FEASIBILITY STUDY AND EVALUATION OF NON-TRADITIONAL OCCUPATION DEMONSTRATIONS

Literature Review Report

FINAL

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EXECUTIVE SUMMARY

Non-Traditional Occupations (NTOs) are occupations where specific populations and subpopulations are traditionally underrepresented. The United States Department of Labor (DOL) defines underrepresented occupations as those in which individuals from one gender or minority group constitute less than 25 percent of the individuals employed in such occupations.

Barriers associated with entry into NTOs can prevent these populations from accessing employment in certain occupations and realizing the benefits of that employment, including economic self-sufficiency, higher wages, improved benefits, broader job opportunities and advancement potential, and job satisfaction.

A wide range of barriers cause specific populations and subpopulations to be under-represented in NTOs. One potential barrier to equal opportunity is job expectations and experiences. While all individuals can choose among numerous occupations, many workers make this decision based on traditional or established choices, expectations, thoughts, and/or behaviors. These influences can be enough to steer job seekers towards certain occupations and away from others.

Most notably, barriers for entry of women and minorities in Science, Technology, Engineering and Math (STEM) fields are apparent – and they are even greater for minority women.[1] The staff of Senator Bob Casey of the U.S. Congress Joint Economic Committee published a 2012 report noting that women, African Americans, and individuals of Hispanic descent were dramatically underrepresented in STEM bachelor's programs around the country.[2] The report concluded that such underrepresentation is a significant contributor to underrepresentation of the same groups in STEM professional fields, which is also corroborated by other publications.[3,4,5,6]

This literature review presents findings from the first phase of DOL's Employment and Training Administration (ETA) contract with IMPAQ International, LLC and its partners – the Institute for Women's Policy Research and the National Alliance for Partnerships in Equity (the research team). These findings provide a high-level review of strategies that have been implemented to address an individual's barriers to entering NTOs.

More specifically, the report addresses an important objective for the literature review for the project's second phase, the implementation of a demonstration that can increase opportunities to employment in NTO. Rooted within this objective is the identification of evidence-based strategies or programs that have been tested and proved to be effective. Key findings associated

[1] The bicultural life experience of career-oriented African American women. Journal of Organizational Behavior, Vol. 11, No. 6, pp. 459-477.

[2] STEM Education: Preparing for the jobs of the future. (2012). Washington, DC. Retrieved from http://www.jec.senate.gov/public/index.cfm?a=Files.Serve&File_id=6aaa7e1f-9586-47be-82e7-326f47658320

[3] Griffith, A.L. 2010. Persistence of women and minorities in STEM field majors: Is it the school that matters? Economics of Education Review, Vol. 29, pp. 911–922

[4] Hughes, R. M. (2010). Keeping university women in STEM fields. International Journal of Gender, Science and Technology, Vol. 2, No. 3, pp. 417–436.

[5] Schultz, P. W., Hernandez, P. R., Woodcock, A., Estrada, M., Chance, R. C., Aguilar, M., Serpe, R. T. 2011. Patching the pipeline: Reducing educational disparities in the sciences through minority training programs. Educational Evaluation and Policy Analysis, Vol. 33, No. 1, pp. 95–114.

[6] Jacobs, J.E., 2005. Twenty-five years of research on gender and ethnic differences in math and science career choices: what have we learned? New directions for child and adolescent development, Vol. 110, pp. 85–94.

with the Literature Review and the implications for developing a demonstration include the following:

- **A total of 281 relevant NTO publications have been identified for review.** Of these, 117 pertained to a description of barriers to NTO entry. The remaining 164 included a discussion and/or evaluation of strategies that address such barriers. Most evaluations were generally qualitative in nature, relying on case studies, semi-structured interviews, and focus groups. Quantitative studies were more likely to rely on surveys and descriptive statistics rather than rigorous quantitative methodologies. Less rigorously tested strategies and programs provide opportunities for further research using rigorous methodologies. For example, the *Research Initiative for Science Excellence* program used propensity score matching methods to test its effectiveness at encouraging minority undergraduate students to pursue a research career in biomedical sciences.[7] Future research could use more rigorous methodologies to evaluate elements of the program.
- **Two types of strategies to increase employment in NTOs have been identified as *Workplace- and Career-Related Strategies* and *Education-Related Strategies*.**
    - While both are critical for inclusion in a thorough review of this kind, strategies most relevant to the purview of the DOL objectives are drawn most heavily from the literature on *Workplace- and Career Related Strategies*. They are typically implemented by career guidance professionals, training providers, and employers, addressing barriers associated with bias found in career materials, mechanisms, and policy as well as individual perceptions and responses to the characteristics of NTOs and lack of support services. Outcomes typically include increased NTO employment among women and minorities, and increased access to, retention, and advancement in NTOs.
    - In contrast, *Education-Related Strategies* are typically implemented by education professionals, addressing barriers related to the delivery of academic material as well as student proficiency, academic interest, and self-efficacy to pursue STEM-related academics. Outcomes typically include increased enrollment, retention and graduation rates in STEM degrees.
- **Other relevant and promising strategies have been identified. They are potentially useful for a demonstration designed to increase women and minority employment and earnings in NTOs.** For instance, the *Ground Zero Initiative: Building a Pipeline of Women for the Skilled Trades,* the *Helmets to Hard Hats* program, the *Regional Center for Next Generation Manufacturing,* and the *Construction Management Program* provided extensive job readiness training, an introduction to the trades, a flexible work schedule, and supportive services.

[7] R., Woodcock, A., Estrada, M., Chance, R. C., Aguilar, M., Serpe, R. T. 2011. Educational Evaluation and Policy Analysis, Vol. 33, No. 1, 95–114

CHAPTER 1: INTRODUCTION

This report is a high-level review of the literature on strategies that increase opportunities for employment in Non-Traditional Occupations (NTOs) – defined by the U.S. Department of Labor (DOL) as occupations where specific populations and subpopulations are traditionally under-represented among the industry's workforce. The specific focus of this review is to address an individual's barriers to entering NTOs with strategies appropriate for delivery within the public workforce system.

The under-representation of workers in certain occupations based on their age, race, disability, or familial status continues to limit access to high-skill, high-paying jobs among these populations.

Our report presents findings from the first phase of DOL's Employment and Training Administration (ETA) contract with IMPAQ International and its partners – the Institute for Women's Policy Research and the National Alliance for Partnerships in Equity (the research team). These findings informed discussions and in-depth investigation of certain strategies that served as the base for the project's second phase – program demonstration and research. Both the scope of the review and the presentation of findings were organized to help guide decision-making related to the feasibility of implementing a demonstration. We also selected specific strategies from this review that are of particular interest to DOL.

The literature search conducted was highly inclusive of evidence-based strategies related to all populations facing barriers to NTOs – including women, men, minorities, lesbian, gay, bi-sexual, and transgender persons, persons with disabilities, and veterans. Two aspects of the review are important to note at the outset:

- The majority of the relevant literature pertains to women, while some publications address minorities and men, with virtually nothing on other subgroups.
- This review is not a comprehensive inventory of strategies to address barriers to NTO entry. Rather, the report focuses on strategies that are either intended specifically to increase the employment-related outcomes of women and minorities in NTOs or are highly correlated with such outcomes.

We continue this introductory chapter with the background (section 1.1) and context for understanding the barriers associated with employment in NTOs, including DOL's initiatives (section 1.2), national legislation (section 1.3), and an overview of high-paying NTOs (section 1.4).

1.1 BACKGROUND

According to data from DOL, women represent less than 25 percent of workers in more than 125 occupations (including welding technology, computer installation, and repair and engineering technology), and less than 10 percent of workers in more than 75 even more segregated occupations. The gender wage gap and occupational segregation – men primarily working in occupations performed by men and women primarily working in occupations performed by women – are persistent features of the United States labor market.

