areas of the largest cities. These areas of larger population density were also the five locations (as indicated by asterisk) of the two-year colleges included in this study:

- Billings (3)\*
- Bozeman (1)
- Butte (1)\*
- Great Falls (2)\*
- Helena (2)\*
- Kalispell (2)
- Missoula (3)\*

Likewise, Class C corresponded to population density of the towns with the least population. The number of high schools in each category has fluctuated slightly each year as enrollment trends necessitated consolidation of smaller schools or addition of new schools. Montana has been considered a rural state, with 59% of the high schools having fewer than 119 students. The smallest Class C high school in Montana had four students, while the

largest Class AA high school had 2,143. Figure 2 illustrates the rural status of Montana with comparisons of the total number of high schools in each *class*.

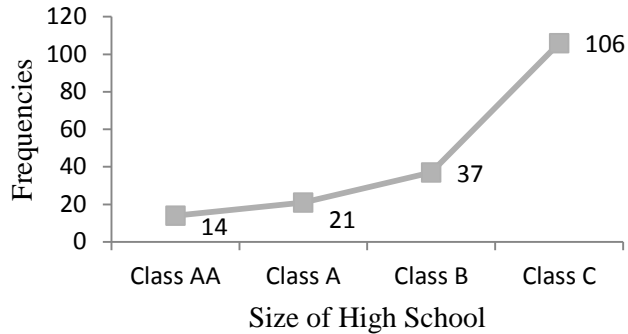


Figure 2. Frequencies of Montana high schools (n=178) by size (class). (Office of the Commissioner of Higher Education, 2011a)

The 14 largest (urban) high schools enrolled 46.7% of the student population in Montana public high schools, while the 106 smallest (rural) schools represented 12% of student population.

The total number of Montana students enrolled as high school juniors or seniors who potentially were eligible to participate in DE/DC opportunities is shown in Figure 3. Young men comprised 51% of total and young women 49% of total.

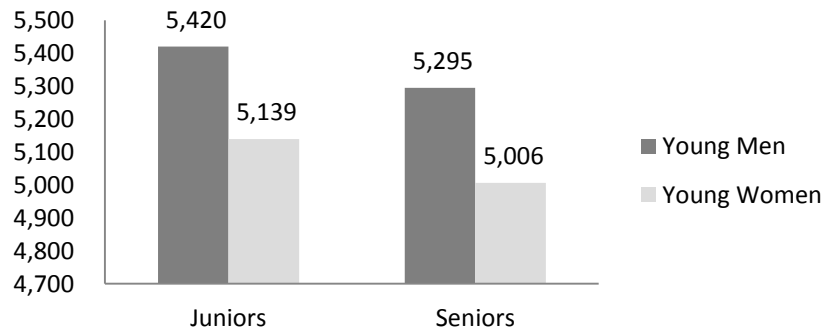


Figure 3. Frequencies of Montana high school juniors and seniors (n=20,860) by gender in 2010.

Data provided by the National Center for Educational Statistics (2011a) provided additional description of the population in this study with the following statewide characteristics of Montana students:

- 12% of student population were American Indian/Alaskan Native,
- 40% of the students were considered economically disadvantaged,
- 3% of students were limited English proficient,
- 12% of students had disabilities, and
- per-pupil expenditure was \$10,189 (\$402 less than the national average).

Demographics of young women in high schools participating in DE/DC were typical of other rural states (Table 2). According to the OPI (2012) yearly report, 141,807 students were enrolled in 827 public schools in Montana. Of the 827 public schools, 78.7% were designated Title I schools (low-achieving, high-minority, or high-poverty designations) with 39.6% of students eligible for free lunch. Of this total, 178 were public high schools with an 81% graduation rate. The rate of Montana high school graduates who go on to college is 51.9%.

Table 2

*Comparison of Public High School Demographics for Montana and Adjacent States 2009*

	Number Public High Schools	Title I Schools	Students Qualified for Free Lunch	HS Graduation Rates	High School Graduates Continuing on to college
ID	232	70.4%	44.7%	91.3%	49.1%
MT	178	78.7%	39.6%	80.8%	51.9%
ND	187	51.8%	31.8%	87.6%	67.6%
SD	249	74.0%	37.0%	89.2%	72.1%
WY	99	41.2%	36.9%	81.4%	59.4%
US	23,920	59.8%	48.0%	75.5%	63.8%

*Note.* Graduation rates calculated for all students who graduated from high school with a regular diploma in the standard number of years (i.e., four years), National Center for Educational Statistics, 2009-2010.

Montana high school students who enrolled in college within the state chose from public two- or four-year institutions, tribal colleges, and private institutions. This study utilized data from two-year public Title IV colleges which were embedded in a four-year university or were colleges within the Montana University System (MUS). Community colleges, tribal colleges, and private colleges were not part of this study. Enrollment based on total headcount for Montana and adjacent states is summarized in Table 3.

Table 3

*Post-secondary Access, Persistence, and Success Rates for Montana and Adjacent States*

	Public Two-Year			Public Four-Year		
	Access	Persistence	Success	Access	Persistence	Success
ID	24.1%	51.0%	20.2%	75.9%	64.6%	37.8%
MT	24.0%	53.7%	40.0%	75.9%	68.8%	43.0%
ND	16.0%	64.7%	38.8%	84.0%	75.0%	48.1%
SD	15.3%	69.6%	52.9%	84.7%	70.1%	46.7%
WY	97.1%	55.5%	30.4%	2.9%	72.2%	53.0%
US	27.7 %	55.7%	29.2%	42.4%	76.9%	55.5%

*Note.* Completion rates based on 150% of time to graduation, NCES, 2010

### **Parameters of Study**

The census data used in this study represented the entire population and was considered nominal level data using guidelines suggested by Cozby (2009). The data were either dichotomous or categorical, in which counts were unduplicated and each individual was assigned to one category (Cozby, 2009). The study described the results in terms of gender, participation in DE/DC, STEM majors, access, persistence, and success. Young women who participated in DE/DC in high school and who also enrolled in a college STEM major in Montana were the population. Nontraditional fields for women included computer and

information sciences, engineering, biological and biomedical sciences, mathematics and statistics, physical sciences, and sciences technology (National Center for Educational Statistics, 2011c). As part of the data analysis process, percentages of categorical totals were calculated.

### **Instrumentation**

A request for limited-use, primary-source, *real-time* data from OCHE was submitted for academic years 2007-2012 in order to identify enrollment, persistence, and success patterns of the freshman cohorts as they matriculated through their Montana post-secondary education. No hard-copy surveys or reporting instruments were used in collecting or reporting data.

### **Data Collection**

Data were reported from the five two-year colleges in Montana that were affiliated with, or embedded in, a four-year institution within the Montana University System (MUS). OCHE has oversight of these institutions. The affiliations of the two-year colleges were with either Montana State University (MSU) in Bozeman, or the University of Montana (UM) in Missoula. These colleges with their affiliations and locations follow:

- City College (MSU), Billings
- Great Falls College (MSU), Great Falls
- Helena College (UM), Helena
- Highlands College (UM), Butte
- Missoula College (UM), Missoula

Data focused on the access, persistence, and success of women enrolled in two-year STEM majors who previously participated in at least one DE/DC early-college course while

in high school. Because the data queries included all students in the five colleges involved in the study, it was considered census data (Han et al., 2012). These census data were anonymous as only summative information was requested. OCHE reported the number (frequencies) of Montana students who enrolled in college with DE/DC in STEM related courses for the years 2007, 2008, and 2009. Data were examined by STEM major, DE/DC, and gender. Available data for each two-year college was examined to describe progress from initial enrollment to completion.

### **Data Analysis**

The analytical process for the data reported by Montana two-year colleges began with submitting a request for data to the database administrator for the Montana University System. The raw data was received in spreadsheet format. SPSS was also used for the descriptive statistics.

Data for DE/DC and non-DE/DC students enrolled in STEM majors at two-year colleges in Montana were evaluated over a five-year timeline of 2007-2012. The identified success timeline for two-year programs is three years for a degree or transfer to four-year institution (U.S. Department of Education, 2011a). Thus, students who graduated from high school in 2007, 2008, and 2009 should have graduated from a two-year program within the identified timeline (2010, 2011, and 2012 respectively) to be considered successful in a two-year program of study. The graduation data were intended to describe young women taking DE/DC coursework in high school who subsequently attained a credential from a two-year college in a STEM major. Totals for each parameter of the descriptive study were totaled and compared among categories of gender, DE/DC, access, persistence, and success.

