Nontraditional Career Preparation
ROOT CAUSES & STRATEGIES

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ACKNOWLEDGMENTS

Nontraditional Career Preparation: Root Causes and Strategies is an update of Improving Performance On Perkins III Core Indicators: Summary of Research on Causes and Improvement Strategies, Chapter 6 – Participation in Secondary and Postsecondary Non-Traditional Programs published by the National Dissemination Center for Career and Technical Education and written by Mimi Lufkin.

Special thanks to the Illinois Center for Specialized Professional Support, Lynn Reha, Director for conducting an exhaustive review of the research literature and authoring the document. Thanks also to Mimi Lufkin, CEO of the National Alliance for Partnerships in Equity (NAPE) and Laurie Harrison, Foothill Associates for their many reviews and contributions. At NAPE, Nancy Tuvesson copyedited the document and Holly Blue prepared the final layout.

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Nontraditional Career Preparation: Root Causes & Strategies
Part I: Introductory Guide

The goal of *Nontraditional Career Preparation* is to assist you in recruiting and retaining more students into nontraditional careers through the most effective means possible. Examining what has proven effective is the most efficient way to utilize the resources we have to put toward this effort. *Part I* provides a "quick find" to the research and effective strategies; links are provided to more detailed information in *Part II. Part I* is intended as a summary and an example guide to *Part II,* and the two parts should always be used together. An online version of this document is available at http://02b47b1.netsolhost.com/foundation/page.php?55.

Introductory Guide Features

- The guide is organized into **categories** based on their areas of influence.
- Each category is further divided into **root causes** about which a **theory** is proposed. The **evidence** for each theory is discussed in *Part II*.
- The most significant improvement **strategies** are listed in the table below. More detailed descriptions of the strategies are provided in *Part II*.
- Selected **effective practices and resources** are described in *Part II.*
- A hyperlink is provided for each root cause in *Part I* to its related discussion in *Part II*.
- **An acronym/definition finder** explains the shortened versions of terms that are used in the Introductory Guide and in *Part II.* In addition, terms that may be unfamiliar are defined.

Acronym/Definition Finder	
Acronym/Word	**Meaning**
AAUW	American Association of University Women
AP	Advanced Placement
Aspiration	Individuals aspire to careers based upon their perceptions of their competence at career-related tasks.
Attribution Theory	This complex social cognitive theory, originated with Julian Rotter and Fritz Heifer and extended through the work of Wiener, maintains that to what we attribute our achievements and failures affects our motivation (AWE, 2005).
CTE	Career and Technical Education
Fixed Traits	Fixed traits refer to the belief that an attribute, for example, intelligence, is determined at birth (Viadero, 2006).
IT	Information Technology
NSF	National Science Foundation
NT	Nontraditional for gender
NTO	Nontraditional occupation refers to occupations or fields of work, including careers in computer science, technology, and other emerging high-skill occupations, for which individuals from one gender comprise less than 25 percent of the individuals employed in each such occupation or field of work.
Self-efficacy	Self-efficacy measures a person's individual perception of his or her ability to achieve a certain goal; self-efficacy is greatly influenced by the social environment.
Stereotype Threat	Stereotype threat refers to being at risk of confirming, as self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995).

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EDUCATION		
Root Cause	**Theory**	**Strategies**
Academic Proficiency	When women are academically proficient, they are more likely to persist in choosing nontraditional careers.	• Teach students that ability can be enlarged and expanded. • Intervene to revise underestimation. • Provide math camps for girls. • Identify and assist students who aspire to science and engineering careers but lack academic proficiency. • Create incentives for taking AP courses. • Teach visual-spatial skills. • Use video games that appeal to girls.
Access to and Participation in Math, Science, and Technology	Participation and success in math, science, and technology courses, especially those taught in an equitable and "hands-on" manner, increase the likelihood of women participating in nontraditional careers.	• Utilize real-life teaching strategies. • Kindle and sustain interest in math. • Make math and science a requirement. • Make other programs available such as after-school or weekend programs or summer camps. • Invite, involve, and educate parents.
Curriculum	Essential elements of a bias-free curriculum include: relevancy, inclusive images and text, and hands-on instructional practice.	• Foster interest and curiosity, as well as skill, in math and science. • Provide comprehensive professional development. • Stress professional development self-assessment. • Utilize intervention programs for information technology (IT) in formal education. • Correct bias in curricular and professional materials.
Instructional Strategies	Females prefer learning experiences that they help to design, that are learner centered, and that involve them in a community.	• Provide comprehensive pre-service and in-service professional development relating to gender issues. • Stress professional development self-assessment. • Utilize intervention programs for IT in formal education. • Incorporate student experiences in the instructional process. • Utilize either virtual or hands-on science activities.

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EDUCATION

Root Cause	Theory	Strategies
School/Classroom Climate	Students who experience a school climate supportive of NTOs and gender equity are more likely to participate in NTOs.	• Facilitate informal support groups. • Enforce civil rights and sexual harassment policies and practices. • Address climate issues. • Practice inclusive hiring processes. • Heed recommendations. • Strengthen support systems and eliminate barriers. • Schedule students in nontraditional programs in cohorts whenever possible. • Support nontraditional student clubs and after-school activities.
Support Services	Students enrolled in nontraditional career and technical education programs who receive support services are more likely to succeed.	Provide tutoring, child care, transportation, and tuition assistance.

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CAREER INFORMATION		
Root Cause	**Theory**	**Strategies**
Materials and Practices: Assessment, Interest Inventories, and Marketing and Recruitment	Career guidance materials and practices that adhere to equitable standards can increase participation in classes that lead to nontraditional careers. Traditional awareness-raising recruitment methods such as brochures, talks, or demonstrations alone are helpful, but insufficient to impact career decisionmaking.	• Educate career counselors about the changing composition of the workforce. • Provide greater intensity of recruitment intervention. • Feature both genders in work and accomplishments. • Practice effective career guidance. • Provide more career guidance for boys. • Provide information about high-wage, high-skill jobs for women. • Make societal benefits known.
Early Intervention	Providing information about nontraditional careers at the ages at which young people are most open to considering a nontraditional career and prior to their excluding essential preparation will increase participation in nontraditional careers.	• Conduct interventions for elementary and middle school students. • Target elementary and middle school students, especially for math interventions. • Intervene early in youth's development.
Characteristics of an Occupation: Job Satisfaction/Career-Family Balance/ Occupational Perception/Wage Potential	Careers that give back to the community, directly or indirectly, can attract both men and women to nontraditional fields. Providing comprehensive information about high-wage, high-skill occupations, especially STEM, promotes participation in NTO.	• Provide information about workplace policies and practices that support both long- and short-term flexibility. • Provide comprehensive employment counseling that is sensitive to the unique needs of women. • Teach negotiation skills. • Educate both genders about work/life balance. • Provide counseling to assist men in clarifying values. • Assist students in realistically assessing desired work/life balances. • Increase occupational choices for women. • Review relevant findings—provide on-site childcare, encourage flexible work schedules, set an example. • Teach money skills to all. • Provide information about high-wage, high-skill jobs for women.

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FAMILY		
Root Cause	**Theory**	**Strategies**
Family Characteristics	Characteristics and engagement of family of origin have a strong influence on career choice.	• Design activities to promote family roles in gender-neutral career guidance. • Invite, involve, and educate parents. • Involve parents in developing a career plan. • Engage Mexican American boys by providing activities they may not have been socialized to participate in.

INTERNAL/INDIVIDUAL		
Root Cause	**Theory**	**Strategies**
Self-Efficacy	The strength of a female's self-efficacy is directly related to entry and persistence in an NTO.	• Utilize real-life teaching strategies. • Teach females to self-affirm. • Teach that intelligence is incremental. • Provide training about self-efficacy.
Attribution	Both attribution and fixed traits can affect motivation and confidence to achieve in nontraditional careers.	• Assess and retrain attribution style.
Stereotype Threat	Achievement is positively influenced by the reduction in stereotype threat.	• Provide professional development on supportive learning environments. • Address the limited development of expressive traits in boys and instrumental traits in girls.

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SOCIETAL ISSUES		
Root Cause	Theory	Strategies
Media (negative)	The constant and often gender stereotypical exposure of electronic media solidifies gender stereotyping.	• Teach critical thinking about the way in which the media portray CTE and nontraditional careers. • Emphasize the role of education.
Media (positive)	National media portrayal of individuals performing the job duties of a nontraditional career in a positive light increases participation of the NT gender in that career.	• Provide positive nontraditional role models through established media. • Emphasize the role of education. • Provide programs that build positive body image.
Peers	The opinions of peers, especially during adolescence, can influence nontraditional career choice.	• Involve men in IT intervention efforts for women. • Involve like-minded peers in programs. • Facilitate information support groups.
Role Models/ Mentoring	A mentoring relationship with an NT role model, especially one who blends career and non-career activities well, is a significant factor in a student's decision to pursue a nontraditional career.	• Provide training and support for mentors and mentees. • Ensure positive role models. • Showcase role models with good work/life balance. • Choose the mentoring format that fits the educational setting. • Provide positive, attainable role models. • Conduct nontraditional student support groups and peer counseling. • Strengthen support systems and eliminate barriers.
Collaboration	Collaboration between educational entities and community-based organizations or business impacts the pipeline for nontraditional careers.	• Factors for quality collaborations: leadership, communication, community development, and sustainability.