- Only four of the 20 largest occupations for men and the 20 largest for women overlap.
- Forty percent of women work in traditionally female occupations and 47 percent of men work in traditionally male occupations.
- Only 6 percent of women work in traditionally male occupations and 5 percent of men in traditionally female occupations.
- Female-dominated occupations often pay very low wages:
  - Teacher assistants (89 percent female) and child care workers (95 percent female) are paid $18,000-$19,000 per year in 2012 dollars.
  - Hairdressers, hair stylists, and cosmetologists (89 percent female) and pre-school and kindergarten teachers (98 percent female) are paid only slightly more, $21,000 - $23,000.[8]

Employment in NTOs can lead to higher paying jobs for women who do not have a four-year degree.[9] Employment in NTOs for men (such as nursing/nursing assistant, legal assistant, or paralegal) provide a sustainable wage as well as a means for advancing to higher wage jobs (such as business owners, school administrators, and managers). Similarly, the under-representation of workers in certain occupations based on their age, race, disability, or familial status continues to limit access to career pathways that could lead to high-skill, high-paying jobs among these populations. For all workers, equal access to these opportunities can result in a host of positive outcomes, including: economic self-sufficiency, higher wages, improved benefits, broader job opportunities and advancement potential, and job satisfaction.

One potential barrier to equal opportunity is job expectations. While all individuals can choose among numerous occupations, many workers make this decision based on traditional or established choices, expectations, thoughts, and/or behaviors. These influences can be enough to steer job seekers towards certain occupations and away from others. For example, a woman may be unwilling to take a construction job because she feels isolated and unable to develop friendships at work or, in some cases, because she fears sexual harassment.[10]

KEY BARRIERS TO NTO ENTRY

Career-related barriers:

- Bias communicated through career materials, mechanisms, and practices.
- Perceptions of and response to the characteristics of occupations.
- Lack of supportive services.

Education-related barriers:

- STEM academic proficiency.
- Access to and participation in STEM education.
- Biased curriculum structure and instructional attitudes.
- Stereotype threat.

[8] Institute for Women's Policy Research. (2013). Fact sheet: The gender wage gap by occupation. http://www.iwpr.org/publications/pubs/the-gender-wage-gap-by-occupation-2.

[9] Mastracci, Sharon H. 2003. Employment and training alternatives for non-college women: Do redistributive policies really redistribute? Policy Studies Journal, Vol. 31, No.4, pp. 585-601.

[10] D. Bobbitt-Zeher. 2011. Gender discrimination at work: connecting gender stereotypes, institutional policies and gender composition of workplace. Gender and Society, Vol. 25, No. 6, pp. 764-786.

A man may be unwilling to enter a nursing profession because it is seen as "feminine" among his peers, which may challenge his sexual identity and create internal discomfort. [11]

For Science, Technology, Engineering and Math (STEM) occupations in particular, lack of women and minorities was in part attributable to the underrepresentation of women and minorities in STEM undergraduate/graduate programs.[12,13,14,15] This is particularly likely since a significant portion of STEM occupations require a bachelor's degree or higher.[1617] Similar barriers to entry for minorities into STEM fields are also apparent - and they are even greater for minority women.[18] The staff of Senator Bob Casey of the U.S. Congress Joint Economic Committee published a 2012 federal report noting the importance of developing STEM careers to America's future. The report noted in particular that women, African Americans, and individuals of Hispanic descent were dramatically underrepresented in STEM bachelor's programs around the country, concluding that such underrepresentation is a significant contributor to underrepresentation of the same groups in STEM professional fields.[19]

1.2 DOL INITIATIVES

DOL strives to implement programs that can assist women and other under-represented populations in achieving economic security through successful participation in the labor force. During the 1990s, for example, DOL's Women's Bureau (WB) was already focusing on increasing the employment of women in NTOs related to science, engineering, and careers in construction and the trades.[20]

Following these priority issues, DOL has implemented a number of initiatives that provide training to women in NTOs. Many of these initiatives have also worked with community stakeholders to address NTO barriers in recruitment, hiring, and retention (Appendix A provides a detailed overview of such DOL initiatives). [21]

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[11] Fitzgerald, L.F., 1980. Nontraditional occupations: Not for women only. Journal of Counseling Psychology, Vol. 27, No. 3, pp. 252–259.

[12] Griffith, A.L. 2010. Persistence of women and minorities in STEM field majors: Is it the school that matters? Economics of Education Review, Vol. 29, pp. 911–922

[13] Hughes, R. M. (2010). Keeping university women in STEM fields. International Journal of Gender, Science and Technology, Vol. 2, No. 3, pp. 417–436.

[14] Schultz, P. W., Hernandez, P. R., Woodcock, A., Estrada, M., Chance, R. C., Aguilar, M., Serpe, R. T. 2011. Patching the pipeline: Reducing educational disparities in the sciences through minority training programs. Educational Evaluation and Policy Analysis, Vol. 33, No. 1, pp. 95–114.

[15] Jacobs, J.E., 2005. Twenty-five years of research on gender and ethnic differences in math and science career choices: what have we learned? New directions for child and adolescent development, Vol. 110, pp. 85–94.

[16] Terrell, Nicholas. STEM occupations. Occupational Outlook Quarterly, Spring 2007, pp. 26-33.

[17] Jacobs, J.E., 2005. Twenty-five years of research on gender and ethnic differences in math and science career choices: what have we learned? New directions for child and adolescent development, Vol. 110, pp. 85–94.

[18] The bicultural life experience of career-oriented African American women. Journal of Organizational Behavior, Vol. 11, No. 6, pp. 459-477.

[19] STEM education: Preparing for the jobs of the future. (2012). Washington, DC. Retrieved from http://www.jec.senate.gov/public/index.cfm?a=Files.Serve&File_id=6aaa7e1f-9586-47be-82e7-326f47658320

[20] Our History: an Overview 1920 – 2012. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/info_about_wb/interwb.htm

[21] Women's Bureau Initiatives in FY 2010. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/previousinitiatives2010.htm

DOL has also facilitated a dialogue about how to create flexible working environments by increasing awareness of the need and bringing together employers to design and implement flexible workplace designs. In addition, DOL supports and provides guidance on policies, such as the Family and Medical Leave Act (FMLA), to accommodate the family responsibilities of employees.[22]

Working to address the financial challenges faced by women, including the wage gap, has been a further priority. DOL has been involved in initiatives to encourage research related to reducing the wage gap and has also hosted forums and implemented programs to provide knowledge and resources to support the financial stability for households headed by women.[23]

DOL's Women's Bureau priority issues to reduce barriers to employment and high paying jobs for women:

- Equal pay for all working women to reduce the wage gap that exists between female and male workers.
- Workplace flexibility to encourage employer policies to promote work-life balance and family care giving.
- Higher paying jobs for women, including those that provide opportunities to acquire skills and knowledge in occupations with sustainable and innovative career pathways.
- Assisting women veterans experiencing homelessness in obtaining financial security through opportunities for employment and careers.

1.3 LEGISLATION

Legislation has been used to address many of the barriers placing women and other minorities at a disadvantage in the workplace. The need to tackle gender segregation in career and technical education first became the explicit subject for the federal framework for career and technical education in 1976. That is, four years after the passage of Title IX of the Educational Amendment Act of 1972, when the 1963 Vocational Education Act was amended to include the goal of overcoming sex discrimination and sex stereotyping in occupations and improves women's access to higher earning occupations.[24]

The most recent iteration of the law – the Carl D. Perkins Career and Technical Education Act of 2006 – continued this approach and added new sanctions and triggers for state and local improvement plans when targets for improvements in women's (and men's) participation and completion of CTE in fields nontraditional for their gender are not met. According to a report published by the National Coalition for Women and Girls in Education (NCWGE), based on analysis of state level data from the U.S. Department of Education, Office of Career, Technical, and Adult Education (OCTAE), progress towards women's participation in nontraditional fields of

[22] Women's Bureau Initiatives in FY 2010. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/previousinitiatives2010.htm

[23] Ibid.