Descriptive analysis has been used in other research studies involving the topics of dual enrollment and women in STEM fields. Hill, Corbett, and St. Rose (2010) used a descriptive, non-experimental research design. This research was selected by the National Science Foundation to study underrepresentation of women in STEM fields. The methodology was similar to this research design in that the researchers used databases to collect the data. The study used frequency distributions, totals, and percentages to describe their results. Tables and figures provided visual descriptions of their findings.

Mead (2009) examined the characteristics of dual-credit students who enrolled in STEM courses using multiple analyses, one of which was descriptive. The study compared students on the demographics of gender, minority status, age, and Pell eligibility for the descriptive statistics portion of the study. Research results described the similarities and differences of the demographics with totals and percentages presented in tables.

Swanson (2008) used summative data from the Department of Education databases to describe the differences between attributes of students who enrolled in college after completing college-level coursework in high school. The research analysis described the differences by comparing rates (percentages) for persistence, time to graduation, and completion.

## **Summary**

The research design of this non-experimental, descriptive, quantitative study was to collect enrollment, retention, and graduation data from two-year post-secondary colleges in Montana. Descriptions of young women participating in DE/DC coursework while in high school, transitioned to college, persisted to third semester, and completed a two-year credential were compiled. Summative data were evaluated and reported. Data attributes were

designed to describe the success of women in STEM majors who had previously participated in DE/DC coursework while in high school. Gender comparisons were also made. The research questions created the framework of this study.

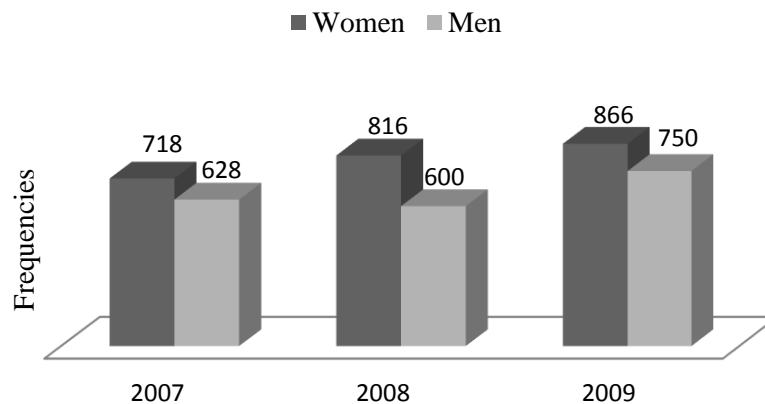
Because the DE/DC early-college experience has been promoted the last five years as a way to encourage women to enter nontraditional fields, this research evaluated the effectiveness of that effort. The results of this research will be available to policymakers, advisors, counselors, department chairs, deans, and admissions staff to provide insights into the dual-enrollment effort. Education entered a new era in which high school students were provided an opportunity to get a “jump-start on college” (Tinberg & Nadeau, 2011). DE/DC was designed to improve access, persistence, and success for all students. This study was designed to describe that effort in Montana.



## CHAPTER FOUR

### Results

The purpose of this study was to describe the impact dual enrollment and dual credit (DE/DC) has had on initial enrollment in college (access), persistence to the third semester, and subsequent completion (success) rates of Montana women. Demographics of young women in high school transitioning to college in STEM majors were the focus of the study. Data were entered into spreadsheet software and SPSS with aggregated counts (frequencies) for first-time, two-year college student enrollment in the fall semester following high school graduation for the years 2007-2009. Figure 4 illustrates the enrollment trends by gender for the cohort used in this analysis.



*Figure 4.* Frequencies of two-year college enrollment in Montana for 2007-2009 by gender (n=4,378).

SPSS produced crosstab totals disaggregated by gender, DE/DC credit while in high school, and STEM major. These totals were then input to the calculations for access, retention, and completion. Of the 4,378 first-time college students, 664 chose a STEM major. Of the 664 STEM majors, 221 had participated in DE/DC in high school. Table 4 summarizes these counts as they were used in the study categorized by gender, DE/DC, and STEM major.

Table 4

*Frequency distribution of first-time enrolled two-year college students in Montana*

	2007 Cohort (n=1,346)		2008 Cohort (n=1,416)		2009 Cohort (n=1,616)		Totals
	Women	Men	Women	Men	Women	Men	
Counts	718	628	816	600	866	750	4,378
DE/DC	51	22	40	35	38	35	221
NonDE/DC	667	606	776	565	828	715	4,157
STEM+							
DE/DC	3	7	3	6	2	6	26
NonStem+	48	15	37	29	36	29	195
DE/DC							
STEM	31	173	40	172	39	209	664
NonSTEM	687	455	776	428	827	541	3,714

Participation in DE/DC in high school by students who enrolled in college the fall following graduation from high school (n=221) was one of the parameters for this research. Enrollment pattern by gender are illustrated in Figure 5.

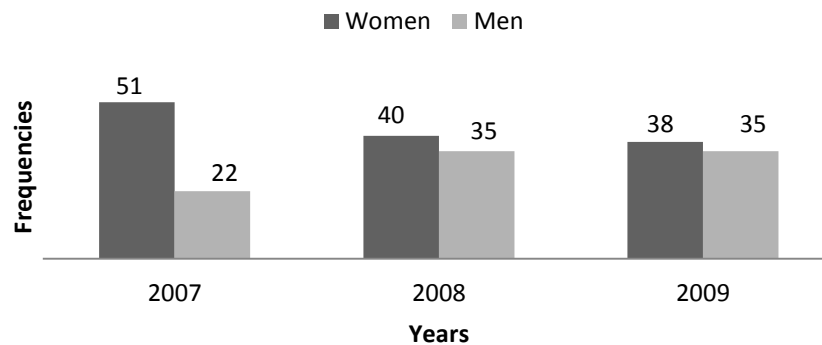


Figure 5. Frequencies of students who took DE/DC in high school by gender (n=221).

Montana dual-enrollment students were able to choose from many courses depending on articulation agreements between their high school and two-year colleges. Students could also take online coursework from any of the colleges if they met the admission criteria. Online courses from out-of-state institutions were another option. The fall cohort students with DE/DC entered college with a transcript for at least one college-level course. During the timeline of this study, DE/DC courses taken by those who subsequently majored in a STEM related program of study included:

- Biology Fundamentals
- College Writing
- Computer Applications
- Computer Software
- Introduction to Business
- Introduction to Public Speaking
- Pre-calculus
- Probability and Linear Mathematics
- Special interest courses

DE/DC courses taken while in high school by those who chose all other majors (nonSTEM) included coursework from the following curriculum areas:

- Art and Theatre
- Business: Management, Accounting, Global Marketing

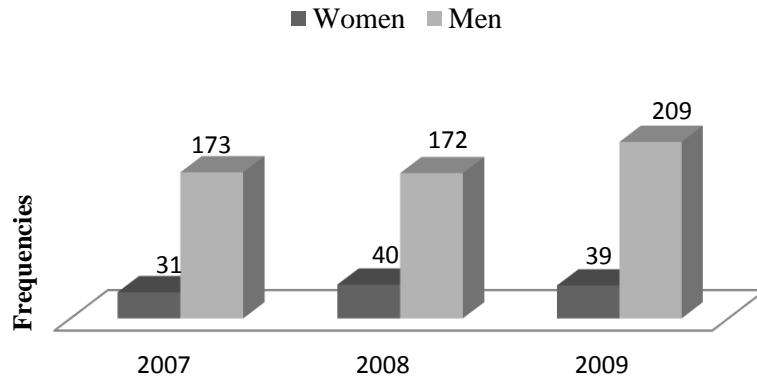
Calculus, College Trigonometry, Finite Mathematics, College Mathematics for  
Technology, Statistics

- Health: Anatomy and Physiology, Nursing, Personal Nutrition, Medical Terminology

- History and Government
- Literature
- Mathematics: College Algebra, Pre-calculus, Probability and Linear Mathematics
- Native American Studies
- Sciences: Biology, Chemistry, Physics, Geology
- Social Sciences: Introduction to Psychology, Introduction to Sociology, Anthropology
- Spanish
- Technology: Auto Cad, Computer Software, Word Processing
- Welding
- Special interest courses

At the time of this research, Montana students participated in 43 unduplicated high school courses at 33 high schools. These courses were taught on the high school campus with a high school teacher as a result of existing articulation agreements with a two-year college. These counts of coursework do not include courses taken on a college campus or taken online where students were able to enroll in any course they desired if they met the prerequisites. For purposes of comparison, Wyoming reported 14 courses available to juniors and seniors in 38 high schools (National Center for Education Statistics, 2011a).