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Nontraditional Career Preparation: Root Causes & Strategies Part II

The Carl D. Perkins Career and Technical Education Act of 2006 provides continued emphasis on enrollment and completion of career and technical education courses (CTE) leading to careers that are nontraditional for gender.* Because of the numerous advantages of nontraditional careers to individuals, to businesses, and to the economy, many educational entities provide activities and practices to encourage recruitment and retention of learners studying for nontraditional careers. This document can assist those organizations and individuals who seek to make a most effective improvement of services through an overview of pertinent research.

Improving Performance on Perkins III Core Indicators pioneered a search for research-based reasons to enact or discontinue practices and strategies in CTE programs, and it provided a direct route for practitioners to apply research findings. Numerous career and technical educators, through workshop direction and in an independent effort to enhance services to students pursuing careers that are nontraditional for gender, utilized this valuable information through a 5-STEP Process to create programs and policies designed to improve access, participation, and completion of education that leads to nontraditional careers.

Since the publication of *Improving Performance on Perkins III Core Indicators* in 2003, numerous investigations have deepened the field of research on the topic of root causes and effective strategies for encouraging participation and completion of CTE courses that lead to careers that are nontraditional for gender. This document, *Nontraditional Career Preparation: Root Causes & Strategies,* updates the Perkins III document, and extends the scope to include a few examples of the many effective programs that have applied research-based practices.

This document is a literature review organized into research theories, evidence, recommendations and strategies, and effective practice and resources based upon root causes; it is designed to be used by CTE professionals at secondary and postsecondary institutions. This information is most effectively utilized when embedded in a program improvement process that involves self-study. Two examples of program improvement processes are the 5-Step Process and the New Look Process. Both of these processes provide support for CTE professionals as they review services at their educational entity, analyze gaps, study the research in this document, and create the activities that will be most effective in impacting the nontraditional Perkins Core Indicators. Engaging in a program improvement process ensures that gaps in performance will be identified and linked to the research, thus aligning the utilization of funds and efforts as closely as possible to activities that will promote achievement.

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No one factor, activity, or influence affects the many decisions that we make as we choose our careers. In fact, the adage "It takes a village to raise a child" could be adapted to state that "It takes a diverse team to build the pipeline for nontraditional careers." This "NTO pipeline team" is envisioned by this document to consist of educational administrators, instructors, counselors, business leaders, family members, students, and professionals in social service and workforce development organizations. The root causes, strategies, and models offered here are organized into five overlapping and linked groupings based upon that individual or group that may have the most direct influence to affect change for a particular root cause. For example, instructors and administrators will have the most influence over the root causes in the Education section; parents will be most directly involved in the Family section. The "NTO pipeline team" should be diverse, varied, and most importantly, collaborative.

Improving Performance on Perkins III Core Indicators sought to group root causes and improvement strategies into those that supported participation and those that encouraged completion. The review of the literature here, however, has found those root causes and improvement strategies to be so overlapping that the distinctions are blurred. For example, a strategy that is effective at retaining nontraditional students also adds greatly to the recruitment capacity of the educational entity. However, when a particular strategy is deemed more highly effective at improving participation or completion, it is so noted.

Numerous literature reviews have addressed similar issues with different foci. For example, the Assessing Women in Engineering Project has provided literature reviews of topics similar to those listed below, but with investigation into what causes women to enter and persist in the field of engineering. Another comprehensive and current compilation of reviews is available in *Achieving Gender Equity through Education,* edited by Susan Klein. The "What the Literature Says" sections are not designed as comprehensive literature reviews, but rather as snapshots of the most cogent reasons for the barriers preventing individuals from participation or completion of education leading to nontraditional careers.

The resources listed for each root cause are recommended as effective but do not carry the same research base as the root cause theories and strategy recommendations. The main difficulty is that insufficient longitudinal and coordinated studies have been done. Where the data collection and analysis is sufficient, the project is often closed. For these reasons the emphasis is upon promising active projects so that readers who seek to apply these principles might contact current implementers of these solutions.

This document is created with the intent that its optimum use will result in greater, more-coordinated efforts that are carefully crafted by teams of concerned and committed individuals. It is offered in the hope that these teams will provide thorough, integrated services that will achieve greater career equity. *Under the Microscope,* the AAUW Educational Foundation's 2004 study of a decade of National Science Foundation and AAUW projects, poses this question, "How can we move beyond the model of isolated one-time efforts and create a network of strategic approaches to achieving gender equity in STEM?" The utilization of *Nontraditional Career Preparation: Root Causes & Strategies* is a step in that direction.

*Nontraditional refers to occupations or fields of work, including careers in computer science, technology, and other emerging high-skill occupations, for which individuals from one gender comprise less than 25 percent of the individuals employed in each such occupation or field of work.

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Education

The root causes, strategies, and models in this section are ones for which educational professionals, especially instructors and administrators, have the most direct impact and concern. The topics in this section include the following:

- Academic Proficiency
- Access to and Participation in Math, Science, and Technology
- Curriculum
- Instructional Strategies
- Classroom and School Climate
- Support Services

Root Cause: Academic Proficiency

Back to Part I

What the literature says: theory
When women are academically proficient, they are more likely to persist in choosing nontraditional careers. Stereotype threat and lack of training in visual/spatial skills may erect barriers to achievement.

What the literature says: evidence
Academic proficiency was found to be the most predictive of educational factors for female NTO career choice persistence, and **math self-efficacy** (a self-perception of math ability) was the most predictive of personal factors (Mau, 2003). A survey of 1000 IT professionals indicated that "their own skills and abilities" motivated them to enter and persist in the IT field (Girl Scouts, 2008, p.4). Although gender-based differences in math course-taking and skills achievement are few, academic proficiency, especially in math and science courses, is still an issue that demands our attention because mathematics-related careers and career aspirations do have many gender-based discrepancies (Lacampagne et al., 2007 in Klein, 2007). A survey of over 1500 college, high school, and middle school students indicated that test anxiety and subject difficulty were the top perceived barriers for women in science, technology, engineering, and math (STEM) careers (Fouad et al., 2007).

Not as predictive for men An updating of Lemkau's (1984) study of men in atypical occupations by Lease, however, found that "perceived academic ability" did not predict atypical career choice and that higher academic ability actually predicted gender traditional occupations for men (Lease, 2003, p. 51).

Stereotype threat refers to being at risk of confirming, as self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995). This fear can sometimes affect performance and appears to be a very real part of the test anxiety and subject difficulty mentioned above. For example, when stereotype threat was high on an engineering skills test, women performed worse than men. When stereotype threat was not present, women performed as well as men (Bell et al., 2003). Also, if men and women

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with the same preparation for a math test are told that men generally do better on the test, men will outperform women (Spencer et al., 1999). It also appears that actual gender differences on spatial ability tests may be "related to stereotype threat" (AWE, 2005). There is some evidence, however, that boys outperform girls on many tests of spatial skills, especially ones that require visualizing what an object will look like when it is rotated in space (Halpern et al., 2007).

Recommendations and strategies

Teach students that ability can be enlarged and expanded. This recommendation, with a "moderate" research endorsement from the National Center for Educational Research, tells students that working hard and exercising their minds will help them improve (Halpern et al., 2007).

Intervene to revise underestimation. Develop methods and interventions to target girls' and women's underestimation of their abilities in math and physical science (Frome et al., 2006).

Provide math camps for girls. Math camps that include drawing, manipulative models, and cooperative group work have been found to increase confidence, which can later be applied in the classroom (Frost & Wiest, 2007).

Incentivize AP courses. One Midwestern high school added weighted grades for AP courses and saw a steady increase in female enrollment in such courses (Denith, 2008).

Teach visual/spatial skills. Women's test scores after visual/spatial skills education improve in greater proportion than those of their male peers (Baartmans & Sorby, 1996). Opportunities for learning and practice of visual/spatial skills in an encouraging environment impact educational success (AWE, 2005). Targeted training can serve to improve spatial skills performance beginning in early childhood and continuing into adulthood (Halpern et al., 2007).

Develop video games that appeal to girls. Video game playing not only builds specific cognitive and motor skills, but also it encourages spatial and problem-solving skills (Denner et al., 2005).

Circumstances in which researchers found **stereotype threat to have little effect** included small educational institutions where personal attention of instructors is expected, women are no longer in the minority, a female role model was present during testing, tests were conducted in same-sex groups of three, and students have read about female role models (Rivardo et al., 2008).

Effective practices and resources

Tech REACH strives to increase middle school students' interest in STEM through hands-on, high-quality curriculum, mentoring, and teacher professional development.

Teaching Spatial Reasoning to Improve Retention of Women in Technology, a webinar presented by Sheryl A. Sorby, Ph.D., the author of "Introduction to 3D Spatial Visualization: An Active Approach" and professor in the Civil and Environmental Engineering Department at Michigan Technological University

Math Camps This resource page on the STEM Equity Pipeline website has links to many math and science camps for girls.

Reducingstereotypethreat.org This website offers summaries of research on stereotype threat, including some research-based suggestions for reducing the negative consequences of stereotyping, particularly in academic settings.

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What the literature says: theory

Participation and success in math, science, and technology courses, especially those taught in an equitable and "hands-on" manner, increase the likelihood of women participating in nontraditional careers.

What the literature says: evidence

Timing It is essential that girls and women persist and achieve in math, science, and technology careers, because young women are increasingly attracted to a wider, more diverse range of jobs as they get older. However, by the time young women start to fully consider a wide range of jobs as attractive options, critical decisions about qualifications will already have been made, restricting the actual options available to them (Miller & Hayward, 2006).