[24] Mertens, D. M. (1984). "Federal Policy for Sex Equity in Vocational Education." *Educational Evaluation and Policy Analysis*, Vol. 6, No. 4, pp. 401-409

CTE remains uneven across states, and the number of high-performing states has fallen since 2010.[25][26]

The 2014 Workforce Innovation and Opportunity Act (WIOA) is the primary federal workforce development legislation. It authorizes job training and related services to increase access to employment, education, and training, particularly for individuals with barriers to employment, including activities to increase women's access to in-demand occupations where women are fewer than 25 percent of the workforce (and likewise men's access to occupations where men are fewer than 25 percent of the workforce).[27] Provisions for affirmative action to improve women's access to nontraditional occupations were first included in the federal workforce in 1980.[28] WIOA mandates greater integration of workforce development activities funded through WIOA and career and technical training activities funded through the Perkins Act.

Especially pertinent to DOL is legislation passed in the early 1990s that offered federal funding to expand the participation of women in NTOs through the provision of training and technical assistance. The Non-Traditional Employment for Women Act (NEW) offered states incentives to provide training to low-income women. The Women and Apprenticeships in Non-Traditional Occupations Act (WANTO) offered funding for community-based organizations to provide technical assistance to employers and labor unions in recruiting, selecting, training, and retaining women in apprenticeships and NTOs. Both programs were voluntary, offering funding through a competitive grants process. Evidence suggests that the WANTO and NEW legislation, as well as the grant projects they funded, were successful in increasing women's employment in NTOs.[29]

1.4 IDENTIFYING HIGH-PAYING AND FAST-GROWING NTOS

The literature review process began by contextualizing the literature on barriers to NTO entry and strategies that address those barriers with the use of Bureau of Labor Statistics (BLS) standard occupational classification system data. The purpose of this research was to identify not only NTOs for men and women, but also which NTOs pay high wages and are projected to grow rapidly over the next decade. Understanding the potential for high wage and high growth NTOs was crucial to the selection of interventions as likely candidates for testing in the second phase of this project. Without this analysis, the intervention selected for the demonstration would not have an impact in a stagnant or shrinking occupation, even if the program was in itself successful.

[25] National Coalition for Women and Girls in Education (NCWGE). (2017). Title IX at 45: working to ensure gender equity in education. Washington, DC: NCWGE.

[26] Carl D. Perkins Career and Technical Education Act of 2006: Report to Congress on State Performance, Program Year 2013–14. U.S. Department of Education, Office of Career, Technical, and Adult Education (OCTAE), 2016

[27] Public Law 113–128—JULY 22, 2014

[28] Reskin, B. F. and Hartmann, H. eds. (1986). Women's Work, Men's Work. Sex Segregation on the Job. Washington, DC: National Academy of Sciences - National Research Council.

[29] Mastracci, S. H. (2005). Persistent problems demand consistent solutions: Evaluating policies to mitigate occupational segregation by gender. Review of Radical Political Economics, Vol. 37, pp. 23-38.; Reed, Debbie, Albert Yung-Hsu Liu, Rebecca Kleinman, Annalisa Mastri, Davin Reed, Samina Sattar, and Jessica Ziegler. 2012. An Effectiveness Assessment and Cost-Benefit Analysis of Registered Apprenticeship in 10 States. Prepared by Mathematica Policy Research for U.S. Department of Labor, Employment and Training Administration under Contract Number DOLQ091A20941/DOLU121A21906. Westat. 2003. Women in Apprenticeships and Nontraditional Occupations Grant Program: Final Report. Report prepared for the U.S. Department of Labor Women's Bureau on Contract No. GS-23F-8144H.

Exhibits 1 and 2 show the 25 highest paying NTOs for women and men, respectively, and their expected growth rates.[30] For women, this list consists largely of STEM-related occupations, which offer wages far over the U.S. median annual wage of $45,790,[31] promising high levels of financial security for entrants. Medical practitioners and computer science professionals are predicted to be the fastest growing and highest paid NTOs, occupying nine of the occupations on the list. All nine of these occupations are predicted to grow by double-digit percentages over the next decade. Engineers and managerial occupations, while not as fast growing, are still projected to add a significant number of jobs of the next 10 years.

Exhibit 1. Top 25 Highest-Paying Female NTOs

Occupation Title	2012 % of Female Workers in Occupation	2012 Employment (in thousands of jobs)	% Predicted Growth in Jobs 2012-2022	2012 Median Annual Wage (in Dollars)
Oral and maxillofacial surgeons	24.2%	6.7	16.1%	$>187,200
Orthodontists	24.2%	7.5	16.3%	$>187,200
Software developers, systems software	19.7%	405.0	20.4%	$99,000
Chemical engineers	17.7%	33.3	4.5%	$94,350
Engineers, all other	13.2%	133.0	3.8%	$92,030
Electronics engineers, except computer	9.0%	140.0	3.4%	$91,820
Computer network architects	8.1%	143.4	14.6%	$91,000
Software developers, applications	19.7%	613.0	22.8%	$90,060
Industrial production managers	17.6%	172.7	-2.4%	$89,190
Electrical engineers	9.0%	166.1	4.7%	$87,920
Information security analysts	15.1%	75.1	36.5%	$86,170
Construction managers	6.4%	485.0	16.1%	$82,790
Transportation, storage, and distribution managers	15.6%	105.2	4.9%	$81,830
Computer occupations, all other	24.4%	205.8	3.8%	$81,140
Mechanical engineers	4.5%	258.1	4.5%	$80,580
Civil engineers	13.7%	272.9	19.7%	$79,340
Industrial engineers	18.8%	223.3	4.5%	$78,860
First-line supervisors of police and detectives	15.2%	103.7	4.9%	$78,270

[30] To create this exhibit, we used DOL's further specified definition of a gender NTO as any occupation where that gender held 25 percent or fewer jobs in that occupation. Since we have found no accepted way of defining NTOs for any population of interest other than men and women, we did not replicate this process for DOL's other populations of interest (even for minorities and veterans).

[31] Bureau of Labor Statistics' May 2012 National Occupational Employment and Wage Estimates. Retrieved 2/20/2014 from http://www.bls.gov/oes/current/oes_nat.htm.

Occupation Title	2012 % of Female Workers in Occupation	2012 Employment (in thousands of jobs)	% Predicted Growth in Jobs 2012-2022	2012 Median Annual Wage (in Dollars)
Health and safety engineers, except mining safety engineers	18.8%	24.1	11.0%	$76,830
Detectives and criminal investigators	24.8%	115.2	2.0%	$74,300
Computer programmers	22.5%	343.7	8.3%	$74,280
Commercial pilots	4.1%	37.6	9.4%	$73,280
Architects, except landscape and naval	23.5%	107.4	17.3%	$73,090
Network and computer systems administrators	25.0%	366.4	11.7%	$72,560
First-line supervisors of non-retail sales workers	24.7%	394.4	-0.8%	$70,060

Source: Bureau of Labor Statistics Employment Projections & Standard Occupational Classification System.

For men, the highest paying NTOs offer modest wages compared to those in the female NTOs. However, the very top of the male NTO list is dominated by the nursing and health professions, which are poised to grow rapidly over the next decade and also pay high wages, suggesting that strategies helping men enter nursing and other health occupations identified should also be looked at closely.