A goal of the DE/DC effort in Montana was to ease the transition to college. In addition, STEM enrollment for women was a focus of this study. Figure 6 illustrates the counts of STEM majors within the fall cohort disaggregated by gender. These totals include those who had DE/DC coursework during high school.



*Figure 6.* Enrollment in STEM majors disaggregated by gender. The frequency description includes both DE/DC and nonDE/DC participants.

Twenty-four STEM programs of study were available at the five Montana colleges included in this research. These programs were identified by the Classification of Instructional Programs (CIP) codes. Montana offers two-year programs in four of the six STEM classifications. STEM related programs that were available for enrollment at one or more of the two-year Montana colleges were in the following categories:

- Computer and Information Sciences CIP code range 11.0101 – 11.1004
- Engineering and Engineering Tech CIP code range 14.0101 – 15.1501
- Physical Sciences CIP code range 40.0101 – 40.0810
- Sciences Technologies CIP code range 41.0101 – 41.0301

The two categories of STEM career fields that were not included in two-year program offerings at any of the five Montana colleges were:

- Biological and Biomedical Sciences CIP code range 26.0101 – 26.1309
- Mathematics and Statistics CIP code range 27.0101 – 27.0502

## **Descriptive Analysis**

The population of this study included women who enrolled in STEM majors at two-year colleges in Montana. Parameters (attributes) for the research were DE/DC and gender with descriptive results judged on access, persistence, and success. The research questions guided the study and conceptual framework for this descriptive study. When analyzing results of non-experimental research investigations, the first step is to construct frequency distributions to look at data (Cozby, 2009; Creswell, 2008; Johnson, 2001; Huck, 2008; Han et al., 2012). These totals are the number of individuals in each category which can then be described further in tables, charts, and graphs. In addition, it is a general consensus among the researchers guiding this study that comparing group percentages, rather than percentages of total establishes a relationship for comparisons. These reporting techniques were used in this analysis. The assumption of independence for descriptive studies (Huck, 2008) was met by using census data representing the population and describing women as they transitioned from high school to initial enrollment in college. Persistence in a STEM program and completion of an associate's degree or transfer to four-year program completed the analysis.

## **Results**

Frequency distributions and percentages of total counts provided descriptive results of young women taking DE/DC in high school and their initial enrollment (access), persistence to third semester, and success (graduation within 150% of program length or transfer to four-year program). Results for each research question were as follows:

1. Was DE/DC coursework taken in high school a factor for increasing numbers of women transitioning into initial enrollment in two-year, post-secondary education with a STEM major during the years 2007-2009?

The results of the data analysis of those with DE/DC in all majors showed 58.4% within group (n= 221) were women and 41.6% were men. Of those who did not have DE/DC in high school, 51.5% within group (n=4,157) were women and 48.5% were men. Of the total cohort of incoming freshman (n = 4,378), women with DE/DC comprised 2.9% and men 2.1% of total. Table 5 summarizes results with percentages for the categories.

Table 5

*Frequency distribution of first-time enrolled two-year college students who took at least one DE/DC course in high school (2007-2009)*

	Gender						Total
	Women			Men			
	N	% Within Group	% Total	N	% Within Group	% Total	
DE/DC	129	58.4	2.9	92	41.6	2.1	221
Non DE/DC	2,142	51.5	49.0	2,015	48.5	46.0	4,157
Totals	2,271		51.9	2,107		48.1	4,378

Of the DE/DC enrollees who chose a STEM major (n=26), eight were women and 18 were men. Women comprised 30.7% within group, while men were 69.3%. Of those with DE/DC but not majoring in STEM (n=195), 63% were women and 37% were men. Of the total DE/DC cohort (n=221), women majoring in STEM were 3.6% of total and men were 8.1% of total. Table 6 summarizes the results of the gender percentages between STEM/nonSTEM majors with DE/DC.

Table 6

*Frequency distribution of first-time enrolled students majoring in STEM who took at least one DE/DC course in high school (2007-2009)*

	Gender						Total
	Women			Men			
	N	% Within Group	% Total	N	% Within Group	% Total	
STEM	8	30.7	3.6	18	69.3	8.1	26
Non STEM	121	63.0	55.7	72	37.0	32.6	195
Totals	129		59.3	92		40.7	221

2. Was DE/DC coursework taken in high school a factor for increasing numbers of women persisting to the third semester in two-year, post-secondary education with a STEM major during the years 2007-2009?

Of the 129 women who had taken DE/DC in high school and initially enrolled in college, eight majored in a STEM field. Six of those eight women (75%) returned for a third semester.

Of the total STEM majors (n=664), 16.6% within the group were women, while 83.4% were men. This total includes those with DE/DC. STEM majors returning for the third semester (n= 398) indicated that 15.3% were women within the STEM group and 84.7% were men. When analyzing the nonSTEM majors (n=3714), women returned at the rate of 57.6% for the third semester, while 42.4% of men returned. Table 7 summarizes retention of those with DE/DC in high school with or without STEM majors.



Table 7

*Frequency distribution for persistence of first-time enrolled students who majored in a STEM field (2007-2009)*

	Gender Retention						Total	% Total
	Women			Men				
	N	% Within Group	% Total	N	% Within Group	% Total		
<b>STEM</b>								
Return	61	15.3	1.4	337	84.7	7.7	398	9.1
No Return	49	18.4	1.1	217	81.6	5.0	266	6.1
Subtotal	110	16.6		554	83.4		664	15.1
<b>NonSTEM</b>								
Return	1,151	57.6	26.3	847	42.4	19.3	1,998	45.6
No Return	1,139	66.4	26.0	577	33.6	13.2	1,982	39.2
Subtotal	2,290			1,424			3,714	84.8
<b>Totals</b>	2,400		50.8	1,978		49.2	4,378	100.0

Note: Included those who had DE/DC in high school

For purposes of comparison with students in all majors, 26.8% women returned for the third semester, while 18.1% of men returned. Of those not returning, 14.5% were women and 40.7% were men. Table 8 summarizes these retention results for all majors.

Table 8

*Frequency distribution of persistence of first-time enrolled students in all majors*

	Gender Retention				Totals
	Women		Men		
	N	% Total	N	% Total	
Return	1,172	26.8	791	18.1	3,963
No Return	634	14.5	1,781	40.7	2,415
<b>Totals</b>	1,806		2,572		4,378

Note. Includes those who had DE/DC in high school

3. Was DE/DC coursework taken in high school a factor for increasing numbers of women succeeding in two-year, post-secondary education with a STEM major during the years 2007-2009?

Of the eight women who enrolled with DE/DC and chose a STEM major, six persisted to third semester and two graduated within 150% of timeline.

In order to compare results, frequencies, totals, and percentages of the 2007-2009 fall cohort (n=4,378), which includes those with DE/DC in high school, was calculated. Women (all majors) succeeded at a rate of 17.2%, with men succeeding at a rate of 12.7%. Table 9 summarizes results of graduation by gender.

Table 9

*Success (graduation) of first-time enrolled students (2007-2009)*

	Gender Graduation				Totals
	Women		Men		
	N	% Total	N	% Total	
Grad	755	17.2	558	12.7	1,313
NoGrad	1,529	34.9	1,536	35.1	3,065
Totals	2,284	52.2	2,094	47.8	4,378

Note. Includes DE/DC data

Table 10 summarizes the results of DE/DC cohort by gender. The success rate of all students in all majors who had DE/DC in high school was 0.2%. Students without DE/DC graduated at a rate of 23%.