Methods One study found that a one-unit increase in calculus in high school doubled the odds that women would later choose a science or math major (AAUW, 2007). However, some methods of teaching mathematics, ones that do not allow a "connected, relational understanding," disenfranchise or exclude women, students of color, and students of low socioeconomic status from equitable learning opportunities (Boaler, 2002, p. 135). Women's desire for conceptual and connected understanding is thwarted by traditional mathematics teaching methods (Hart et al., 2007).

Math interest Linver et al. found that, although young women achieve at a rate comparable to young men, young women's interest in math courses remains flat. "For young men in higher-level math tracks, math interest is much more strongly related to math school grades than for young women in the same math courses" (2002, p. 9). Both girls and boys have made impressive achievement gains between 1990 and 2000 on the National Assessment of Educational Progress (2001). Nearly half of the mathematics bachelor's degrees are awarded to women. However, the number of women working as mathematicians is low (AAUW Educational Foundation, 2004), and less than 5 percent of full mathematics professors in the top 50 science and engineering departments are women (Nelson & Rogers, 2004). Women earned less than 27 percent of bachelor's degrees in computer science in 1998., but there was no difference in technology use between men and women. "We can but we don't want to" seems to be the philosophy (AAUW Educational Foundation, 2004). Women's attainment of bachelor's degrees in computer science has declined since this study was done in 1998 to less than 25% in 2004 (NSF, 2004)

Recommendations and strategies

Kindle and sustain interest in math. Kindling and sustaining interest in math, science, and technology fields seems to be as important as achievement. Intervene early to make math more interesting and relevant. "Interventions need to be designed that focus not on the academic achievement of women but in how to make math- and science-related occupation[s] more interesting for young, high achieving [sic] women" (Linver et al., 2002, p. 9).

Make mathematics and science a requirement. Requiring mathematics and science rather than offering them as electives can increase participation in STEM fields (Society of Women Engineers, 2007). Pre-college programs incorporating hands-on activities, role models, internships, and field trips tend to increase self-confidence and interest in STEM courses and careers (AAUW Foundation, 2004).

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Make other programs available. Participation in intervention programs such as after-school, weekend programs, or summer camps that provide more conceptual and connected instructional strategies often results in increased levels of comfort with mathematics, resulting in an improvement in confidence, motivation, engagement, and achievement (Thompson et al., 2004). Young women who participated in a two-week Camp Reach engineering program were more likely to enroll in elective math and science courses (Hubelbank et al., 2007).

Invite, involve, and educate parents. Emphasize the important role that parents play in influencing their children's career decisions (Jacobs et al., 2006). A survey of more than 1500 college, high school, and middle school students indicated that parental expectations to take more classes and choose a STEM career were the top perceived supports for women in STEM careers (Fouad et al., 2007). Seventy-eight percent of high school students in a Ferris State University study reported their parents to be the most influential adults in their career decisionmaking process (Ferris State University, 2002).

Effective practices and resources

Mathematics Mentors for Rural Girls served a rural community with few female professional role models by offering a camp with female mathematics and science professionals who served as mentors. **Multidisciplinary Skill-based Summer Program and Math Computer Tutors** offered to high school girls a residential summer project that was skill-oriented and multidisciplinary and assisted advocates in ensuring that women and girls were prepared to make a STEM occupational choice (AAUW Educational Foundation, 2004). Summaries are available for numerous other similar projects (New Formulas for America's Workforce 2, 2006).

Since 1987, Chicago Women in Trades has provided pre-apprenticeship training through its **Technical Opportunities Program,** which has trained more than 1200 women. Approximately 600 of them have entered into trades apprenticeships or nontraditional careers (Mastracci, 2004).

Root Cause: Curriculum

Back to Part I

What the literature says: theory

The way in which curriculum is organized, sequenced, and prioritized may carry gender bias and prevent participation or completion of coursework leading to nontraditional careers. Essential elements of a bias-free curriculum include: relevancy, gender-inclusive images and text, and hands-on instructional practice.

What the literature says: evidence

Preparation in early grades followed by a high school curriculum of high academic rigor is crucial to ensuring equal opportunity in the sciences at the college level and beyond (AAUW, 2004). A lack of participation in STEM courses has been attributed to bias toward males in curricula (Sanders et al., 1997). **A bias-free re-conceptualization of courses leading to nontraditional careers is necessary.** Girls Math Camp participants reported improved confidence when geometry lessons included drawing and manipulative models (Frost & Wiest, 2007). Respondents to a survey of 1000 female IT professionals named a **relevant** curriculum as one of four factors contributing to their entrance and persistence in an IT career (Girl Scouts, 2008). Curricular materials need to be relevant to a student's prior experience (Zuga, 1999).

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Recommendations and strategies

Provide comprehensive professional development. Teachers who receive rich and sustained professional development, and professional development that is geared toward higher-order thinking skills and concrete activities, are more likely to engage in effective classroom practices (Wenglinsky, 2000).

Stress professional development self-assessment. Train teachers on how to assess integrated practice (AAUW Educational Foundation, 2004).

Utilize intervention programs for IT in formal education. A study at The Ohio State University found that school experiences, such as taking computer courses and having encouraging teachers, impacted successful women in IT and indicated that formal schooling is a good place for intervention (Turner et al., 2002).

Foster interest, as well as skill, in math and science. The National Center for Educational Research recommends a classroom environment that encourages curiosity and embeds efforts to sustain interest and relevance in math and science (Halpern et al., 2007).

Correct bias in curricular and professional materials. Adopting a framework for assessing curricular bias provides learning for teachers and students of all educational levels (Zittleman & Sadker, 2002/2003).

Effective practices and resources

An Assessing Bias in Materials Appendix is found in the **New Look Self-Study**.

Alice is software that teaches introductory computer science by allowing the user to actively construct new knowledge. It has been shown to improve persistence and skill in college freshmen (Moskal et al., 2004) and to increase retention for high-risk students (those with little to no programming experience. Learning about computer programming through ALICE is an example of an experience that can change the perception of a career that is nontraditional for women.

Rosie's Girls from Vermont Works for Women and the **Technical Opportunities Program** from Chicago Women in Trades provide pre-technical training that includes spatial awareness.

Root Cause: Instructional Strategies

Back to Part I

What the literature says: theory

Some research indicates that there are instructional methods, learning styles, and interests that can be characterized as distinctly female (Weber & Custer, 2005). As evidenced below, women prefer learning experiences that they help to design, that are learner centered, and that involve them in a community.

What the literature says: evidence

Designing learning experiences Women's preference for designing learning experiences and men's preference for utilizing learning experiences are found to be consistent with gender stereotype research. This is particularly true when the design activities include a focus on problem-solving (Weber & Custer, 2005).

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Collaboration and community A Society of Women Engineers review of research studies that involved the recruitment and retention of women engineers found that the key to attracting more women and minorities into engineering is to make teaching more learner centered. Data indicate that women and minority students prefer environments where they feel as though there is a community, especially one in which they feel involved (Society of Women Engineers, 2007). One project sought to retain first-year female undergraduates by giving them access to collaborative laboratory research work. The result was that the retention rate was nearly double that of a control group (AAUW Educational Foundation, 2004).

Practical applications Providing relevant and practical hands-on experience with STEM helps to boost girls' and women's interest in STEM (Goldberg Dey & Hill, 2007). A study of 804 undergraduate engineering students found that both men and women prefer that the course emphasize practical application rather than theory (Bagilhole et al., 2006 as referenced in Allison & Cossette, 2007).

Recommendations and strategies

Provide comprehensive professional development. Teachers who receive rich and sustained professional development, and professional development that is geared toward higher-order thinking skills and concrete activities, are more likely to engage in effective classroom practices (Wenglinsky, 2000). An application of comprehensive professional development was found in **The Dallas Gender Equity Project** that incorporated full-day workshops, mini-assignments, half-day follow-up workshops and resulted in dramatic increases in AP physics enrollments (Sanders & Nelson, 2004).

Stress professional development self-assessment. Train teachers on how to assess integrated practice (AAUW Educational Foundation, 2004).

Utilize intervention programs for IT in formal education. A study by The Ohio State University found that school experiences, such as taking computer courses and having encouraging teachers, impacted successful women in IT and indicated that formal schooling is a good place for intervention (Turner et al., 2002).

Foster interest, as well as skill, in math and science. The National Center for Educational Research recommends a classroom environment that encourages curiosity and embeds efforts to sustain interest and relevance in math and science (Halpern et al., 2007). One technique for nurturing science interest and identity is to **c**reate "hybrid" space in the science classroom. A hybrid space is one that incorporates the experience of the student so that the science classroom is no longer "another world." Not only does this increase female students' interest in science, but also it impacts the way teachers then teach other students (Barton et al., 2008).

Effective practices and resources

The **Intergenerational Mentoring for Science Faculty Project** consisted of a course, a faculty institute, a freshman seminar, scholarship, and intergenerational mentoring as well as small grants for faculty or secondary teachers for course and project development. A higher retention rate for females resulted (AAUW Educational Foundation, 2004).

The **Generating Expectations for Student Achievement** model incorporates data-based classroom observation and administrative involvement to achieve whole-school equity.

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The **National Alliance for Partnerships in Equity/Women Work! Professional Development Institute** (Spring, annual, Washington, DC) combines networking, equity resources, expert speakers, and advocacy training to create a uniquely effective and powerful conference.

The **STEM Equity Pipeline Project** provides resources for professional development, including online links to equity resources on the web, the 5-Step Process, state-level Train-the-Trainer, and monthly webinars on equity topics.