Exhibit 2. Top 25 Highest-Paying Male NTOs

Occupation Title	2012 % of Male Workers in Occupation	2012 Employment (in thousands of jobs)	% Predicted Growth in Jobs 2012-2022	2012 Median Annual Wage (in Dollars)
Nurse practitioners	13.9%	110.2	33.7%	$89,960
Occupational therapists	6.0%	113.2	29.0%	$75,400
Dental hygienists	7.0%	192.8	33.3%	$70,210
Speech-language pathologists	4.8%	134.1	19.4%	$69,870
Registered nurses	9.4%	2,711.5	19.4%	$65,470
Makeup artists, theatrical and performance	18.5%	2.7	3.1%	$64,450
Compensation, benefits, and job analysis specialists	18.9%	91.7	5.8%	$59,090
Special education teachers, secondary school	13.8%	131.3	4.6%	$56,830
Special education teachers, middle school	13.8%	94.6	5.2%	$55,780
Librarians	13.2%	148.4	7.4%	$55,370
Dietitians and nutritionists	6.7%	67.4	21.1%	$55,240
Social workers, all other	19.4%	61.2	9.5%	$54,560

Occupation Title	2012 % of Male Workers in Occupation	2012 Employment (in thousands of jobs)	% Predicted Growth in Jobs 2012-2022	2012 Median Annual Wage (in Dollars)
Career/technical education teachers, middle school	18.6%	18.2	5.2%	$54,220
Special education teachers, elementary school	13.8%	194.6	6.2%	$53,820
Middle school teachers, except special education	18.6%	614.4	12.4%	$53,430
Elementary school teachers, except special education	18.6%	1,361.2	12.3%	$53,400
Therapists, all other	16.4%	28.8	31.7%	$53,210
Legal support workers, all other	21.0%	57.3	3.1%	$52,660
Special education teachers, preschool	13.8%	22.3	16.2%	$52,480
Special education teachers, all other	13.8%	40.7	9.5%	$51,980
Fundraisers	24.7%	65.7	17.3%	$50,680
Kindergarten teachers, except special education	1.9%	158.5	13.0%	$50,120
Healthcare social workers	19.4%	146.2	26.8%	$49,830
Health educators	24.3%	58.9	19.0%	$48,790
Court reporters	21.0%	21.2	9.6%	$48,160

Source: Bureau of Labor Statistics Employment Projections & Standard Occupational Classification System.

1.5 SUMMARY

The importance and focus of this literature review - to identify barriers and strategies associated with employment in NTOs – was set in the following context:

- Women represent less than 25 percent of workers in more than 125 occupations, such as computer installation and engineering technology. The gender wage gap and occupational segregation are persistent features of the United States labor market.
- Equal access to NTOs for both men and women can result in a host of positive outcomes, including economic self-sufficiency, higher wages, improved benefits, and broader job opportunities and advancement potential.
- DOL's Women's Bureau priority issues to reduce barriers to employment and high paying jobs for women include the following: equal pay, workplace flexibility, higher paying jobs for women, and assistance to female veterans experiencing homelessness.
- The first pieces of legislation aimed to tackle gender segregation in career and technical education date from the 1970s, and legislation from the early 1990s offered federal funding to expand the participation of women in NTOs through the provision of training and technical assistance.

- More recently, the Carl D. Perkins Career and Technical Education Act of 2006 added new sanctions and triggers for state and local improvement plans, and the 2014 Workforce Innovation and Opportunity Act (WIOA) authorized job training and related services to increase access to employment, education, and training, particularly for individuals with barriers to employment.

Based on this context, the literature review process began with a focus on barriers to NTO entry and strategies that address them. Additionally, understanding the potential for high wage and high growth NTOs was crucial to the selection of interventions as likely candidates for testing in Phase 2 of this project. Without this analysis, the intervention selected for the demonstration would not have an impact in a stagnant or shrinking occupation, even if the program was in itself successful.

Chapter 2 details the approach used to conduct this review. Chapter 3 presents the findings from this review. Chapter 4 ends the report with a summary discussion.

CHAPTER 2: APPROACH TO DEVELOPING THE LITERATURE REVIEW

The approach used to develop this literature review was driven by the overarching objective of this phase of the project – to identify evidence-based strategies to address barriers associated with NTO employment that 1) may be replicated and evaluated and 2) are appropriate for delivery within the public workforce system. This action-oriented objective – which differentiates the review from more traditional literature reviews – guided key decisions associated with developing this review, including decisions on its scope, methodology, and presentation.

The scope of this literature review (section 2.1) and the methodology used (section 2.2) are described below. See Appendix B for the full methodology.

2.1 SCOPE OF THE REVIEW

This is a high-level review of the literature on strategies that *directly* address barriers associated with employment in NTOs. Thus, it is not intended to serve as a comprehensive inventory of all related strategies. *Strategies that do not explicitly seek to reduce barriers to NTOs but only incidentally result in employment in NTOs as a result of their operation are not included*.

- Several types of publications were reviewed, including academic articles (e.g., written by sociologists and other academics), implementation studies (e.g., from governmental agencies or other implementing institutions), and institutional reports (e.g., from advocacy groups).
- Strategies and evaluations were only included if the target outcomes were direct measures of NTO entry, such as new and retained employment in NTOs among the target population. Exceptions to this rule were made where the target outcome included increased female and minority enrollment, retention, and graduation from university-level STEM programs. As stated previously, the identified literature repeatedly found a strong link between underrepresentation of women in STEM undergraduate/graduate programs and the underrepresentation of women in STEM fields.
- Further, while evidence-based strategies were identified as the focus of this review, only a limited number of strategies were found to have been rigorously evaluated (through randomized-controlled trials or quasi-experimental methods). As a result, the review was not limited to evaluated strategies, and thus most publications relied on less rigorous methods, such as descriptive statistics (some of them based on surveys), interviews, or focus groups.

2.2 METHODOLOGY

The methodology used for the literature review involved an extensive two-stage process (see Appendix B for the full Methodology).

The first stage involved a systematic search of all relevant sources for publications related to NTOs. This search included: 1) quantitative and qualitative evaluations of strategies for overcoming barriers to entry into NTO fields, 2) materials describing barriers to entry into NTO fields, and 3) materials describing strategies to overcome these barriers.

Sources searched included articles published in peer-reviewed journals identified through internet search engines (e.g., Google Scholar) and literature databases (e.g., EBSCO, Wiley Online Library, JSTOR), as well as relevant non-academic materials, such as federal reports, conference proceedings, and career counseling materials.

All pertinent data from each publication were collected using an information gathering protocol and Microsoft Access database. Identified materials were briefly scanned and characterized by whether or not each involved an evaluation, a barrier, and/or a strategy. Characteristics associated with the barriers and strategies were also captured, including the population affected by the barriers, the setting of the intervention, and its target outcomes, among others (see Appendix C for full details of the information captured).

The second stage in this process involved analyzing the recorded characteristics of the strategies. In so doing, the studies were grouped into 11 categories of similar strategies. These categories were then further organized into the following two major topic areas:

- **Workplace- and Career Related Strategies** are typically implemented by career guidance professionals, training providers, and employers to address barriers associated with bias found in career materials, mechanisms, and policies. These strategies also attempt to address individual perceptions and responses to the characteristics of NTOs and lack of support services. Outcomes may focus on increased NTO employment among women and minorities, and increased access to, retention, and advancement in NTOs.
- **Education-Related Strategies** are typically implemented by education professionals, addressing barriers related to the delivery of academic material as well as student proficiency, academic interest, and self-efficacy to pursue STEM-related academics. Outcomes typically include increased enrollment, retention and graduation rates in STEM degrees.

Exhibit 3 shows the 11 identified strategy categories, demonstrates how they link to the two major topic areas, and describes each strategy category. The NTO workplace and career-related strategies identified in the exhibit focus on recruitment, training, and retention strategies, as well as staff development, policies or interventions. The NTO education-related strategies focus on the development of education programs, curriculum, educators, and mentors, as well as self-affirmation techniques.