Table 10

*Frequency distribution of success of first-time enrolled students who took at least one DE/DC course in high school (2007-2009)*

	Graduation						Totals
	DE/DC	% Within Group	% Total	Non DE/DC	% Within Group	% Total	
Grad	7	3.2	0.2	1,007	24.2	23.0	1,014
No Grad	214	96.8	4.9	3,150	75.8	72.0	3,364
Totals	221		5.0	4,157		95.0	4,378

Note. Includes those who had DE/DC in high school

### Summary

The purpose of this study was to describe whether or not participating in DE/DC in high school was a factor for access, persistence, and success of women entering Montana two-year colleges with STEM majors. With increased emphasis on encouraging women to enroll in STEM fields, this study was relevant to potential students, counselors, teacher preparation, government officials, college administration, enrollment services, and retention efforts. Efforts to increase the numbers of women in STEM majors present challenges for the colleges in budgeting, recruiting, scheduling, curriculum, retention and placement. Because this study was specific to Montana demographics, it was not intended to be generalizable to other states or nationwide. This descriptive study was not designed to answer *why* the differences exist, nor does it indicate *causation* of outcomes.

Frequency distributions, totals, and percentages of totals provided insight into the status of DE/DC in Montana for students taking early-college coursework in high school and subsequent enrollment in college for the years 2007-2012. Results indicated more young women than young men enrolled in DE/DC in high school and more women than men with

DE/DC early-college credit initially enroll in college. More men than women major in a STEM field and more men persist and graduate within the STEM majors. Of nonSTEM majors, more women than men enroll, persist, and graduate.

## **CHAPTER 5**

### **Discussion**

Since 2006 increased efforts have been put in place to encourage and assist in creating opportunities for more women to gain degrees in the science, technology, engineering, and mathematics (STEM) fields. Modern society and our economy are becoming more science and technology oriented. Therefore, it was important that women, who have been historically underrepresented in these fields, get assistance in gaining their STEM degrees. Early-college coursework in the form of dual enrollment and dual credit (DE/DC) has been identified as one option.

The literature review produced few studies directly related to this research. However, some researchers had similar findings and recommendations for further study (Mead, 2009; Swanson, 2008; Adelman, 2007; Hill, Corbett, and St. Rose, 2010). Because the DE/DC early-college experience has been promoted the last six years as one way to encourage women to enter nontraditional fields, this research evaluated the status of that effort. The results of this research will be made available to policymakers, advisors, counselors, department chairs, deans, and admissions staff to provide insights into the dual-enrollment effort in Montana. Public education is changing in order to provide high school students an opportunity to get a “jump-start on college” (Tinberg & Nadeau, 2011). DE/DC was designed to ease the transition to higher education and to improve access, persistence, and success for all students. This study described that effort in Montana.

### **Research Questions**

The research questions that framed this study were designed to describe differences related to high school students’ participation in college-level coursework (DE/DC) and their

subsequent initial enrollment in college (access), retention to the third semester (persistence), and graduation (success) within 150% of the identified timeline for the program. Table 11 provides a summary of the counts of women students with DE/DC credit during 2007-2009 (n=129), majoring in STEM (n=8), persisting to the third semester (n=6), and succeeding (n=2).

Table 11

*Frequency distribution of access, persistence, and success of women in Montana two-year colleges who took at least one DE/DC course in high school*

	2007	2008	2009	Result
Question 1: <i>Access</i>				
DE/DC	51	40	38	Decreased enrollment yearly
STEM	3	3	2	Small yearly difference
Question 2: <i>Persistence</i>	2	3	1	Small yearly difference
Question 3: <i>Success</i>	1	0	1	Small yearly difference

Answering the research questions provided insights into the status of dual-enrollment efforts in Montana during 2007-2009.

1. Was DE/DC coursework taken in high school a factor for increasing numbers of women transitioning into initial enrollment in two-year, post-secondary education with a STEM major during the years 2007-2009?

The answer to the question was no. There was decreased participation in DE/DC each year of the study, and there was little difference in women choosing STEM majors each year. Table 11 summarizes this data.

For purposes of comparison, within the DE/DC cohort (n=221), 58.4% were women and 41.6% were men. Of those, 69.3% men (n=18) and 30.7% women (n=8) chose a STEM major. Figure 5 describes the totals and percentages within group of enrollment by gender for the fall cohort of DE/DC and Table 5 shows further comparisons.

Even though fewer men than women took advantage of DE/DC, more men chose a STEM major at college. Unlike women with the DE/DC experience, men within the DE/DC group enrolled at a lower rate (40.7%) than men without (48.5%) the DE/DC experience. Figure 6 summarizes the counts and percentages for STEM majors.

When analyzing the percentages of the 2007-2009 fall cohort totals, those with DE/DC are a small percentage of the total because of the wide disparity in frequencies. Fall semester enrollees from 2007-2009 included women with DE credit (2.9%) and of those, 3.6% were majoring in STEM. These resulted in a total of eight women in STEM who had taken DE/DC. These results indicate more men than women chose STEM majors and more women than men chose non-STEM degree programs. Results indicate that fewer women than men were majoring in STEM fields in Montana colleges during the years 2007-2009.

2. Was DE/DC coursework taken in high school a factor for increasing numbers of women persisting to the third semester in two-year, post-secondary education with a STEM major during the years 2007-2009?

The answer to this question was no. There was little difference in the numbers of women with DE/DC persisting to the third semester of a two-year STEM

program during the years of this study. Of the eight women with DE/DC who enrolled, six of those persisted to the third semester. This results in a 75% retention rate for those women in STEM majors who had DE/DC. In comparison, women without DE/DC majoring in STEM fields persisted at the rate of 15.3%. Tables 7 and 8 summarize totals, percentages within groups, and percentages of total.

3. Was DE/DC coursework taken in high school a factor for increasing numbers of women succeeding in two-year, post-secondary education with a STEM major during the years 2007-2009?

The answer to this question was no. There was no increase in the numbers of women completing STEM degrees in college during the time frame of this study. Of the 2007-2009 DE/DC cohort majoring in STEM (n=8), two women graduated. This represented 25% within DE/DC group graduating with a degree in a STEM field. This was slightly higher than for those without DE/DC, in which 24.2% graduated. Tables 9 and 10 summarize totals and percentages for success in a two-year degree.

## **Conclusion**

Results of the calculations for this study indicated that DE/DC participation by students in high school was low. Five percent of the fall cohort (n=4,378) enrolled in a two-year college in Montana during 2007-2009 with prior DE/DC credit. Women made up 58.4% of that DE/DC category (n=221). Students majoring in a two-year STEM program (n=664) comprised 15.2% of the total 2007-2009 fall cohort. Women were 16.5% of the STEM majors. This result is lower than the McComas (2010) study in which 30% of the STEM



majors were women. In Montana, more women than men took advantage of DE/DC and enrolled in college, but more men majored in and were successful in STEM majors. Women in non-STEM majors were more likely to continue and succeed. These results are consistent with the Hutton (2009), Speroni (2011), Swanson (2008), and Mead (2009) studies.

The data analysis in this study was an example of one concern for descriptive studies. When working with small frequencies, the resulting percentages are considerably affected by small changes in total counts. Pallant (2005) suggests that when looking at percent of totals, rather than percent within group or category, results may appear to be trivial because of the low percentages. In this study, which used census data, low percentages were the result of comparisons with the total. The original cohort created a large total which was then used for calculations or comparisons. Because the data in this study revealed small counts in DE/DC participation and STEM majors, the results showed very low percentages of total. Therefore, reporting percentages within group provided another level of description for the population.

As highlighted in the literature review, a complicated set of circumstances exist that contribute to development of interest in science, technology, engineering, and mathematics (STEM). Barriers to women in these fields have been identified in numerous research studies. Trends in enrollments show that more women than men have been enrolling in college across all majors. When considering STEM majors, women are still underrepresented nationally. This study revealed that women enroll in STEM majors at a lower rate than men in Montana as well. In addition, the research found that young women who do participate in DE/DC while in high school are not choosing STEM fields at the same rate as men, nor do those who initially enroll in a STEM field persist or graduate at the same rate as men. Because multiple

factors contribute to the underrepresentation of women in STEM, multiple solutions are necessary to correct the imbalance (Hill et al., 2010).