Root Cause: School/Classroom Climate

Back to Part I

What the literature says: theory

Students who experience a school climate that is supportive of nontraditional occupations and gender equity are more likely to participate in nontraditional occupations.

What the literature says: evidence

School climate barriers School-based barriers such as biased counseling, the provision of incomplete information to students on the consequences of their career training choices, or the sexual harassment of students who enroll in nontraditional classes lead to students opting for traditional careers and against nontraditional careers. Eighty-seven percent of female CTE students and 85 percent of male CTE students select the traditional choice (NWLC, 2007). A person's immersion in a culture that strongly prescribes gender roles has a lasting impact. Curran and Renzetti (2003) found that the lack of representation of girls in nontraditional courses could not be attributed to less interest or participation, but to problematic treatment by teachers based on gender, sexual harassment, and retaliation by peers.

School and classroom positive influence A survey of more than 900 high school and middle school students indicated that teacher expectations of success were the top perceived supports for women in STEM careers (Fouad et al., 2007). Respondents to a survey of 1000 female IT professionals named access to a computer at school as one of the most common IT-related experiences (Girl Scouts, 2008).

Recommendations and strategies

Enforce civil rights and sexual harassment policies and practices. In the words of the U.S. Government Accountability Office, "without making use of all compliance activities available, agencies lack a complete picture of federal grantee efforts to address occurrences of sex discrimination" (GAO, 2004, p. 28).

Address climate issues. Periodic surveys of "faculty concerns to develop information about factors such as inclusive social atmosphere or sexist attitudes…raise awareness of the … [educational entity] to attitudes and practices that may make it uncomfortable for women at the institution" (GAO, 2004, p. 27).

Practice inclusive hiring processes. An inclusive process includes wide dissemination of job openings, representation of women and minorities on search committees, and the requirement that members of underrepresented groups be in a pool of candidates (GAO, 2004).

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Heed recommendations. According to the **Assessing Women in Engineering Project (2005),** faculty should

- Be accessible and provide positive face-to-face interaction.
- Be a steward of the climate and culture of the classroom.
- Reward gender equity initiatives and achievement.

Administrators should

- Make childcare available and affordable on campus.
- Facilitate "re-entry" for students who are changing careers.
- Ensure adequate financial assistance to students from diverse family backgrounds.
- Provide accurate and realistic information about how long degree completion normally takes.

Facilitate informal support groups. Women need continued support and encouragement to stay in the science and engineering pipeline. Support groups may be "helpful in addressing the problems of young women who are enrolled in courses leading to nontraditional careers" (Mau, 2003, p. 241).

Support groups When nontraditional participants enroll individually, they are less likely to integrate effectively into the social structure, more likely to suffer decreased performance, and more likely to drop out. Change is carried in cohorts, not in single individuals (Ingle, 2000).

Conduct nontraditional student support groups and peer counseling. A group of studies found the following retention strategies to be effective: (1) access to nontraditional student clubs and team support systems and (2) participation in math clubs, competitions, and after-school programs (Foster & Simonds, 1995; Silverman, 1999; Gavin, 2000).

Effective practices and resources

New Look Online is a programmatic self-study for entities concerned with services for students pursuing nontraditional careers; one aspect collects data about computer lab staffing and use, while another surveys instructors, administrators, and counselors for gender fairness (ICCB & ISBE, 2007).

Multicultural lessons that focus on social problems such as racism or sexism help to increase educational equity in our schools. The teaching of catchphrases to interrupt gender bullying produced far greater effects on students' gender attitudes (Moss, 2007). The **Gender Doesn't Limit You Curriculum** is available from Teaching Tolerance.

Destination Success provides the **Checking Your School for Sexism** checklist, among others, for a self-study method of evaluating school climate. A more extensive **Gender Equity Item Bank** is available from the Midwest Equity Assistance Center. Two resources that can assist in civil rights self-study are ***Tools of the Trade*** from the National Women's Law Center and the ***Civil Rights Self-Assessment: A Tool for the Illinois Educational Community and Illinois Community Colleges*** from the Illinois Center for Specialized Professional Support.

Project Implicit from Harvard University blends basic research and educational outreach in a virtual laboratory that enables visitors to examine their own hidden biases. Project Implicit is the product of research by three scientists whose work produced a new approach to the understanding of attitudes, biases, and stereotypes.

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Root Cause: Support Services

Back to Part I

What the literature says: theory

Students enrolled in nontraditional career and technical education programs who receive support services are more likely to succeed.

What the literature says: evidence

Support services Nontraditional employment programs that offer tutoring, mentoring, support groups, child care, and transportation report greater success rates with students who access these support services than with students in programs that do not provide these services (Montclair State University, 1997).

Recommendations and strategies

Conduct nontraditional student support groups and peer counseling. A group of studies found the following retention strategies to be effective: (1) access to nontraditional student clubs and team support systems and (2) participation in math clubs, competitions, and after-school programs (Foster & Simonds, 1995; Silverman, 1999; Gavin, 2000).

Provide orientation programs, especially for older students. Orientation programs should include information about course expectations and the amount of out-of-class time and personal energy required for satisfactory completion. These programs should be tailored to the life situation of the audience and should be offered prior to and in the initial stressful stages of enrollment and semester beginning (Carney-Crompton & Tan, 2002).

Facilitate informal support groups. Women need continued support and encouragement to stay in the science and engineering pipeline. Support groups may be "helpful in addressing the problems of young women" who are enrolled in courses leading to nontraditional careers" (Mau, 2003, p. 241).

Support groups When nontraditional participants enroll individually, they are less likely to integrate effectively into the social structure, more likely to suffer decreased performance, and more likely to drop out. Change is carried in cohorts, not in single individuals (Ingle, 2000).

Effective practices and resources

The Boston Museum of Science's **Computer Clubhouse** provides a creative and safe after-school learning environment where young people from under-served communities work with adult mentors to explore their own ideas, develop skills, and build confidence in themselves through the use of technology

Men in Childcare provides supportive services for men teaching young children.

The **Assembly for Men in Nursing** provides a framework for nurses to meet, discuss, and influence factors that affect men as nurses.

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Career Information

The root causes, strategies, and models in this section are ones about which career guidance professionals have the most direct impact and concern. The topics in this section include the following:

- Materials and Practices, including
  - Assessment
  - Interest Inventories
  - Recruitment and Marketing Materials
- Early Intervention
- Occupational Characteristics, including
  - Job Satisfaction
  - Career-Family Balance
  - Occupational Perceptions and Choice
  - Wage Potential

Root Cause: Materials and Practices, including Assessment, Interest Inventories, and Recruitment and Marketing Materials

Back to Part I

What the literature says: theory

Traditional awareness-raising recruitment methods such as brochures, talks, or demonstrations alone are insufficient to impact career decision making.

Career information materials and practices that adhere to equitable standards can increase participation in classes that lead to nontraditional careers.

What the literature says: evidence

Intensity of awareness-raising and interest in the field Many of the traditional methods used to arouse a student's interest in a STEM career, such as brochures and other print materials, field trips, talks, demonstrations, etc., are neither pivotal nor sufficient to prompt women to explore STEM fields. For men, **interest** precedes self-confidence, but for women, self-confidence and efficacy in the field precede interest (Allison & Cossette, 2007). In a study in which this gender-based difference was applied to computing, Zarrett and Malanchuk found that women's career decisions are more impacted than men's by **attitudes** towards computers. These attitudes included both negative (geekiness and social isolation) and positive (IT solves problems and helps the world) schemas (Zarrett & Malanchuk, 2005). Sanders (2005) reinforced this concept by stating that "a female's loss of confidence in her computer abilities precedes a drop in her interest in computers" (p.10).

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Career guidance practice A Ferris State University study provided a summary statement of the career guidance situation for students in its title: Decisions without Direction (Ferris State University, 2004). This lack of direction might add to the selection of traditional gender-based careers. In fact, in one study of over 800 Californian high school students, the vast majority could not describe what computer science majors study (Carter, 2006). In addition, the findings of a study by Women at Work point to the necessity of career guidance personnel promoting the benefits of high-wage, high-skill occupations (AAUW, 2004). Schools have been successful in reducing dropout rates when they offer career education programs and make the link between academic work, college success, and careers (NWLC, 2007). However, the use of established career assessment inventories can place needed emphasis on similarities in skill sets for a particular occupation (Swan, 2005).

Women's career "ways of knowing" Theories of career development are changing as the workforce changes. Today's career counseling practice originated when the audience for career counseling was mostly male, white, and young (Cook et al., 2002). A number of theories have evolved that are seemingly more responsive to "women's ways of knowing" (Gilligan, 1982), but these theories are not empirically tested and none seem to capture the full explanation of career development for women (AWE, 2005). Turner et al. found that the paths of women to IT careers formed a roadway with many on ramps and that "interest and talent in IT emerged gradually and developed over time" (2002, p. 16).

Assessments and interest inventories Some assessments and interest inventories analyze a male's career interest more accurately than a female's, and may rely too heavily on supposed aptitude. Holland's Vocational Identity Scale and Super's Salience Inventory, versions of which have been incorporated into online career counseling websites, were, in large part, created for and tested on males (Allison & Cossette, 2007). "Screening by supposed aptitude is exclusionary and may therefore not be the best approach for increasing recruitment into STEM fields" (Allison & Cossette, 2007, p. 5).

Career guidance for men Studies of men in nontraditional careers reinforce the need for career guidance practices to encourage men to pursue nontraditional careers (Dodson & Borders, 2006).