As we proceeded through this process, efforts were made to reconcile some overlap 1) across topic areas in the characteristics of strategies and 2) across the strategy categories within the same topic area, making it challenging to identify the appropriate category for discussion. Below are several scenarios that describe the challenges and the approaches used to select the appropriate topic area or category:

- **Some strategies were found to use multiple approaches to addressing barriers to NTOs.** The multiple approaches described in the publications reviewed made it particularly challenging to identify the placement of the strategy within one category over another similarly appropriate category. While in some cases the reader may find different aspects of the same strategy mentioned in more than one category, in most cases the strategy will be discussed in the category most closely aligned with the strategy's main objective.

- For instance, while the National Science Foundation (NSF) ADVANCE Institutional transformation grant program has been discussed in "Institutional Changes in NTOs," mentoring strategies specific to the NSF ADVANCE program have been elaborated under the "Professional Mentoring Programs" strategy category.

- **While some strategies may be thought to align with more than one category, each category is unique.**
  - For instance, a strategy that only involves providing childcare to employees and does not involve a concurrent change in organizational policy or procedures would more aptly be discussed under the category of "Family-Friendly Workplace Policies and Supportive Practices" rather than "Institutional Changes in NTOs".
- **In some cases, the environments in which some strategies are implemented obscure the objective of the strategy and, thus the appropriate topic area assignment.**
  - An example of this includes a strategy implemented in an educational environment that addresses biases associated with the advancement of female, college professors in STEM-based disciplines. In this case, this strategy would most appropriately be discussed within the *Workplace- and Career-Related Strategies* as the strategy's outcomes include advancement of female college professors in NTO-related disciplines.
- **While pre-apprenticeship and apprenticeship programs may seem intuitively aligned with education-related strategies, the objective for this strategy is to address barriers to NTOs and to increase NTO employment-related outcomes.** Therefore, it is more accurately described under *Workplace- and Career-Related Strategies*.

Exhibit 3. Strategy Categories and Topic Areas

Category	Description
Workplace- and Career-Related Strategies	
Apprenticeship/Pre-Apprenticeship Programs	Paid on-the-job learning generally resulting in a nationally recognized credential which offer job seekers immediate employment opportunities in high wage, high skilled occupations. Pre-apprenticeship programs provide exposure to a wide variety of high skill, high wage careers.
Institutional Changes in NTOs	Changes that reshape organizational structure and policy to create a culturally responsive environment for one or more NTO populations.
Targeted Recruitment Practices and Materials	Targeted recruitment materials and practices tailored specifically to women's and minorities' workplace issues and needs.
Family-Friendly Policies and Supportive Practices	Policies such as subsidized child care and maternity leave that encourage parents to stay in the workforce.
Professional Development for Career Counselors	Interventions sensitizing counselors to the specific challenges and job trends facing women/minorities professionally.
Professional Mentoring Programs	New hires from NTO populations are given an equity-trained mentor, often with the same gender/race as the mentee, to guide their career development and provide support in various ways.
Education-Related Strategies	
Supplemental Education Programs	Extracurricular activities that encourage women and minorities to take an interest in STEM fields through community-based and interactive exercises.
Curriculum Development	Expanding the cultural lens of educational curricula to create a warmer classroom environment for women and/or minorities in STEM programs.
Student Mentoring Programs	Women and minority students in STEM assigned a mentor to provide academic counseling and support.
Professional Development for Educators	Programs seeking to alter the way teachers teach students STEM subjects to be more sensitive to the needs and perceptions of women and minorities.
Self-Affirmation Techniques	Programs that build on existing skills and abilities to build confidence early in the career decision-making process.

CHAPTER 3: LITERATURE REVIEW FINDINGS

The literature search yielded many items pertaining to barriers to NTO entry. A smaller, but still sizable portion discussed strategies to address those barriers and/or presented evaluations of the strategies. Using the search techniques described in Section 2.2, a total of 281 items were identified for review. As shown in Exhibit 4, the 117 reviewed pieces included only a discussion of barriers to NTO entry. The remaining 164 publications included a discussion and/or evaluation of strategies that addressed such barriers (50 of these publications discussed *Workplace- and Career-Related Strategies*, while 114 publications discussed *Education-Related Strategies*).

Exhibit 4. Number of Reviewed Publications by Strategy Type

Publications	Number of Publications Identified
No Strategy Identified – Barrier Discussion Only	**117**
Workplace- and Career-Related Strategies	**50**
Apprenticeship/Pre-Apprenticeship Programs	13
Institutional Changes in NTOs	11
Targeted Recruitment Materials and Practices	9
Family-Friendly Policies and Supportive Practices	6
Professional Development for Career Counselors	6
Professional Mentoring Programs	5
Education-Related Strategies	**114**
Supplemental Education Programs	45
Curriculum Development	37
Student Mentoring Programs	20
Professional Development for Educators	6
Self-Affirmation Techniques	6
Total	**281**

Below we first describe the findings associated with *Workplace- and Career-Related Strategies* followed by *Education-Related Strategies.* In addition to providing a description of strategies, these sections discuss the barriers addressed and the evidence given to support the effectiveness of each strategy in promoting NTO entry. Evidence associated with each strategy is bolded in the discussion below.

3.1 WORKPLACE- AND CAREER-RELATED STRATEGIES

Strategies that involve workplace and career opportunities related to NTOs have been extensively used to achieve better employment and earning outcomes for women and minority populations. These strategies address the following types of barriers to NTO entry:

- **Bias Communicated through Career Materials, Mechanisms, and Practices.** Mechanisms such as discrimination, physical segregation, and lack of information reduce NTO workers'

expectations of positive workplace experiences and increase their perception of exclusion from workplace support, information, and assistance.[32]

- **Perceptions of and Response to an NTO's Characteristics.** An occupation's characteristics and how individuals perceive or respond to those characteristics have been shown to be a barrier to entering NTOs. Long working hours, extended periods of travel, and job insecurity are examples of characteristics that may serve as barriers to NTO entry.[33] Gender role orientation, employment inequities, ideas about masculinity, and family responsibilities are examples of factors that shape how individuals perceive occupations.[34]
- **Lack of Supportive Services.** A barrier primarily specific to women, lack of supportive services/benefits in NTOs that would allow women to both raise a family and have a career include lack of child care subsidies/programs, maternity leave, and flexible working hours.[35] While lack of these benefits also impacts a father's ability to enter an occupation, this type of barrier seems to affect mothers' career choices more so than fathers'.[36]

Exhibit 5 summarizes key characteristics of the six *Workplace- and Career-Related Strategies* identified in the literature – providing summary information related to the target population and age groups served, setting or locations for the interventions, targeted outcomes, and short descriptions of the applied strategies. As we moved forward with a feasible evaluation design, these six strategies will be given consideration for demonstration and evaluation.[37] More specifically, the remainder of this section examines in detail the barriers for individuals seeking entry into NTOs, identifies relevant programs and services from the literature review, and summarizes the strategies and their effectiveness from the evidence described in the studies.

[32] Kmec, J. A., 2003. Minority job concentration and wages. Social Problems, Vol. 50, No. 1, pp. 38-59

[33] Bourne, D. & Özbilgin, M.F., 2008. Strategies for combating gendered perceptions of careers. Career Development International, Vol. 13, No. 4, pp. 320–332.

[34] Coogan, P. a. & Chen, C.P., 2007. Career development and counselling for women: Connecting theories to practice. Counselling Psychology Quarterly, Vol. 20, No. 2, pp. 191–204.

[35] Taylor, C.J. 2010. Occupational sex composition and the gendered availability of workplace support. Gender & Society, Vol. 24, No. 2, pp. 189–212.

[36] Ibid.

[37] O'Farrell, B. Harlan, S. L. (1984). Job integration strategies: Today's programs and tomorrow's needs. In Sex Segregation in the Workplace: Trends, Explanations, Remedies, edited by Barbara F. Reskin.