“In an era when women are increasingly prominent in medicine, law, and business, why are so few women becoming scientists and engineers” (Hill et al., 2010, p. ix)? The literature review produced no definitive answers for the lack of women in STEM fields. Relationships are difficult to define because career choice is a function of academic growth as well as cultural experiences. These contributing factors change throughout a student’s development and may complicate the choices of women entering nontraditional fields. Other contributing factors could be poor mathematics skills, stereotypes, lack of role models, or lack of workplace flexibility. This study researched whether or not participation in DE/DC was a contributing factor, but with small numbers it was difficult to get a true picture of its effect.

The availability of the DE/DC opportunity may not be the same for all Montana students. One contributing factor for student participation in DE/DC opportunities could be the educational system itself. With 59% of the Montana high schools rated as Class C (<119), resources may be scarce. In a small high school it may be difficult to have enough students to create a DE/DC class. In addition, location may preclude creating articulation agreements. As discussed in the literature review, Montana has four models of delivering DE/DC instruction in an effort to meet the needs of students. Those choices were:

- High school class with high school teacher
- High school class with college teacher
- College class with college teacher
- Online class with college teacher

The literature review described advantages of each instructional method. More Montana students attended DE/DC class on the high school campus with a high school teacher than the other three options. Identified advantages of the college class/college teacher model may have an effect on initial enrollment because students who attended the course on a college campus in a mixed-level classroom were more likely to experience the expectations of college courses, become familiar with college atmosphere, participate in diverse classrooms, and receive instruction from college instructors while still in their high school support system (Office of the Commissioner of Higher Education, 2010). Perhaps this model is a better *bridge* between high school and college. The reality, however, is that this model is only available for those near a college. The majority of the schools in Montana are considered rural, thereby necessitating other delivery methods—online with a college instructor, or a high school course taught by a high school teacher developed as a result of an articulation agreement between the institutions.

### **Recommendations**

Inequity affects the nation as well as individual citizens. The future viability of all fields, including STEM careers, depends on diversity. Research and revolutionary practice within the education system is needed to fulfill an ethical commitment to diversity. While the U.S. public educational system is committed to providing equal opportunities for all learners, it often takes legislation to fund special initiatives which bring about wide-sweeping changes to meet the educational needs of our citizens and prepare them for living and working in a global society.

This study presented a picture of the current status of women majoring in STEM fields in Montana. However, there is a complex set of factors that influence students as they

progress through the educational system and choose a major. Supportive parents, motivating teachers, mentors, role models, summer enrichment activities, science fairs, or natural inclinations and abilities all affect students in varying ways (Hill et al., 2010). Research studies which focus on completion rates do not take other factors into consideration, and therefore cannot determine reasons or causation for decisions resulting in college enrollment, persisting within a degree, and graduating successfully. This leaves a gap in the findings that could be filled using mixed-methods research design. Broader, more inclusive, parameters could better reflect student demographics. For instance, this study would have benefited from including four-year data because Montana is currently refocusing its two-year college system. Numbers are low in two-year college STEM programs, and it would be beneficial to study the status of four-year STEM programs. College!Now (Office of the Commissioner of Higher Education, 2011b) efforts are encouraging colleges to increase the number of STEM programs offered. This in turn provides more options for students. Nationally, data indicated that 86% of DE/DC students enroll initially at a four-year institution rather than begin their careers at a two-year college and ladder degrees from associate's to bachelors and beyond (National Center for Education Statistics, 2011a). In addition, the mission of two-year institutions in Montana is to serve those who attend part-time or have gaps in their enrollment; therefore, a study that includes these data would be beneficial. Findings within the scope of this research did provide insights into the status of DE/DC in Montana.

Dual enrollment continues to have an increased impact on high school students and two-year colleges in Montana. It is designed to provide a rigorous curriculum, give students a college experience, save tuition costs, create portability options for credits, and shorten time to graduation. Continuing studies could judge whether or not those goals are being met. It is

recommended that challenges/solutions to the few women in STEM majors in Montana also be recognized.

DE/DC has implications for easing transitions between high school and college, necessitating assistance and guidance from high school counselors and teachers. Professors who are teaching courses in which high school students are integrated are impacted as they experience a need to accommodate more diversity in the classroom. DE/DC will also impact four-year schools as two-year students build upon their DE/DC high school credits and matriculate to the bachelor's level and beyond. Teacher-preparation programs will be impacted as many high school teachers will be expected to teach dual-credit courses. These teachers will need pre-service/in-service training to attain credentials equal to a college instructor. Both high schools and colleges will need support in designing articulation agreements for course content.

The literature review established a basis for the need to encourage more young women to pursue STEM-related coursework in preparation for college majors and careers in those areas. One of the goals of this study was to describe the characteristics of young women taking DE/DC in high school and their college success in a STEM field. Historically, early-college efforts were designed to increase rigor for those who were already academically successful using advanced placement or international baccalaureate. It was the intention of recent DE/DC efforts in Montana that the early-college experience should include a more diverse demographic. Results of this study indicated that the goal for greater diversity, specifically women in nontraditional fields, had not been met during the timeline of this study. Therefore, one recommendation would be for stakeholders to reevaluate investments of time and money and refocus the DE/DC efforts with alternatives to meet State goals. This

study found that initial efforts to implement DE/DC in Montana has created an increased interest in this opportunity through rising enrollments, and it is recommended that further research should be conducted to ensure a process of continuous improvement to meet the needs of all high school students.

### **Implications for Future Research**

At the time of this research, gaps existed in the data which were needed to track individual students between levels of education. In addition, few related studies were found for comparison of results. As the data management systems evolve and become more universally accessible, research should continue with longitudinal studies following students through their educational experiences and careers. The mission of two-year education in Montana includes laddering credentials and degrees (Office of the Commissioner of Higher Education, 2011b). Therefore, expanded research should examine the results of the process to transfer into four-year STEM majors and identify how the opportunity is put into practice. It would also be beneficial to identify any existing barriers and develop a strategy for removing them.

Because of the changing demographics of students and the complicated combination of factors that lead to successful STEM graduates, following are implications for future research:

- Replicate the study using the new coding and reporting process (started in 2012) that would allow increased ability to track students among all levels of education. Study the effect DE/DC had on finding employment before finishing a two-year degree. Research the time it takes to graduation from college; theoretically, getting early-college credit should shorten time to graduation.

- Conduct a mixed-methods study with a qualitative component to determine variability in precollege characteristics (i.e. enrichment activities, educational level of parents, spatial skill development), motivations, personal attributes, as well as economic factors which may lead to choices in college majors for women who major in a STEM field. Cozby (2009) would agree that multiple methods are needed to fully understand results since no single study is definitive.
- Conduct a study to determine the impact the four models of instruction currently in place have on access, persistence, and success. This study could give insights into teacher preparation or in-service needs. Pedagogy may also need to be adjusted.
- Examine individual college data across the state of Montana to determine if students enrolled initially at the same college they were associated with taking the DE/DC coursework. Crockett-Bell (2007) found that students chose their sponsoring college for first-time enrollment.
- Conduct research using two-year as well as four-year institutional data for DE/DC and STEM majors. Mattis and Sislin (2005) suggested that one way to increase the number of engineering students at four-year colleges is to recruit students pursuing engineering science studies at community colleges.
- Research whether or not the DE/DC opportunity was available to a diverse group of students in Montana. Adelman (2007) suggested that DE/DC has been successful because the academically talented students are recruited and they would succeed regardless of this effort.

- Conduct a gap analysis between college program requirements for STEM fields and DE/DC courses available to students at the high school level. Also, conduct the gap analysis between two-year and four-year STEM programs to facilitate ease of transfer.
- Repeat the study after data is available from the Common Core State Standards for Mathematics initiative. A longitudinal study to determine if there was increased interest and success of girls and young women in STEM related coursework may be helpful to stakeholders.

At present, the disconnect of data gathering and reporting between the educational levels, school districts, university/college system, and State agencies does not allow researchers to easily identify contributing factors or variables which are needed for longitudinal research projects. This limitation is being removed by new coding implemented in 2012. In addition, conducting qualitative research would produce a richer picture of the outcomes of the dual-enrollment effort and should be an essential part of future study into the efficacy of DE/DC on college success.

When viewing the results of this study through the lens of the *Advocacy and Participatory Worldview* described by Creswell (2009), the social issues of empowerment and inequality are evident. Women have made gains in other historically male fields of business, law, and medicine, but not in STEM (Hill, Corbett, & St. Rose, 2010). Montana follows the national trend of few women in STEM fields. Continuing studies could establish a sustainable process to regularly collect, organize, and report data. Stromquist (2007) supported a “holistic probing of the existing educational system” with results available to stakeholders as input for making informed decisions to bring about meaningful changes.