Recommendations and strategies

Provide greater intensity of recruitment intervention. Interventions such as special programs, courses, and camps were found to increase interest in the activities offered (Phillips et al., 2002).

Practice effective career guidance. Dodson and Borders encourage career guidance practices that

- Indicate how gender role socialization can shape interest and constrict choices.
- Communicate the possible stress of high-status male traditional careers.
- Provide a realistic picture of actual on-the-job activities.
- Stress the influence of job security of some nontraditional careers, especially for males from lower socioeconomic backgrounds (Dodson and Borders, 2006).

Provide more career guidance for boys. Miller and Hayward's survey of adolescents' occupational preferences indicated that for girls there is a clear link between knowledge of what the job entails and a liking for the job. For boys at any age, there was no relationship between knowledge and liking for a job. This suggests that identifying ways to provide boys with more career information should be one priority (Miller & Hayward, 2006).

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Provide information about high-wage, high-skill jobs for females. According to another study by Miller and Hayward (2006), girls prefer jobs that they believe should be performed by females. However, they will consider traditionally male jobs because of their higher status and pay. Career advisers should provide information on the range of jobs available to students at an early age.

Educate career counselors about changing the landscape of the workforce. Counselors, coordinators, and administrators need to understand that women's internal, professional, and family needs are all interwoven and affect each other (AWE, 2005).

Make societal benefits known. Providing information about the societal benefits of nontraditional careers helps to boost girls' and women's interest in STEM (AAUW, 2007).

Effective practices and resources

At the **University of Texas Health Sciences Center** in the Houston School of Nursing, male enrollment has increased 23 percent since the university adopted many of the marketing recommendations of a male focus group. Marketing activities included changing the language of recruitment materials from flowery and fluffy to factual and objective, increasing the emphasis on the traditionally masculine aspects of nursing such as trauma and emergency care, advertising in the sports section of the newspaper, and providing more male role models (Meyers, 2003).

Acting on the advice of middle school guidance counselors, the **Oregon Center for Nursing** produced "Are You Man Enough to Be a Nurse?" that features male nurses carrying out "masculine" hobbies and duties. Other sites can, for a fee, utilize the images and imprint their organizational names and logos, thus creating recruitment materials that have been tested by focus groups.

The Safe Schools Coalition's poster, **Guidelines for Identifying Bias in Curriculum and Materials**, provides guidelines and examples for avoiding stereotypical language and representation in curriculum and materials.

A checklist from Multistate Academic Vocational Curriculum Consortium's (MAVCC's) Destination Success, **Am I a Fair Counselor?**, provides self-study information on counseling practices in a local educational entity.

The New Jersey Nontraditional Career Resource Center at Rutgers University produced **Could This Be Your Life?,** a career "game" that incorporates a career interest inventory, planning for family needs, self-sufficiency data, and information about nontraditional careers to assist young people in realistic career planning for thriving in New Jersey. An Illinois version is also available.

The **Guide to Gender Fair Counseling** was developed by the National Science Foundation Counseling for Gender Equity Project. Counselors are urged to keep the following in mind when providing guidance for course selection:

- Grades 1-4: Girls this age are testing their independence and are curious about the world.
- Grades 5-8: Immediately before and during middle school, girls' self-esteem and self-confidence take a nosedive.
- Grades 9-12: More girls than ever are completing advanced placement and upper-level courses in chemistry, biology, and mathematics. The disciplines that still do not draw girls are physics and computer science.

I Am an Engineer, from Cisco Learning Institute's Gender Initiative, is a video of diverse females in computer engineering that aims to recruit more women into computer engineering.
Engineer Your Life is an online recruitment tool that utilizes real-life role models.

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Root Cause: Early Intervention

Back to Part I

What the literature says: theory

Providing information about nontraditional careers at the ages at which young people are most open to considering a nontraditional career and prior to their excluding essential preparation will increase participation in nontraditional careers.

What the literature says: evidence

Timing critical The extent to which individuals sex-stereotype occupations decreases through the later stages of adolescence and adulthood, with the pattern particularly marked among females. However, "by the time young women start to fully consider a wider range of jobs as attractive options (ages 17-18), crucial decisions about qualifications will already have been made, restricting the actual options available to them" (Miller & Hayward, 2006, p. 89).

More equitable math career distribution The discrepancy between mathematics competence and the actual representation in the scientific world appears to have its roots in childhood and early adolescence (Muzzatti & Agnoli, 2007).

Male seekers Men in nontraditional careers can be divided into three groups with regard to the way by which they arrived at their career choice: seekers, who actively chose the "female" occupation; finders, who did not actively seek a nontraditional career; and settlers, who actively chose the occupation, often as a result of being dissatisfied in a traditional occupation. The seekers are the ones who would be influenced by early intervention (Simpson, 2005).

Recommendations and strategies

Conduct interventions for middle school students. NSF's New Formulas for America's Workforce 2 (2006) projects provide programming for American girls for whom timing of their future plans can have an ill-timed conjunction with eroding self-efficacy and greater awareness of social messages, about femininity (NSF, 2006).

Target elementary and middle school students, especially for math interventions. "Intervention programs should be started early to counteract the belief that 'mathematics is a matter for boys'" (Muzzatti & Agnoli, 2007, p. 18).

Intervene early in youth's development. Interventions that address occupational factors may be vital to getting students ages 10-13 more interested in an information technology (IT) career (Zarrett & Malanchuk, 2005). This is especially true for math and science. "Interventions need to be designed that focus not on the academic achievement of women but in how to make math- and science-related occupation[s] more interesting for young high achieving [sic] women" (Linver et al., 2002).

Effective practices and resources

Aiming for Algebra, Girls Creating Games, Explanatoids, and Click! The Urban Adventure bring STEM to the attention of girls and their families. Program findings and outcomes help us understand, for example, how to maintain girls' interest in science past middle school (National Science Foundation, 2006).

Sisters in Science's year-long program for elementary school girls already interested in science significantly increased science and math achievement test scores.

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Diva Tech Day, which is offered by Minot Public Schools, Minot, North Dakota (a 2005 Programs and Practices That Work Award Winner), is a hands-on, fun-filled nontraditional workshop for girls in grades 8-11. The goal of the workshop is to introduce girls to opportunities in occupations that are traditionally considered to be for men.

Root Cause: Occupational Characteristics of an Occupation: Job Satisfaction, Career/Family Balance, Occupational Perception and Choice, Wage Potential

Back to Part I

What the literature says: theory

Nontraditional careers that give back to the community, directly or indirectly, are attractive to both men and women. Men find greater job satisfaction in some traditionally female jobs; women seek or attempt to create occupational flexibility within existing male fields.

Providing comprehensive information about high-wage, high-skill occupations promotes participation in nontraditional careers. Misperceptions and lack of information, especially for women about traditionally male fields, add to the gender-based barriers.

Women will participate in nontraditional occupations at a higher rate because many nontraditional occupations are high-wage, high-skill occupations.

What the literature says: evidence

Greater job satisfaction Male elementary school counselors reported more job satisfaction and less role conflict than male engineers in a study by Dodson and Borders (2006). Dodson and Borders found that men who choose a nontraditional career that represents upward mobility in contrast to their family of origin, have higher job satisfaction. One longitudinal study found that females in male-typed occupations are much more satisfied than those in gender-neutral occupations (Jacobs et al., 2006). Nozik (1987), as reported in Lease (2003), found that men in nontraditional occupations have less need to achieve high career status and "may value other components of their occupations" (p. 254).

Interpersonal interactions and relationships Men in nontraditional careers indicate an interest in working with people. Since many female-dominated jobs are service-oriented and focus on helping, teaching, nurturing, and healing others, men who are interested in interacting with others might find a good fit in a nontraditional career (Jome et al., 2005).

Community contribution for women Twenty-four percent of women currently looking to re-enter the workforce are seeking "jobs that allow them to contribute to their communities in some way" (Hewlett & Luce, 2005, p. 45). In a study of the motivation behind IT professionals, one study found that males are motivated to pursue computer science because they enjoy it. Females are engaged by how useful the IT field can be to themselves and to others (Margolis & Fisher, 2002).

Occupational flexibility One study found that a high desire for a family-flexible job was one of three factors that motivated women to persist toward a nontraditional career (Frome et al., 2006). However, another study that searched for factors of persistence for women in physical sciences found that young women who had male-dominated occupation aspirations in the 12th grade, who had a low desire for a job that allows flexibility, and who placed high intrinsic value on physical sciences were less likely to "leak out" of the math/science pipeline. By contrast, women who believe that occupational flexibility is important when trying to combine a career with childcare may be more likely to change their aspirations out of male-dominated occupations (Frome et al., 2006).

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Advantages for men in nontraditional careers Traditional female-concentrated careers offer three main advantages for men: job security, public-sector employment that reflects public-sector values, and “room to pursue interests and commitments outside work” (Lupton, 2006, p. 118). These advantages were especially true for working class men in nontraditional careers, perhaps most clearly reflecting their “understanding of the place of work in their life” (Lupton, 2006, p. 118). Job satisfaction is the most important factor influencing the commitment of men to nursing (Simpson, 2005).

Traditional barriers high for women Findings from Women at Work research indicate that one-third of women are still concentrated in 10 of the 500 occupations identified by the U.S. Census Bureau and “women do not appear well-positioned to access high-paying, high-quality jobs” (AAUW Educational Foundation, 2008, p. 3).