Exhibit 5. Summary of Workplace- and Career-Related Strategies

Target Population Group/Age Group	Setting of Intervention/ Strategy	Target Outcomes	Description
Strategy: Apprenticeship/Pre-Apprenticeship Programs			
Women and Minorities/ Adult	Community colleges; technical training providers; workplace settings	Increased NTO employment among women and minorities; Increased retention and advancement in NTO employment; Increased earnings	Paid on-the-job learning generally resulting in a nationally recognized credential offering job seekers employment opportunities in high wages, high skilled occupations. Pre-apprenticeships provide exposure to a variety of high skill, high wage jobs and careers. Programs facilitate participation by providing access to childcare and transportation.
Strategy: Institutional Changes in NTOs			
Women, Minorities/ Adult	Universities, colleges and STEM departments; workplace settings	Increased NTO employment among women and minorities; Increased retention in NTO employment	Changes that reshape organizational structure and policy to create a less imbalanced environment for one or more NTO populations. This also includes policies related to the inclusion of supportive services.
Strategy: Targeted Recruitment Practices and Materials			
Women, Minorities/ Adult	Universities, colleges, workplace settings	Increased NTO employment among women and minorities	Targeted recruitment materials and practices tailored specifically to women's and minorities' workplace issues and needs.
Strategy: Family-Friendly Policies and Supportive Practices			
Women/ Adult	Workplace settings	Increased labor force participation and retention by mothers.	Policies such as subsidized child care and maternity leave that encourage mothers to stay in the workforce.
Strategy: Professional Development for Career Counselors			
Women, Minorities/ Adult	Career counseling environments including universities, colleges or workplaces	Increased NTO employment among women and minorities; Increased retention and advancement in NTO employment; Unbiased and effective career counselors	Interventions sensitizing counselors to the specific challenges & job trends facing women/minorities professionally.
Strategy: Professional Mentoring Programs			
Women, Minorities/ Adult	Workplace settings	Improved STEM-related careers among women and minorities	New hires from NTO populations in NTOs are given a mentor, often with the same gender/race as the mentee, to guide their career development and provide support in miscellaneous ways.

3.1.1 Apprenticeship/Pre-Apprenticeship

(Pre) Apprenticeship programs are mechanisms for women and minorities to obtain high-wage, high-skilled jobs through classroom training, supportive services, and paid, on-the-job training.

Designed to counteract lack of occupational training or inadequate skill sets among workers, apprenticeship and pre-apprenticeship programs can be especially useful in providing valuable skills and high wage jobs to minority groups.[38] Enabling workers from under-represented communities to gain exposure to the demands and standards of the many different industries, learn the educational and vocational skills needed for entry, and address any personal challenges that might prevent them from successfully completing an apprenticeship or pre-apprenticeship program are common goals of these programs.

Apprenticeships provide paid on-the-job learning, generally resulting in a nationally recognized credential that offers job seekers immediate employment opportunities in high wage, high skilled occupations. Pre-apprenticeship programs, in contrast, offer a range of classes and services designed to provide participants with both the *hard* and the *soft* skills needed for admission into apprenticeships or for career advancement. Pre-apprenticeship classes and services include outreach and recruitment, case management, career counseling, remedial academic instruction and tutoring, basic vocational instruction, and referral to and placement in advanced education and training and work.

Barriers to Apprenticeship Completion

- **Financial insecurities** (frequent layoffs, low wages, poor saving habits, and other money management skills).
- **Unsupportive work environment** (inhospitable or hostile workplaces, inadequate on-the-job training).
- **Unsupportive programs** (inadequate classroom instruction, limited oversight of job sites, insufficient support).
- **Poor fit for work** (unrealistic expectations of work and apprenticeship requirements).
- **Weak math skills, misconduct, and poor performance.**
- **Personal and life issues** (difficulty balancing work, school, and family responsibilities).
- **Other issues** (related to child care, transportation, mental health, substance abuse).

It should be noted that participants face numerous barriers to apprenticeship completion, as shown in the box on the right, resulting in relatively high cancellation rates. Using interviews with staff, and survey/interviews with graduated apprentices, one study described the unsupportive work environment female apprentices of the Oregon Apprenticeship System faced, as women described challenges associated with discrimination and men's attitude of

[38] Wilkinson, Lindsey and Maura Kelly. 2016. "Evaluation of Pre-Apprenticeship and Retention Services in the Trades: Interim Report on Waves I and II." <http://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1044&context=soc_fac>

disapproval towards their presence in the program.[39] Additionally, another study conducted in Canada recounts how women are discriminated against in apprenticeship programs, and tend to go through financial insecurities and have personal issues as an apprentice, more so compared to men.[40]

Two DOL programs have improved the representation of women and minorities in NTOs: the *Registered Apprenticeship Program,* and the *Women in Apprenticeships in Non-Traditional Occupations (WANTO)*. The WANTO program funds projects that provide technical assistance to employers and labor unions to recruit, train, and retain women in NTOs. An evaluation related to these programs has found a significant increase in the likelihood of obtaining employment as a result of program implementation.[41]

The WB *Ground Zero Initiative: Building a Pipeline of Women for the Skilled Trades* in Metropolitan New York (Construction Trades Prep)[42] provided working women who wanted to increase their earnings by participating in skilled apprenticeship programs with the following services: job readiness training, an introduction to the trades, a review of trades math, and hands-on shop opportunities. The classes were offered during evening and weekend hours to accommodate work schedules.

The *Helmets to Hard Hats* program, established to connect veterans to the construction industry and apprenticeship programs, has recently developed outreach strategies and programs designed to provide women veterans with the resources needed to transition to a career in the trades.[43] This program recognizes that women veterans often have several advantages for participation in NTOs, including: 1) experience working in a male-dominated field, 2) exposure to technical and mathematical knowledge and the skill set needed to feel comfortable with the trades' vernacular and tools, and 3) experience working in high stress situations, which may reflect the physical, mental, and interpersonal demands found on construction sites.

Additionally, community-based organizations (CBOs) often provide apprentice-related training in retention strategies, mentoring, racial and gender harassment prevention curriculum, and cultural competency. A recent federal report on apprenticeship and CBOs suggested that low-income youth, veterans, minorities, women, and other under-represented populations experienced significant income gains by participation in such programs.[44] For example, in an effort to reduce poverty among women, The *Oregon Tradeswomen Inc. (OTI)* provided women

[39] Kelly, Maura, Lindsey Wilkinson, Maura Pisciotta, and Larry S. Williams. 2015. "When Working Hard Is Not Enough for Female and Racial/Ethnic Minority Apprentices in the Highway Trades." Eastern Sociological Society, Sociological Forum, 30 (2): 415–38.

[40] Levasseur, Karine and Stephanie Paterson. 2016. "Jack (and Jill?) Of All Trades – A Canadian Case Study of Equity in Apprenticeship Supports." Social Policy & Administration 50 (5).
<http://onlinelibrary.wiley.com.proxygw.wrlc.org/doi/10.1111/spol.12125/abstract>

[41] Mastracci, S. H. 2005. Persistent problems demand consistent solutions: Evaluating policies to mitigate occupational segregation by gender. Review of Radical Political Economics, Vol. 37, pp. 23-38.

[42] Strengthening the Family Initiatives 2008. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/family1.htm.

[43] Ibid.

[44] Advisory Committee on Apprenticeship, Workgroup, E. and W. P., & Under-Represented Populations Workgroup. (2013). Recommendations to Encourage Registered Apprenticeship-Community-Based Organization Partnerships (p. 34). Washington, DC.

with information about apprenticeships and careers in the building, construction, technical, and mechanical trades, and assisted them in moving into training and employment. As the highest-paid of blue collar jobs, OTI focuses on trades, such as electrical, plumbing, carpenters, operating engineers, and mechanics. Targeting women that are low-income, unemployed, returning to work from welfare, coming out of incarceration, as well as female veterans and single mothers, OTI has helped women achieve self-sufficiency by providing them entry into the skilled trades.