DE/DC coursework was designed to ease the transition from high school to college, develop a desire to continue education at the post-secondary level, and engage underrepresented student populations in challenging coursework. The framework for this non-experimental, descriptive, quantitative study was based on the premise that advanced coursework through the DE/DC efforts would provide another option to improve access, persistence, and success of women in STEM majors. This study described the status of DE/DC in Montana as it related to young women who entered and persisted to graduation in STEM majors within the two-year college system. Although the results showed no effect at this point in time, the potential exists to further develop the DE/DC effort and implement best practices for providing early-college coursework and easing the transition to college.

## References

- Adelman, C. (2007). Do we really have a college access problem? *Change*, 39(4), 48–54.  
Retrieved from GALE|A166811288
- Andrews, H. A. (2010). Dual credit research outcomes for students. *Community College Journal of Research and Practice*, 28(5), 415–422. doi:10.1080/1066892049044445
- American Psychological Association. (2010). *Publication manual of the American Psychological Association* (Sixth ed.). Washington, DC.
- Association for Career and Technical Information. (2011). *Carl D. Perkins Act Implementation*. Retrieved from <http://www.acteonline.org/perkins.aspx#plans>
- Astin, A. W., & Lee, J. J. (2003). How risky are one-sided cross-sectional assessment of undergraduate students? *Research in Higher Education*, 44(6), 657–672. Retrieved from <http://www.jstor.org/stable/40197335>
- Baber, A. (2011). *Using Community Colleges to Build a STEM-Skilled Workforce*. Retrieved from [http://20.132.48.254/ERICWebPortal/search/recordDetails.jsp?ERICExtSearch\\_Descriptor=%22Building+Trades%22&\\_pageLabel=RecordDetails&accno=ED522079&\\_nfls=false](http://20.132.48.254/ERICWebPortal/search/recordDetails.jsp?ERICExtSearch_Descriptor=%22Building+Trades%22&_pageLabel=RecordDetails&accno=ED522079&_nfls=false)
- Besecke, L. M., & Reilly, A. H. (2006). Factors influencing career choice for women in science, mathematics, and technology: The importance of a transforming experience. *Advancing Women in Leadership (Online Journal)*, 211(Summer), 1–8. Retrieved from ProQuest 1183860991

- Boote, D. N., & Beile, P. (2005). Scholars before researchers: On the centrality of the dissertation literature review in research preparation. *Educational Researcher*, 34(6), 3–15.
- Bryant, S. (2011). *It's nothing personal: Competing discourses for girls and women in mathematics (Dissertation)*. Amherst. Retrieved from ProQuest 3461992)
- Cardoso, P., & Marques, J. F. (2008). Perception of career barriers: The importance of gender and ethnic variables. *International Journal Educational Vocational Guidance*, 8(1), 49–61. doi:10.1007/s10775-008-9135-y
- Carnevale, A. P., Smith, N., & Melton, M. (2011). *STEM: Center on education and the workforce*. Center on Education and the Workforce. Washington, DC: Georgetown University. Retrieved from <http://www.cew.georgetown.edu/STEM>
- Common Core State Standards Initiative. (2010). *Common Core State Standards for Mathematics*. Retrieved from [http://www.corestandards.org/assets/CCSSI\\_Math%20Standards.pdf](http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf)
- Community College of Allegheny County. (2011). *Non-Traditional Careers*. Retrieved from <http://www.ccac.edu/default.aspx?id=145959>
- Corbett, C. (2011). *Are Girls and Women Just Not Interested*. Retrieved from [American nature.com/.../are-girls-and-women-just-not-interested](http://www.americannature.com/.../are-girls-and-women-just-not-interested)
- Cozby, P. C. (2009). *Methods in behavioral research* (Tenth ed.). New York, NY: McGraw Hill Higher Education.
- Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Los Angeles: Sage Publications, Inc.

- Crockett-Bell, S. A. (2007). *The dual-credit program: Measuring the effectiveness on students' transition from high school to college* (Doctoral dissertation). Capella University, Minneapolis. Retrieved from ProQuest 3277657)
- Diament, M. (2011). Most high schools have dual-credit, dual-enrollment programs offering college-level courses. *The Chronicle of Higher Education*, 51(33).
- Duffy, W. R. (2009). *Persistence and performance: The relationship between dual-credit persistence and performance at a four-year university* (Doctoral dissertation). Memphis: University of Memphis.
- Economics and Statistics Administration. (2011). *Women in STEM: A gender gap to innovation*. Retrieved from <http://www.esa.doc.gov/report/women-stem-gender-gap-innovation>
- Else-Quest, N. M., Linn, M., & Hyde, J. (2010). Cross-national differences in mathematics. *Psychology Bulletin*, 136(1), 103–127. Retrieved from <http://www.stemequitypipeline.org/Resources/OnlineResources/Reports.aspx>
- Employment and Training Administration. (2011). *U.S. Department of Labor*. Retrieved from <http://www.doleta.gov/programs/ONET/>
- Eng, P. (2008). *Society of Women Engineers 2007 Retention Study*. Retrieved from <http://societyofwomenengineers.swe.org/index.php/news/152-public-policy/715-pp-october-2008>
- Geise, M. J. (2011). *A longitudinal analysis of outcomes associated with Ohio's postsecondary enrollment options program* (Doctoral dissertation). Bowling Green: Bowling Green State University.

- Greenes, C., Wolfe, S., Weight, S., Cavanagh, M., & Zehring, J. (2011). Prime the pipeline project (P3): Putting knowledge to work. *Contemporary Issues in Technology and Teacher Education, 11*(1), 21–46.
- Grefenstette-Moon, C. A. (2011). *High school course patterns as related to university academic achievement and persistence* (Doctoral dissertation). University of Houston, Houston, Texas. Retrieved from ProQuest 2409602641
- Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review, 29*(6), 911–922.  
doi:10.1016/j.econedurev.2010.06.010
- Guess, A. (2008). *Defining college success*. Retrieved from [www.insidehighered.com/news/2008/05/20/board](http://www.insidehighered.com/news/2008/05/20/board)
- Han, J., Kamber, M., & Pei, J. (2012). *Data mining concepts and techniques* (Third ed.). Waltham: Morgan Kaufmann Publishers.
- Harris, G. L. (2011). The quest for gender equity. *Public Administration Review, 1*(1), 123–126.
- Hegewisch, A. (2010). *Separate and not equal? Gender segregation in the labor market and gender wage gap*. Retrieved from <http://iwpr.org/pdf/C377.pdf>
- Heilman, M., & Wallen, A. (2004). Penalties for success: Reactions to women who succeed at male gender-typed tasks. *Journal of Applied Psychology, 89*(3), 416–427.
- Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and math*. Washington, DC: American Association of University Women. Retrieved from <http://www.aauw.org/files/2013/02/why-so-few-in-science-technology-engineering-and-mathematics.pdf>

- Hoffman, N., Vargas, J., & Santos, J. (2009). New directions for dual enrollment: Creating stronger pathways from high school through college. *New Directions for Community Colleges*, 2009(145), 43–58. doi:10.1002/cc.354
- Hoffman, N., Vargas, J., Venezia, A., & Miller, M. S. (2007). *Minding the gap: Why integrating high school with college makes sense and how to do it*. Cambridge: Harvard Education Press.
- Hoopes, L. (2011). *The pay gap in STEM fields*. Retrieved from <http://www.nature.com/scitable/forums/women-in-science/the-pay-gap-in-stem-fields-19116412>
- Hossain, M. M., & Robinson, M. G. (2012). How to increase American students' participation rate in STEM careers. *Global Conference on Technology, Innovation, Media and Education*, 57–61. Retrieved from <http://www.editlib.org/p/39396>
- Huck, S. (2008). *Reading statistics and research* (5th ed.). Boston, MA: Pearson Education Inc.
- Hugo, E. B. (2001). Dual enrollment for underrepresented student populations. *New Directions for Community Colleges*, 2001(113), 67–73. doi:10.1002/cc.10
- Hutton, J. L. (2009). Enrollment and persistence of female STEM majors at a 2-year college. Capella University, Ohio.
- International Baccalaureate Organization. (2011). *About the International Baccalaureate*. Retrieved from <http://www.ibo.org/general/who.cfm>
- Jobs for the Future. (2009). *Jobs for the Future*. Retrieved from [www.jff.org](http://www.jff.org)
- Johnson, B. (2001). Toward a new classification of nonexperimental quantitative research. *Educational Researcher*, 30(2), 3–13.