Realistic view needed Students may be opting out of a career because they have an incorrect view of the profession. In one study, 50 percent of 836 Californian high school students imagined computer scientists as spending all day in front of computers and programming (Carter, 2006). In fact, in this same study, the vast majority could not describe what computer science majors study (Carter, 2006).

More information provides opportunity Respondents to a survey of 1000 female IT professionals stated that they took advantage of opportunities in the field because they saw availability and earnings potential (Girl Scouts, 2008). They further indicated that “the intellectual challenge of the IT field” motivated them to enter and persist in that field (Girl Scouts, 2008, p 4). Assessment of wages, job satisfaction, and job quality are higher for men than for women with college degrees (Joy, 2000).

Higher paid traditionally male jobs Women may lose $434,000 in income, on average, over a lifetime due to the career wage gap. Women in all occupations suffer from this gap, but it ranges widely from one occupation to the next, with the widest gap in finance and management and the smallest gap in construction and maintenance (Arons, 2008). Men feel entitled to high pay and then adjust their self-assessment of skills to match this expectation (Society of Women Engineers, 2008). Women report salary expectations between 3 percent and 32 percent lower than those of men for the same jobs (Babcock and Laschever, 2003). Fair pay policies can be effective in improving equity for women and in improving productivity and retention as well (AAUW, 2007).

Negotiation Women are better negotiators when they have solid knowledge about what their job is worth (AAUW, 2004).

Recommendations and strategies

Educate both genders about work/life balance. Conduct interventions for young men that focus on taking equal responsibility for childcare and household responsibilities (Frome et al., 2006).

Provide counseling to assist men in clarifying values. Career counselors should be prepared to assist men in considering a greater variety of careers by (1) helping them to clarify their values and to understand how social attitudes and values about prestigious careers and related issues may influence their career choices and (2) discussing the time commitments related to parenting roles (Lease, 2003). Providing learning experiences that “promote the development of self-efficacy in people-oriented occupations” can affect men’s interest in social occupations (Jome et al., 2005, p.194).

Assist students in realistically assessing desired work-life balances. Provide information about the flexibility of the job schedule and the ability to combine certain occupations with family responsibilities (Frome et al., 2006).

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Review relevant findings. The following good practices in the workplace can be utilized to set an example of good practices in an educational entity.

- **Provide on-site child care.** This practice is recommended; a separate daycare facility for sick children is desired but often not fiscally practical (GAO, 2004).
- **Encourage flexible work schedules.** Job shadowing and part-time or flexible schedules are recommended (GAO, 2004).
- **Set an example.** Extend the tenure clock by one semester or one year when a junior faculty member has a child (GAO, 2004).

Increase the occupational choices for women. Increase the occupational choices of women by

- Promoting the benefits of education in computer science, engineering, mathematics, and technology to women and girls.
- Creating opportunities and incentives for women and girls to pursue STEM fields (AAUW, 2008).

Provide comprehensive employment counseling that is sensitive to the unique needs of women. Job search, interviewing, and negotiating workshops that provide the "skills and information [needed] to combat some of the barriers to labor-market advancement that [women] face" might aid in neutralizing "demand-side discrimination" (Joy, 2000, p. 472).

Teach negotiation Educate employers to negotiate fairly with both men and women (AAUW, 2007). Educate women on the rights and responsibilities inherent in negotiations (AAUW, 2004).

Teach money skills to all. AAUW Educational Foundation Women at Work findings recommend enhancing women's education and training in financial management and economic self-sufficiency (AAUW, 2004).

Provide information about high-wage, high-skill jobs for females. According to a study by Miller and Hayward (2006), girls prefer jobs that they believe should be performed by females. However, they will consider traditionally male jobs because of their higher status and pay. Career advisers should provide information on the range of jobs available at an early age (2006).

Effective practices and resources

Johnson & Johnson's reduced hour option has resulted in increased loyalty and productivity. New practices at Ernst & Young that included a focus on life balance, mentoring, flexible work arrangements, and networking for women resulted in a tripling of its percentage of women partners (Hewlett & Luce, 2005).

Work to enable sustainable well being in developing countries, completed by groups such as **Engineers without Borders** provides a different face of engineering to students (Malcom, 2008).

Wi$eUp is a program designed for Generation X and Y women. Its goals are to promote financial security through online education and to encourage responsible saving habits for future retirement.

The President's Advisory Council on Financial Literacy (2008) initiated a high school financial literacy exam, a middle school curriculum, and a **Financial Literacy Volunteer Corps**, which are all projects designed to improve the management and ownership of assets by understanding basic financial concepts.

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Family

The root causes, strategies, and models in this section are ones about which parents and significant others have the most direct impact and concern. Educators, however, can affect the level of awareness of family members based upon the amount of information about nontraditional careers that parents and significant others receive. The topics in this section include the following:

- Family Characteristics and Engagement

Root Cause: Family Characteristics and Engagement

Back to Part I

What the literature says: theory
Characteristics and engagement of family of origin have a strong influence on career choice.

What the literature says: evidence
Parents: a lot of influence A Ferris State University survey found that 78 percent of 809 high school students considered their parents to be the most influential adults in their career decisionmaking process (Ferris State University, 2004). A survey of more than 1500 college, high school, and middle school students indicated that parental expectations to take more classes and choose a STEM career were the top perceived supports for women in STEM careers (Fouad et al., 2007). The parents of female engineers place greater emphasis on educational achievement and on learning and have tend to have fewer stereotypes concerning gender (AWE, 2007).

Parents: more gender-stereotyping Parents' gender-typed expectations continue to be fulfilled as young people begin their adult roles and make their own career choices (Jacobs et al., 2006). Gender-differentiated parent perceptions, as well as adolescents' self-perceptions, play a large role in career decisions (Bleeker & Jacobs, 2004). In an experiment with parents and children involved in structured science teaching activities, parents' beliefs predicted the children's interest and self-efficacy in science: parents were more likely to believe that science was less interesting and more difficult for daughters than for sons (Tenenbaum & Leaper, 2003).

Mothers and fathers A survey of 1000 female IT professionals indicated that one of the most common IT-related experiences was "support and encouragement from parents." Family members, especially fathers, provided strong support to these female IT professionals and heavily influenced their career choice. Forty percent of the respondents had fathers who held work positions in STEM (Girl Scouts, 2008, p.4). A large-scale study of undergraduate women revealed that girls who chose an IT career discussed their decision predominately with their mothers (Creamer et al., 2005). Mothers' beliefs about their adolescents' abilities in math and science are shaped by gender stereotypes and are related to the development of their adolescent children's self-perceptions of math ability (Bleeker & Jacobs, 2004).

Ethnicity and socioeconomic status Dodson and Borders point out that when men choose nontraditional careers they tend to represent upward mobility in contrast to the career choices which might be expected in their family of origin (Dodson & Borders, 2006). Birenbaum and Nasser (2006) demonstrated that ethnicity and gender contribute to students' attitudes toward mathematics. Lupton (2006) suggests that working class men who have been excluded from jobs with higher status and pay, which are typically

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male-concentrated, may choose nontraditional careers. This exclusion may result from less academic ability or a less clear and supported career path than that for middle class men.

Significant others The support and encouragement of significant others was an important influence in females' persistence in pursuing a career in IT (Van Leuvan, 2004).

Mexican American men One study found that among Mexican American adolescent men the support of parents led to increased nontraditional career self-efficacy and that the fathers' role modeling was a direct predictor of boys' nontraditional career choices (Flores et al., 2006).

Recommendations and strategies

Invite, involve, and educate parents. Educate parents about the satisfaction found by females in gender-nontraditional fields, the range of occupational options that are available to their children, and the important role that their opinions and parenting play in later career decisions (Jacobs et al., 2006).

Involve parents in developing a career plan. The National Association of State Directors of Career and Technical Education Consortium considers it crucial for parents to be involved and informed about postsecondary education and employment options, and recommends that a career plan based upon Career Cluster Programs of Study be started no later than middle school (National Association of State Directors of Career Technical Education Consortium, 2008).

Design activities to promote family roles. These activities should support families in encouraging daughters to achieve educationally, in motivating for academic achievement, and in reducing stereotypes. Educational entities can design outreach activities for students from under-resourced families (AWE, 2005).

Engage Mexican American boys. Provide "activities that they may not have been socialized to participate in as boys" and help them to develop a level of mastery (Flores et al., 2006, p. 230).

Effective practices and resources

The **American Career NTO Parent Magazine** educates parents about keeping career options open for their sons and daughters and expanding their vision of what those options might be.

Project Lead the Way's **Talented Girls, Bright Futures** booklet provides an introduction to science, technology, and engineering careers for young women.

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Internal/Individual

The root causes, strategies, and models in this section are ones about which the individual is most concerned. However, educators and social workers can have an impact on the school practices that affect these psychological issues. The topics in this section include the following:

- Self-Efficacy
- Attribution and Fixed Traits
- Stereotype Threat

Note: These root causes are so circularly causal and overlapping that the definitions, theories, and evidence are offered separately, but the recommendations, strategies, effective practices, and resources are offered together at the end of this section.

Root Cause: Self-Efficacy

Back to Part I

What the literature says: theory

The strength of a female's self-efficacy is directly related to entry and persistence in NTO.