OTI also has programs serving middle and high school girls, as well as incumbent tradeswomen seeking leadership development. In 2011, OTI graduated 116 women, with 82 achieving trade employment - including 36 in apprenticeship, 15 in a variety of construction helper positions that will lead to apprenticeship over time, 12 weatherization technicians, and many other blue-collar fields. OTI's participants have achieved tremendous success, with wages for graduates averaging $13.50 an hour – significantly higher than Oregon's current hourly minimum wage of $8.50.

Outcomes of interest for apprenticeship and pre-apprenticeship programs vary among studies but generally include increased NTO employment among women and minorities, increased retention and advancement in NTO employment, and increased earnings. Most of these studies find net positive benefits as the result of these programs. However, it is important to note that none of the methodologies used to evaluate the impact of apprenticeships and pre-apprenticeships on the desired outcomes is capable of attributing *causation*.

One study came close by comparing the outcomes of enrollees who completed apprenticeships to the outcomes of similar individuals living in the same state. Nevertheless, most studies use qualitative methodologies involving case-studies, focus groups, and interviews. For instance, case studies were used to evaluate strategies for addressing barriers for women participating in a carpentry apprenticeship program in construction.[45] The study's findings included recommendations for use of a systematic recruitment program targeting women, preferably in conjunction with CBOs and other female-oriented service providers to prepare them for commercial carpentry through pre-apprenticeship training. Supports evaluated included:

- Job search support for female applicants.
- Peer support group for participating women.
- A formal mentoring program.
- Training for employers, job foremen, superintendents, to create a more female-friendly work environment.

Evaluations that quantitatively measured the impact of apprenticeship and pre-apprenticeship-based strategies were not technically rigorous. Most studies used simple analytical tools, such as ANOVA tests or ordinary least squares (OLS) methods. For example, one study assessed the effectiveness of and examined the barriers that women face in apprenticeship and identified best practices for promoting success. [46] The study measured program effectiveness based on the association between apprenticeship participation and employment and earnings over a period of up to nine years following entrance into the apprenticeship program, using dosage models and

[45] B. Byrd. 1999. Women in carpentry apprenticeship: A case study. Labor Studies Journal, Vol. 24, No. 3, pp. 3-22.

[46] Reed, D., Liu, A. Y.-H., Kleinman, R., Mastri, A., Reed, D., Sattar, S., & Ziegler, J. (2012). An effectiveness assessment and cost-benefit analysis of registered apprenticeship in 10 states (pp. 158). Washington, DC.

cost-benefit analysis. The study found apprenticeship participants had substantially higher earnings than did nonparticipants.[47] In the ninth year following program enrollment, apprenticeship participants earned an average of $5,839 more than similar nonparticipants. Female apprentices expressed positive views of apprenticeship, regarding their participation as a pathway to career advancement and higher pay. However, these women also recommended the following changes to apprenticeship and program sponsors to further promote women's success:

- Attract females to apprenticeship through targeted outreach campaigns.
- Help position women for success (in organizations like those run by the WANTO grantees) by building basic skills and managing their expectations about particular occupations.
- Support enrollees by helping them arrange and pay for child care to accommodate classroom and on-the-job training schedules.
- Help employers create and enforce policies to combat harassment at male-dominated worksites and by connecting women with peers for support and encouragement.

Summary of Apprenticeship/Pre-Apprenticeship Strategy:

- Addresses lack of occupational training or inadequate skill set among minority workers as well as under-representation of women and minority populations in apprenticeship and pre-apprenticeship programs.
- Directed to women and minority populations in community colleges, technical training schools, and trade-related workplaces.
- Designed to increase employment, retention, and advancement in NTOs.
- Strategy Examples:
  - DOL Registered Apprenticeship Program improving representation of women/minorities in NTOs.
  - DOL WANTO technical assistance in recruiting, retaining, and training women in apprenticeship programs.
  - Ground Zero Initiative worker readiness program.
  - Helmets to Hard Hats connecting veterans with construction industry.
  - Oregon Tradeswomen, Inc. building awareness about careers for women in trade occupations.

Summary of Effectiveness:

- Evidence suggests that apprenticeship and pre-apprenticeship programs can lead to substantially higher earnings however quantitative measures were weak.
- Studies based on qualitative evaluations recommended systematic recruitment programs targeted at women and minorities.

[47] Ibid.

3.1.2 Institutional Changes in NTOs

Institutional change to companies or other key organizations in an industry involve reshaping organizational structure and policy to create a less imbalanced environment for one or more NTO populations. These institutional changes in NTOs address biased career mechanisms and practices.

Institutional changes reshape NTO organizational structure and policy to create a culturally responsive environment for women and minorities.

It should be noted that equal employment policies established by law, aimed at combating discrimination and guaranteeing equal treatment between men and women, may alone not be an effective tool to increase female employment in NTOs. A study conducted in Australia using data from 90 companies in the construction sector shows no correlation between these practices and the number of women in NTOs.[48] The studies listed in this section identify deeply rooted practices that are harmful to gender equity, and propose ways to mitigate them, other than through anti-discrimination legislation.

Examples of deeply rooted practices that threaten female participation in NTOs are listed in a study with women at the United States Army Corps of Engineers-South Atlantic Division (US-ACESAD): 1) work/life balance; 2) male dominance; 3) unfair perception of women's capabilities; 4) slow career progression; and 5) socio-cultural issues.[49] The study also mentions strategies that US-ACESAD have used to successfully mitigate these practices: 1) increased awareness by the public and private industry of the issues women face in construction; 2) shift in organizational policies to better address the needs of women; and 3) increase in leadership roles for women.

Another study discussed that crucial to attracting and retaining women and ethnic minorities is the mitigation of overt and covert sexist and racist behavior in the workplace.[50] The study also reported that significantly less support and encouragement was provided to women than men. The study recommended the following institutional changes specific to the construction trades:

- Include women and/or ethnic minorities on decision-making bodies.
- Create explicit equality policies in professional bodies and trade unions.
- Establish standards on gender and racial equality with major construction clients.
- Design a communications and marketing strategy for recruiting under-represented groups (including the development of publicity materials, web sites, and job fairs).
- Systematically provide information about the industry to schools and colleges with high ethnic minority population and community groups.
- Pilot career development schemes for non-traditional entrants to the industry.

[48] French, Erica and Glenda Strachan. 2015. "Women at Work! Evaluating Equal Employment Policies and Outcomes in Construction." Equality, Diversity and Inclusion: An International Journal; Birmingham 34 (3): 227–43.

[49] Azhar, Salman and Miranda K. Amos Griffin. 2014. "Women in Construction: Successes, Challenges and Opportunities – A USACE Case Study." In 50th ASC Annual International Conference Proceedings. Washington, DC. <http://ascpro0.ascweb.org/archives/2014/CPRT249002014.pdf>

[50] Dainty, A.R.J. , B. M. Bagilhole, K. H. Asaril and J. Jackson., 2004. Creating equality in the construction industry: An agenda for change for women and minorities. Journal of Construction Research, Vol. 5, pp. 75-86

- Target areas with new and large construction projects for focused recruitment activities.
- Provide equal opportunity training.
- Develop organizational guidance to tackle bullying.
- Create an organizational task group to monitor gender and racial inequality.