- Kaniuka, T. S., & Vickers, M. (2010). Lessons learned: How early college high schools offer a pathway for high school reform. *National Association of Secondary School Principals (NAASP) Bulletin*, 94(3), 165–184. doi:10.1177/0192636510384982
- Kimmel, H., Carpinelli, J., Cano, R., & Perna, A. (2012). *The K-16 engineering pipeline: A working model*. New Jersey Institute of Technology, New Jersey: New Jersey Institute of Technology. Retrieved from <http://ebookbrowse.com/the-k-16-engineering-pipeline-a-working-model-pdf-d272401828>
- Koebler, J. (2011). *Women, minorities vastly underrepresented in engineering profession*. Retrieved from <http://www.usnews.com/news/blogs/stem-education/2011/10/28/women-minorities-vastly-underrepresented-in-engineering-profession>
- Konings, K., Brand-Gruwel, S., van Merriënboer, J., & Broers, N. J. (2008). Does a new learning environment come up to students' expectations? A longitudinal study. *Journal of Educational Psychology*, 100(3), 535. Retrieved from <http://search.proquest.com/docview/210996423?accountid=14593>
- Kuh, G. D., Kinzie, J., Buckley, J. A., Bridges, B., & Hayek, J. (2006). *What matters to student success: A review of the literature*. National Center for Educational Statistics. Washington D.C.: National Postsecondary Education Cooperative. Retrieved from [http://nces.ed.gov/npec/pdf/kuh\\_team\\_report.pdf](http://nces.ed.gov/npec/pdf/kuh_team_report.pdf)
- Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011). *STEM: Good jobs now and for the future*. Washington, D.C.: Department of Commerce.
- Lederman, D. (2011). *New data on STEM gender gap*. Retrieved from <http://www.insidehighered.com/quicktakes/2011/08/04/new-data-stem-gender-gap>

- Leon, C. E. (2010). *Career success factors for women in aerospace* (Doctoral dissertation). Claremont, California.
- Maltese, A. V. (2008). *Persistence in STEM: An investigation of the relationship between high school experiences in science and mathematics and college degree completion in STEM fields* (Doctoral dissertation). Charlottesville: University of Virginia. Retrieved from ProQuest 1594965211
- Mastekaasa, A., & Smeby, J. C. (2008). Educational choice and persistence in male- and female-dominated fields. *Higher Education*, 55(2), 189–202. doi:10.1007/s10734-006-9042-4
- Mattis, M. C., & Sislin, J. (2005). *Enhancing the community college pathway to engineering careers*. Washington D.C.: National Academies Press.
- McCauley, D. (2007). *The impact of advanced placement and dual enrollment programs on college graduation (Applied Research Project)*. San Marcos: Applied Research Projects, Texas State University. Retrieved from <http://ecommons.txstate.edu/arp/206>
- McComas, M. A. (2010). *Degree completion and acceleration rates of Iowa community colleges' concurrent enrollment students* (Doctoral dissertation). Iowa State University, Ames.
- Mead, R. A. (2009). *A Comparison of the Enrollment and Academic Success of Dual Credit and Non-Dual Credit Students at Des Moines Area Community College* (Doctoral dissertation). Ames: Iowa State University. Retrieved from 3369862).
- Montana Office of Public Instruction. (2012). Retrieved from <http://opi.mt.gov/Reports&Data/index.html>



- National Association of Colleges and Employers. (2010). *Top paid majors for 2009-2010*. Retrieved from <http://www.naceweb.org/so021710/toppaid/>
- National Center for Education Statistics. (2011a). *America's high school graduates: Results of the 2009 NAEP high school transcript*. Retrieved from <http://nces.ed.gov/nationsreportcard/pubs/studies/2011462.aspx>
- National Center for Educational Statistics. (2011b). *Digest of Education Statistics: 2010*. Retrieved from <http://nces.ed.gov/programs/digest/d10/>
- National Center for Educational Statistics. (2011c). *Postsecondary awards in science, technology, engineering, and mathematics*. Retrieved from <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2011226>
- National Science Foundation. (2011). *Women, minorities, and persons with disabilities in science and engineering*. Retrieved from <http://www.nsf.gov/statistics/wmpd/tables.cfm>
- Nicholls, G., Wolfe, H., Besterfield-Sacre, M., Shuman, L., & Larpkiattaworn, S. (2007). A method for identifying variables for predicting STEM enrollment (Doctoral dissertation). *Journal of Engineering Education*, 96(1), 33–44.
- Office of Public Instruction. (2010-2011). Big Sky pathways initiative toolkit. *Montana Career Clusters/Big Sky Pathways*. Helena: Office of Public Instruction.
- Office of the Commissioner of Higher Education. (2010). *Dual enrollment landscape in Montana: Preliminary overview of policy issues*. Retrieved from [http://mus.edu/board/meetings/2010/Mar2010/Workforce/DualEnrollment\\_a1.pdf](http://mus.edu/board/meetings/2010/Mar2010/Workforce/DualEnrollment_a1.pdf)
- Office of the Commissioner of Higher Education. (2011a). *MUS strategic plan college participation*. Retrieved from <http://mus.edu/data/StratPlan/StrategicPlan.asp>

- Office of the Commissioner of Higher Education. (2011b). *College!Now*. Helena, Montana.  
Retrieved from [http://www.mus.edu/2r/2yr\\_main.asp](http://www.mus.edu/2r/2yr_main.asp)
- Olszewski-Kubilius, P. (2010). *Special schools and other options for gifted STEM students*.  
*Roeper Review*, 32(1), 61–70. doi:10.1080/02783190903386892
- Oregon Department of Education. (2010). *Oregon 2010 dual credit executive summary*.  
Retrieved from <http://www.ode.state.or.us/search/results/?id=222>
- Oregon State University. (2012). *OSU degree partnership program*. Retrieved from  
<http://oregonstate.edu/partnerships/>
- Ormrod, J. E. (2012). *How motivation affects learning and behavior*. Retrieved from  
<http://www.education.com/reference/article/motivation-affects-learning-behavior/>
- Pallant, J. (2005). *SPSS survival manual* (Second ed.). Maidenhead, Berkshire, UK: Open  
University Press.
- Peterson, A. (2008). *Abysmal graduation rates*. Retrieved from [http://blog-  
aauw.org/2008/05/13/abysmal-graduation-rates/](http://blog-aauw.org/2008/05/13/abysmal-graduation-rates/)
- Richardson, T. (2007). Dual-credit: A key to the future. *On the Horizon*, 15(4), 239–244.  
doi:10.1108/10748120710836255
- Riegle-Crumb, C., & King, B. (2010). Questioning a white male advantage in STEM.  
*Educational Researcher*, 39(9), 656–664. doi:10.3102/0013189x10391657
- Rosenbaum, J. E. (2011). The complexities of college for all: Beyond fairy-tale dreams.  
*Sociology of Education*, 84(2), 113–117.
- Rosenbaum, J. E., & Becker, K. I. (2011). The early college challenge: Navigating  
disadvantaged students' transition to college. *American Educator*, 35(3), 14–20.