What the literature says: evidence

Self-Efficacy Self-efficacy measures a person's individual perception of his or her ability to achieve a certain goal and is greatly influenced by the social environment. When it comes to choosing a major or career choice, there tends to be a positive correlation between self-efficacy and choice for both males and females, divided along traditional occupational lines (AWE, 2005). For example, the higher assessment that men make of their mathematical abilities contributes to men's higher participation in STEM majors (AAUW Educational Foundation,2007), and females' lower intrinsic value of and lower self-concept of ability in mathematics and science may explain why many talented women eventually decide not to choose careers in male-dominated fields (Frome et al., 2006).

Aspiration Individuals aspire to careers based upon their perceptions of their competence at career-related tasks. However, men and women form those perceptions based upon gender-based beliefs. This is how aspirations to a nontraditional career may be constrained (Correll, 2004). It follows that the higher students assess their abilities in a subject, the more likely they are to enroll in classes in that subject or choose it as their major (AAUW, 2004).

Power to change tradition A person's self-perception of ability may have as much to do with achievement in the related field as actual ability (Bussey & Bandura, 1999). In one study of women in STEM careers, academic and personal self-efficacy created persistence and resiliency. As referenced in Allison and Cossette (2007), Choudhuri (2004) and Pietsch (2003) maintain that for women interest and career goals come first; for men it is the opposite. These findings were consistent with Bandura's social cognitive theory and the work of Gilligan (Zeldin & Pajares, 2000). In a study of gifted boys and girls in grades 6-8, girls who perceived themselves as harder working and more internally motivated were more likely to aspire to careers that are male dominated. In contrast, the career aspirations of boys seemed largely unrelated to their self perceptions (Raffaele Mendez & Crawford, 2002).

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Intrinsic career orientation Men in nontraditional careers report a higher priority for intrinsic rather than extrinsic rewards. For example, 72 percent of the "settlers" (men who actively chose the nontraditional occupation after dissatisfaction with a traditional career) reported a preference for "remaining close to professional and occupational practice rather than moving into management" (Simpson, 2005, p. 371).

Root Cause: Attribution and Fixed Traits

Back to Part I

What the literature says: theory

Both attribution and fixed traits can affect motivation and confidence to achieve in nontraditional careers.

What the literature says: evidence

Attribution theory This complex social cognitive theory, originated with Rotter and Heifer and extended through the work of Wiener, maintains that to what we attribute our achievements and failures affects our motivation (AWE, 2005).

Fixed traits refer to the belief that an attribute, for example intelligence, is determined at birth (Viadero, 2006). Both fixed traits and to what we attribute our achievements and failures can negatively affect participation and completion of classes leading to nontraditional careers.

Attributing achievement Both the source of and lack of achievement may be attributed differently for men than for women. In a study of engineering students, women attributed their successes to hard work or sources outside themselves and their failures to lack of innate ability. Men generally had opposite opinions: successes resulted from their innate abilities and failures from lack of effort or outside sources (Felder et al., 1995).

Effect on retention An additional study of engineering students found that 100 percent of female students who dropped a class because of academic issues believed in fixed ability; women in engineering majors were more likely than men to declare successful engineering ability a fixed aptitude (Heyman et al., 2002).

Root Cause: Stereotype Threat

What the literature says: theory

Achievement is positively influenced by the reduction in stereotype threat**.**

What the literature says: evidence

Definition Stereotype threat refers to being at risk of confirming, as self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995).

Females in testing situations Women performed worse than men on an engineering skills test when stereotype threat was high and equally well when stereotype threat was not present (Bell et al., 2003). If men and women with the same preparation for a math

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test are told that men generally do better on the test, men will outperform women (Spencer et al., 1999). Experimental work by Inzlicht and Ben-Zeev (2000) has established that stereotype threat can undermine the math performance of females.

Recommendations and strategies

Teach females to self-affirm. In one study, self-affirmation improved the performance of women under stereotype threat, but did not affect the performance of men (Johns et al., 2005). Develop methods and interventions to remedy girls' and women's underestimation of their abilities in math and physical science (Frome et al., 2006).

Teach that intelligence is incremental. In an experimental study with middle school students, college student mentors taught middle school students to see that intelligence is incremental, not fixed, and to attribute poor performance to outward circumstances. The gender gap on math achievement as measured by standardized test scores disappeared for the students who had been mentored. Students have more motivation to succeed when they believe that intelligence is malleable. For example, if a student believes that hard work, rather than giftedness, at math is responsible for her math achievement, she will be more likely to achieve (Viadero, 2006).

Provide professional development on supportive learning environments. Learning environments should convey the following messages: an incremental view of intelligence, no "overnight geniuses," and praise for hard work instead of for being "smart" (Viadoro, 2007).

Address the limited development of expressive traits in boys and instrumental traits in girls. An understanding of the issues regarding the limited development of expressive traits in boys is beginning to surface. Also, if educators want to develop interests in nontraditional occupations, they can foster assertiveness, confidence, and mastery orientation in girls (Raffaele Mendez & Crawford, 2002).

Utilize real-life teaching strategies. Some evidence suggests that pre-college programs that incorporate hands-on activities, role models, internships, and field trips tend to increase self-confidence and interest in STEM courses and careers (AAUW Educational Foundation, 2004).

Assess and retrain attribution style. Attribution style is the tendency for an individual to consistently attribute success or failure to a particular cause; an example is habitually blaming failure on teacher bias. Ziegler and Heller (2000) applied retraining to girls in an 8th-grade physics course with a resulting positive change in attribution style. "Helping women to understand the importance of their attribution styles may be beneficial" (AWE, 2005, p. 1).

Effective practices and resources

Improving Girls' Self-Efficacy with Virtual Peers, an NSF-funded project of the Utah State University, tries to help girls overcome their negative self-images when it comes to STEM. This project utilizes pedagogical agents to create positive electronic mentors for girls and young women. The agent's purpose is to build high school girls' confidence and positive attitudes toward learning math and to assist their learning.

In the **Writing About Values** project, University of Colorado at Boulder professor Geoffrey L. Cohen saw 7th-grade students shrink achievement gaps by having them write for 15 minutes, several times a year, on the values they cherish (Cohen & Garcia, 2006).

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Strategic Education Research Partnership researchers are currently testing a three-week summer program called **Academic Youth Development**, which provides students with the opportunity to learn about how the brain grows with new information, to study fundamental math processes, and to participate in accelerated math classes.

Interactive Effects in the Theory of Planned Behavior is an NSF-funded partnership between Dr. Bettina Casad and Dr. Faye Wachs at California State Polytechnic University and Azusa Unified School District. The partners are interviewing 600 middle school students, math teachers, counselors, and parents about stereotype threat. The final product will identify barriers and protective factors that affect math performance and career and course-taking plans. Preliminary findings indicate that girls in middle school are affected similarly to college students.

Tips for Reducing Stereotype Threat, along with additional valuable information about stereotype threat, have been collected and posted by Steven Stroessner and Catherine Good at www.reducingstereotypethreat.org and include the following:

- Reframing the task
- De-emphasizing threatened social identities
- Encouraging self-affirmation
- Emphasizing high standards with assurances about the capability for meeting them
- Providing role models
- Providing external attributions for difficulty
- Emphasizing an incremental view of intelligence

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Societal Issues

The root causes, strategies, and models in this section are ones about which members of the “pipeline team” from the non-educational community—businesses, community-based organizations, workforce development organizations, public media systems, other students—have the most direct impact and concern. Educators, however, can provide the impetus for action. The topics in this section include the following:

- Media
- Peers
- Role Models/Mentoring and Other Support
- Collaboration

Root Cause: Media

Back to Part I

What the literature says: theory

(Positive) National media portrayal of individuals performing the job duties of a nontraditional career in a positive light increases participation of the nontraditional gender in that career.

(Negative) The constant and often gender-stereotypical exposure of electronic media solidifies gender stereotyping.

What the literature says: evidence

Stereotyped and constant Not only are students bombarded with electronic media (Roberts, et al, 2005) that contain gender biases of many kinds but also there are no assessments to determine whether students are made aware of gender biases in the few formal opportunities that are provided for students to learn media literacy (Taylor et al., 2007). A survey of more than 700 young women and 400 young men ages 13-21 revealed that young women believe that the media put out many negative and overly sexual images of women. They also believe that the media have a responsibility to portray positive images and messages, but believe that they have little influence to change the media (Women’s Foundation of California, 2006).

Powerful influence for change One study found that forensic science was the seventh and ninth most popular job among girls and boys, respectively. Forensic science has been the subject of several TV series (Miller & Hayward, 2006). Historically, the media have portrayed technology as a male domain. However, emerging technologies supportive of personal interaction creates more interest for girls’ natural interests; the fact that girls use technology for those social interactions gives them more technological experience (Abbot et al., 2007).

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Recommendations and strategies

Provide positive nontraditional role models through established media. TV programs can have a fairly strong and immediate impact on the impressions that young people form of occupations. The following are models that might affect this impact:

- Provide an award for the best TV production presenting images of women in STEM.
- Work with scriptwriters and producers to consider how plot lines concerning jobs in the STEM sector might be introduced into TV "soaps" (Miller & Hayward, 2006).

Emphasize the role of education. Curricula need to include overt attention to gender norms, patterns, and outcomes to make sure that students understand and can evaluate the gendered expectations found in all sources: academic, social, and cultural (Taylor et al., 2007).

Provide programs that build positive body image. A large survey of young men and women found that programs that aim at building self-esteem and positive body image, as well as those that assist young women in discovering career and educational options and explore confidence and leadership, were very popular among those surveyed (Women's Foundation of California, 2006).

Effective practices and resources

Media Literacy Training for Middle School Students assists younger women in thinking critically about media images (National Science Foundation, 2006).

Just Think: Ignite Your Mind is an interactive media literacy education course for teachers and community workers incorporating production and critical thinking.

Root Cause: Peers

Back to Part I

What the literature says: theory

The opinions of peers, especially during adolescence, can influence nontraditional career choices, especially for females.

What the literature says: evidence

Peers "Peers are both the product as well as the contributing producers of gender differentiation" (Bussey & Bandura, 1999, p. 37).

Concern about "looking dumb" In a 1990 study of elementary students, "children were more reluctant to seek help from peers, compared with adults (including teachers), because they were afraid to 'look dumb' in the eyes of their classmates. Girls were more concerned about public appearances than boys, especially in mathematics classes, compared with reading classes.... The more the children thought help seeking would benefit them, the more likely they were to ask" (Bruning et al., 2004, p. 123).

Support for nontraditional choices Respondents to a survey of 1000 female IT professionals stated that "support and encouragement from friends" was one of the most common IT-related experiences. Friends may have influenced them by encouraging, supporting, or sharing an interest in IT together (Girl Scouts, 2008). Parents, teachers, and peers were among the most important factors for youths' IT careers (Zarrett & Malanchuk, 2005).

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Men choosing nontraditional careers may pay less attention to peers Men who choose nontraditional occupations may be "reference group independent" (Wade, 1998), allowing themselves greater role flexibility and opting for career satisfaction. In Lease's study men "with more ideologically liberal social attitudes were more likely to choose occupations that had higher percentages of women working in them." These attitudes include gender roles and may indicate that these men are independent of their reference group (2003, p. 253).

Support groups When nontraditional participants enroll individually, they are less likely to integrate effectively into the social structure, more likely to suffer decreased performance, and more likely to drop out. Change is carried in cohorts, not in single individuals (Ingle, 2000).

Recommendations and strategies

Involve men in IT intervention efforts for women. A study of The Ohio State University found that successful IT women cited "male friends and colleagues as being powerful influences in their career decisions" (Turner et al., 2002).

Involve like-minded peers in programs. A longitudinal study of urban, low-income students in a year-long, high school, informal science program revealed that their career and educational decisions were influenced by the interaction with staff, skill acquisition, and socialization with like-minded peers (Fadigan & Hammrich, 2004). This program is Women in Natural Sciences.

Facilitate informal support groups. Women need continued support and encouragement to stay in the science and engineering pipeline. Support groups may be "helpful in addressing the problems of young women" enrolled in courses leading to nontraditional careers (Mau, 2003, p. 241).

Effective practices and resources

Operation SMART, the most popular and widely implemented program of Girls Inc., has reached over 500,000 girls across the country. It boosts girls' interest in studying science and math and opens their eyes to the existence and importance of these subjects in all aspects of their lives.

The **Expanding Your Horizons in Science and Mathematics™** conferences nurture girls' interest in science and math courses to encourage them to consider careers in science, technology, engineering, and math.

Girl Scouts introduces girls of every age to STEM activities that are relevant to everyday life. Whether they're discovering how a car's engine runs, becoming math whizzes, or learning about careers in STEM fields, girls are moving forward into the future. They can host science fairs, design Web sites, plan for space exploration, visit geological sites, and more.

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Root Cause: Role Models/Mentoring and Other Support

Back to Part I

What the literature says: theory

Support services, such as the provision of career-related role models and mentors, aid participation and completion of education leading to nontraditional careers.

What the literature says: evidence

Role models Respondents to a survey of 1000 female IT professionals named engaging staff as one of four factors contributing to their entrance and persistence in an IT career (Girl Scouts, 2008). A study of more than 350 female undergraduates revealed that the influence of role models accounted for a significant variance in career choices, slightly more than for self-efficacy. The study cites work that ties the influence of role models to career aspirations, career choice, and attitude toward nontraditional careers (Quimby & DeSantis, 2006).

Influential mentors Mentoring benefits the mentee, the mentor, and the organization and has been shown to prevent women from leaving engineering programs (AWE, 2005). Women who have occupational achievement in their profession that is equal to that of their male peers attribute their achievement to having mentors in that profession (Kerr & Kurplus, 2004).

Female teachers as scientists? While role models were found to be helpful, one study of female science teachers discovered that the fact that females were teaching science did not mean that those women were seen as scientists. The relationship between high school science teaching and scientific work was not explicit (Gilmartin et al., 2007).

Mentor training valuable Another study pointed out the importance of relationships in the mentoring process: both the 8th-grade girls who were mentees and their science mentors benefited from identifying the cognitive process used in contemplating science mentoring (Buck et al., 2008).

Recommendations and strategies

Ensure positive role models. Universities can be a resource for elementary and secondary schools to ensure that a positive image of women in STEM is established early on (National Research Council, 2006).

Showcase role models with good work/life balance. Provide young women with opportunities to interact with role models who blend STEM careers and family (Frome et al., 2006).

Provide training and support for mentors and mentees. "Training has been recognized as instrumental for the success of mentoring projects" (AAUW, 2004, pp. 16-17).

Choose the mentoring format that fits the educational setting. Applications of mentoring range from e-mentoring to one-to-one pairs to supported groups (AWE, 2005).

Provide positive, attainable role models. This methodology has been shown to be effective for college students, but little research has been done for pre-college students. When role models are used, it is recommended that information about mentoring also be offered. Parents are also encouraged to seek opportunities for girls to have positive contact with women working in the fields of math and science (Halpern et al., 2007).

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Conduct nontraditional student support groups and peer counseling. A group of studies identified the following retention strategies as effective: access to nontraditional student clubs and team support systems, and participation in math clubs, competitions, and after-school programs (Foster & Simonds, 1995; Silverman, 1999; Gavin, 2000).

Effective practices and resources

The **Intergenerational Mentoring for Science Faculty Project**, **as described in AAUW Educational Foundation's *Under the Microscope*,** provided a short course, a faculty institute, a freshman seminar, scholarships, and intergenerational mentoring to interest more women from rural and tribal areas in science. It also provided small grants to faculty or secondary teachers for course and project development. Evaluations revealed that the project had a positive impact on course design and perceptions and resulted in higher retention rates for females (AAUW Educational Foundation, 2004).

High Tech Girls Society is an example of a successful mentoring program (Reese, 2006). This project was selected for the 2006 Programs and Practices That Work Award, meeting the criteria for having an evidence-based impact on the recruitment and retention of students pursuing nontraditional careers.

University of North Texas in Denton found that teenage mentors open doors to science for younger girls. The 4th and 5th graders who received mentoring had increased enthusiasm, and their teenage mentors were more persistent in their math and science studies (Goforth, 2005).

The University of Chicago at Illinois' **Girls E-Mentoring in Science, Engineering and Technology GEM-SET** program encourages girls to pursue STEM careers.

The Seattle Public School System's **IGNITE** provides presentations at schools, field trips to local companies, job shadowing, conferences, and many other events to connect high-tech women mentors with young women. In addition, IGNITE provides students with information on scholarships, internships, and community resources to help them succeed in the fields of engineering and technology.

MentorNet is the award-winning, nonprofit, e-mentoring network that positively affects the retention and success of those in engineering, science, and mathematics, particularly but not exclusively women and others underrepresented in these fields.

Men Teach is a nonprofit clearinghouse for anyone seeking information about men in teaching.

Engineer Your Life is an online recruitment tool that utilizes real-life role models.

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Root Cause: Collaboration

Back to Part I

What the literature says: theory

Collaboration between educational entities and community-based organizations or businesses impacts the pipeline for nontraditional careers.

What the literature says: evidence

Tipping point "Early data suggest that collaboration such as that practiced by the National Girls Collaborative Project has the possibility to become vehicles for sustainable outcomes by affecting the tipping point" (Marra et al., 2008, p. 138).

Recommendations and strategies

Arrange for factors for success to be present in collaborations. Two studies have identified factors for quality collaborations: leadership, communication, community development, and sustainability (Hogue et al., 1995, as cited in Marra et al., 2008); internal communications, external communication, membership, and goal setting (Borden, 1997, as cited in Mara et al., 2008). Lessons learned from the National Girls Collaborative Project are to "set expectations clearly and form the outset," "use project resources as intended right from the beginning," and "look for collaboration readiness from the onset" (Marra et al., 2008, p. 137)

Effective practices and resources

Cisco Systems, Inc.'s Gender Initiative was designed for the Cisco Networking Academy Program community and provides reasons for low female participation in IT and strategies and resources for recruitment and retention of females in the Networking Academy.

The **Society of Women Engineers** strives to establish engineering as a highly desirable career aspiration for women. SWE empowers women to succeed and advance in those aspirations and to be recognized for their life-changing contributions and achievements as engineers and leaders.

The **National Girls Collaborative Project** is designed to reach girl-serving STEM organizations across the United States and Puerto Rico. Local collaboratives have an extensive network of organizations and individuals that are engaged in pursuing this common goal, and they maximize opportunities to share with and learn from each other. They vary in focus areas and populations served, but they all work to increase gender equity in STEM fields.

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ACKNOWLEDGEMENTS

Authors: Lynn Reha, Illinois Center for Specialized Professional Support;
Mimi Lufkin, National Alliance for Partnerships in Equity; and Laurie Harrison, Foothill Associates.

The National Alliance for Partnerships in Equity Education Foundation thanks Lynn Reha, Illinois Center for Specialized Professional Support, for her tireless efforts in updating the 2002 version of this document and to Laurie Harrison, Foothill Associates for her assistance.

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