- Saltarelli, C. A. (2008). *An examination of the relationship between early college credit and higher education achievement, persistence, and time to graduation, of students in South Texas* (Doctoral dissertation). Texas A& M University - Kingsville.
- Santovec, M. L. (2011). Use student affairs strategies to retain women in STEM. *Women in Higher Education*, 20(1), 24–25.
- Schmidt, W. H., Cogan, L. S., & McKnight, C. C. (2010-2011). Equality of educational opportunity: Myth or reality in U.S. schooling? *American Educator*, 34(4), 12–19.
- Senechal, D. (2010). The most daring education reform of all. *American Educator*, 34(1), 4–16.
- Simms, R. O. (2010). *An analysis of the outcomes of dual enrollment participants in Kentucky Community & Technical Colleges: 2001-2002 to 2007-2008* (Doctoral dissertation). University of Kentucky. Retrieved from ProQuest 3447693
- Smallwood, S. (2006). Good scores on AP science exams are not good predictors of success in college science, study finds. *The Chronicle of Higher Education*, 52(26), A.37.
- Smith, D. (2007). Why expand dual-credit programs? *Community College Journal of Research and Practice*, 31(5), 371–387. doi:10.1080/10668920600932884
- Solomon, J. (2012). *On the margins, between the lines: Attrition of women from techie majors*. Retrieved from <http://www.stanforddaily.com/2012/02/01/on-the-margins-between-the-lines-attrition-of-women-from-techie-majors/>
- Sorby, S. A., & Baartmans, B. J. (2000). The development and assessment of a course for enhancing the 3-D spatial visualization skills of first year engineering students. *Journal of Engineering Education*, 89(3), 301–307. Retrieved from <http://jee.org/2000/july/315.pdf>

- Speroni, C. (2011). *Essays on the economics of high school-to-college transition programs and teachers* (Doctoral dissertation). New York City: Columbia University. Retrieved from ProQuest 3287129)
- Stromquist, N. P. (2007). Women's education in the twenty-first century: Balance and prospects. In R. F. Arnove, & C. A. Torres (Eds.), *Comparative Education: The Dialectic of the Global and the Local* (Third ed., 151–170). Lanham, Maryland: Rowman & Littlefield Publishing Group.
- Swanson, J. L. (2008). *An analysis of the impact of high school dual enrollment course participation on post-secondary academic success, persistence and degree completion* (Doctoral dissertation). The University of Iowa. Iowa City: University of Iowa. Retrieved from ProQuest 3323472).
- Thompson, C., & Ongaga, K. (2011). *Flying the plane while we build it: A case study of an early college high school*. doi:10.1353/hsj.2011.0000
- Tinberg, H., & Nadeau, J.-P. (2011). Contesting the space between high school and college in the era of dual-enrollment. *College Composition and Communication*, 62(4), 704–725.
- Tinto, V. (2008). When access is not enough. *The Hispanic Outlook in Higher Education*, 19(3), 13. Retrieved from ProQuest 219274280
- Touchstone, A. J. (2010). Perceived factors influencing high school student participation in an integrated statewide dual credit program: An examination of program success and student higher education selection decisions (Doctoral dissertation). University of Idaho, Moscow, Idaho.
- U.S. Bureau of Labor Statistics. (2009). *Employment projections 2008-2018*. Washington, DC: U.S. Department of Labor.

- U.S. Bureau of Labor Statistics. (2010-2011). *U.S. Department of Labor*. Retrieved from <http://www.bls.gov/oco/>
- U.S. Department of Education. (2006). *Carl D. Perkins Career and Technical Education Act of 2006*. Retrieved from <http://www2.ed.gov/policy/sectech/leg/perkins/index.html>
- U.S. Department of Education. (2007). *FY 2007 Allocations for Carl D. Perkins Career and Technical Act of 2006*. Retrieved from <http://www2.ed.gov/programs/techprep/07allot.html>
- U.S. Department of Education. (2011a). *Access to High Standards Act*. Retrieved from <http://www2.ed.gov/policy/elsec/leg/esea02/pg14.html>
- U.S. Department of Education. (2011b). *Tech Prep Education*. Retrieved from <http://www2.ed.gov/programs/techprep/index.html>
- U.S. Department of Education. (2011c). *Statistical Methods for Protecting Personally Identifiable Information...* Retrieved from <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2012151>
- U.S. Department of Education. (n.d.). *Title IX General Provisions*. Retrieved from <http://www2.ed.gov/policy/elsec/leg/esea02/pg107.html>
- U.S. Department of Education Agency Report. (2010). *Report to the white house council on women and girls*. Washington, D.C.: U.S. Department of Education.
- U.S. Department of Labor. (2011). *Hot Jobs for the 21st Century, 2004–2014*. Retrieved from <http://www.dol.gov/wb/factsheets/Qf-HotJobs3.htm>
- U.S. National Economic Council. (2011). *National Economic Council*. Retrieved from <http://www.whitehouse.gov/sites/default/files/uploads/InnovationStrategy.pdf>

Wei, C. C., & Carroll, D. C. (2002). *Persistence and Attainment of Beginning Students with Pell Grants*. Retrieved from <http://nces.ed.gov/pubs2002/2002169.pdf>

Williams, M. R., & Southers, T. (2010). Blurring the lines between high school and college: Early colleges and the effect on adult learners. *Adult Learning*, 21(1), 26–30.

## Appendix A

### Acronyms

Acronyms	Meaning	Relationship to this Study
A2S	Access to Success	Collaborative effort among states to increase participation and success of minority and low income students.
AP	Advanced Placement	One of the original efforts for advanced high school students to receive college credit for courses by passing an exam. Typically taught by high school teachers in that content area.
ARRA	American Recovery and Reinvestment Act	Largest competitive grants to states to provide incentives for large-scale systemic improvements in education.
CCSSI	Common Core State Standards Initiative	The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that young people need for success in college and careers. The mathematics standards are relevant to preparation in STEM fields.
CEW	Center on Education and the Workforce	Independent, nonprofit research and policy institute to study education and

		workforce training outcomes.
CSRDE	Consortium for Student Retention Data Exchange	Two- and four-year institution consortium for student retention and success. Group of researchers and practitioners doing evidence-based research for evaluating student success. Requires a membership.
CWG	Council on Women and Girls	Established 2009 by President Obama to support a diverse workforce by supporting women and girls with their unique needs.
DC	Dual Credit	Students taking college level coursework while in high school. It is commonly collaboration between the high school and a community college. The credit counts toward high school graduation as well as the college major.
DE	Dual Enrollment	Students enrolled concurrently in high school and college for college-level coursework. Courses can be taught at high school or on college campus. Dual credit may be awarded by the high school. Students receive a college



		transcript.
DOE	Department of Education	Federal oversight of educational system in United States.
DOL	Department of Labor	Federal agency providing workforce statistics.
ESA	Economics & Statistics Administration	Division of the U.S. Department of Commerce.
ECHSI	Early College High School Initiative	Creation of separate early colleges integrating the last two years of high school with the first two years of college; results in high school diploma and associate's degree.
FERPA	Family Educational Rights and Privacy Act	Established legal requirements to protect student privacy.
GEAR-UP	Gaining Early Awareness & Readiness for Undergraduate Programs	Initiative funded by a federal grant to Montana to encourage students to set high academic expectations and take appropriate college prep courses.
HEOA	Higher Education Opportunity Act of 2008	Requires that Title IV degree-granting institutions disclose annually the graduation rates of first-time, full-time degree- or certificate-seeking undergraduate students disaggregated

		by gender, ethnicity, and Pell eligibility
IBO	International Baccalaureate Organization	Development, coordination, and oversight of the International Baccalaureate (IB) early college experience.
IB	International Baccalaureate	Often the junior and senior year of high school for students wanting a global focus; designed for advanced students and entry into four-year programs of study.
JFF	Jobs for the Future	Interagency collaboration to aid displaced and disadvantaged workers in getting their education.
MSEIP	Minority Science and Engineering Improvement Program	Designed to expand scientific and technological capacity of the United States.
MUS	Montana University System	Montana statewide public higher education college and university system including tribal colleges.
NACE	National Association of Colleges and Employers	Collaboration effort to align college curriculum with workforce needs.
NCES	National Center for Educational Statistics	Main source of data from the Department of Education.

NCLB	No Child Left Behind	Federal legislation in 2002 designed to improve student performance by making the teachers and schools accountable.
NSF	National Science Foundation	Foundation to promote the sciences; major source of grant funding for innovative educational projects.
OCHE	Office of the Commissioner of Higher Education	Montana oversight for post-secondary educational institutions in Montana.
OCR	Office for Civil Rights	Oversight for civil rights for Title IX
O*NET	Occupational Information Network	Database developed in 1998 to isolate the competencies needed in particular occupations.
OOH	Occupational Outlook Handbook	Information on job and workforce trends.
OPI	Office of Public Instruction	Montana K-12 state agency.
OVAE	Office of Vocational Adult Education	Federal agency with a focus on workforce development through vocational education.
STEM	Science, Technology, Engineering, and Mathematics	Cluster of careers in technology, science which are nontraditional fields for women.

# Appendix B

## Literature Review Map