In another example of institutional change, the *Maine Department of Transportation's (DOT) Office of Equal Opportunity/Employee Relations* contracted with a private compliance consultant (the Portland YMCA) to provide oversight and monitoring of the DOT's civil rights goals over the four-year span (1994-1998) of the $157 million bridge replacement project. The DOT sought to increase the number of women on the project through "women friendly" practices. More than 60 women were employed on the project, which was attributed to 1) aggressive and daily monitoring of access and participation goals from the planning process to completion of the project and 2) the provision of near-site childcare during standard daytime hours, as well as early morning, evening, and overnight, making it possible for women and men with young children to work on the job.[51]

Other strategies discussed reforms at community colleges to increase women and minority participation in middle-skill green jobs career paths involving on-the-job experience. These strategies involved provision of support services, such as child care, flexible schedules, and transportation assistance.[52] *The Regional Center for Next Generation Manufacturing (RCNGM)* used 12 community colleges in Connecticut to address the demand for highly skilled, technical workers in the new manufacturing workplace. Strategies that addressed employment of women and minorities in these NTOs included:

- On-campus child care at all 12 community colleges campuses with sliding scale fees.
- Scholarships, including those funded by the National Aeronautics and Space Agency (NASA) and emergency funds at each community college to assist students with unanticipated costs.
- Academic advising and supports, including basic skills testing, developmental programs and English as a Second Language (ESL) courses.
- Tutoring (including on-line).
- Career planning and placement counselors.
- A Facebook page with chat rooms where students can communicate with each other about school projects and connect with mentors from industry and professional associations to ask questions.

The following outcomes were reported in the first five years of implementation: 1) the total number of students in RCNGM community college programs increased from 2,865 to 3,913, 2) women's enrollment increased from 540 to 630, 3) the number of students of Hispanic descent

[51] Ibid.

[52] Martinson, K., Stanczyk, A. & Eyster, L., 2010. Low-skill workers' access to quality green jobs, Washington, DC.

increased from 666 to 944, and 4) the number of African American students increased from 310 to 407.[53]

In addition to increased participation in trades, several programs have been implemented at the institutional level to increase the representation of female science and engineering faculty.[54] One is the *National Science Foundation (NSF) ADVANCE Institutional Transformation* grant program, which aims to transform academic cultures to increase the participation of women in academic science and engineering fields. ADVANCE change efforts require the participation of faculty and administrators from all levels of the institution and from a variety of disciplines. With nine institutions awarded grants in 2001 and 10 awarded in 2002, this multi-year and multi-campus ADVANCE initiative provided an opportunity to examine how academic and institutional cultures promote or impede institutional transformation.[55]

For instance, Virginia Tech received an ADVANCE Institutional Transformation grant in 2003 as part of the second round of grant awards. The university used its ADVANCE funding to take a comprehensive approach to institutional transformation, incorporating activities to increase the pipeline of women preparing for academic science and engineering careers, improve recruitment and retention of women, develop women leaders, update work-life policies, and develop warmer climates within academic departments.[56]

Assessment of the impact of ADVANCE on Virginia Tech included tracking the numbers of women at various levels across the institution, individual activity evaluations, campus-wide faculty surveys, tracking policy utilization, interviews, and focus groups. The general consensus based on surveys, focus groups, and interviews was that Virginia Tech had become more family-friendly than it used to be. Newer faculty members with families appeared to be having a different experience than their colleagues with more years of service. An important contributor to the university being more family-friendly was that men (e.g., deans and department heads) had become strong advocates for improvement and change.[57]

ADVANCE was also implemented at another research university dubbed 'Snow State University' between 2003 and 2009. This ADVANCE program implemented strategies to increase the transparency of the tenure-track promotion system, improve departmental work climates, improve faculty recruitment practices, assist in dual career accommodation, advance collaborative research opportunities, and improve campus childcare options.

[53] Costello, C., 2012. Increasing opportunities for low-income women and student parents in science, technology, engineering, and math at community colleges. Washington, DC: Institute for Women's Policy Research.

[54] Bakian, A.V., Sullivan, K.A. 2010. The effectiveness of institutional intervention on minimizing demographic inertia and improving the representation of women faculty in higher education. International Journal of Gender, Science and Technology, Vol. 2, No. 2, pp. 29-35.

[55] Plummer, Ellen (2006). Institutional transformation: An analysis of change initiatives at NSF ADVANCE institutions (Doctoral Dissertation).

[56] P. Layne and M. R. Hall, AC 2011-851: Impact of an NSF ADVANCE Institutional Transformation Grant at a STEM-Dominant University, presentation at the ASEE Annual Conference, 2011.

[57] Ibid.

The effectiveness of ADVANCE was evaluated using statistical modeling approaches, such as matrix population models and perturbation analyses. Institutional interventions were found to be effective at enhancing women faculty's representation among science and engineering faculty. A qualitative evaluation of the ADVANCE program implemented in California State Polytechnic University used several case studies to highlight that program's successful strategies.[58] Finally, *PROJECT Juno* was an initiative designed to improve gender friendliness and facilitate the career progression of female staff in university physics departments. Site visits to the UK's 47 physics departments informed the evaluation. The project stimulated advancement processes that equally encouraged men and women to apply; departmental structures/systems that supported/encouraged career progression of all staff equally; open, inclusive, transparent departmental structures; and flexible approaches that enabled individuals to optimize their institutional contributions.[59]

ADVANCE strategies to increase women in administrative and technical leadership roles

- An intensive coaching program for tenured women professors interested in strengthening their leadership skills
- Leadership fellowships allowing a small number of women to spend up to a year in a self-designed intensive leadership development experience
- Seed grants for pre-tenure women faculty to jump start their research programs.
- Informal lunches with current university leaders
- Visiting lectures by senior women already in leadership roles.

ADVANCE strategies to increase STEM faculty

- Developed a brochure (adapted from another ADVANCE institution) and presentation to educate search committee members on unconscious bias in evaluation
- Provided funding to departments to proactively invite potential faculty candidates to campus in advance of a formal search
- Established "liaisons" in the colleges of science and engineering to provide information about university policies on visiting faculty candidates.

Finally, one study[60] identified strategies to increase the diversity of undergraduate STEM disciplines, including:

- Increase institutional accountability by establishing information systems on students' demographics and declared major.
- Create strategic partnerships with programs that create lift.
- Unleash the power of the curriculum.

[58] Bakian, A.V., Sullivan, K.A. 2010. The effectiveness of institutional intervention on minimizing demographic inertia and improving the representation of women faculty in higher education. International Journal of Gender, Science and Technology, Vol. 2, No. 2, pp. 29-35.

[59] Main, P. & Dyer, J., 2009. The JUNO code of practice: Advancing women's careers in higher education. International Journal of Gender, Science and Technology, Vol. 1, No. 1, pp. 129–136.

[60] Estrada, Mica, Myra Burnett, Andrew G. Campbell, Patricia B. Campbell, Wilfred F. Denetclaw, Carlos G. Gutiérrez, Sylvia Hurtado, et al. 2016. "Improving Underrepresented Minority Student Persistence in STEM." CBE-Life Sciences Education 15 (3): es5.

- Address student resource disparities through institutional financial commitments to reduce disparity for low-income students.
- Foster creativity by connecting STEM students to community-based learning opportunities.

A similar study describes how England and Germany have increased women participation in STEM learning through numerous approaches. For example, in England schools can access the STEM Directories - supported by the Department of Education - to support STEM learning. Other initiatives include blogs and campaigns that "expose young people to STEM careers." Germany has an overarching infrastructure in place to teach school-aged individuals about different career choices, including special programs aiming to attract women to STEM jobs.[61]

3.1.3 Targeted Recruitment Practices and Materials

Strategies associated with targeted recruitment practices and materials are designed to correct inaccurate perceptions of NTOs, mitigate the inhibitions of NTO populations regarding these fields, and highlight the benefits of NTOs. Targeted recruitment practices tailored specifically to women and minorities seek to 1) overcome the barriers imposed by perceptions and characteristics of NTOs and 2) provide much needed support services and funding.

Targeted recruitment practices and materials correct the perceptions associated with NTOs and highlight the benefits of NTO employment for women and minorities.

Comprehensive Approaches to Increasing Enrollment and Success in STEM. A pilot program to help existing college/university programs increase the participation of women in nanotechnology was introduced by DOL in Chicago area community colleges. The program involved nano-related courses, lab tours, seminar series, mentoring, peer support programs, and internships.[62]

Another project, *CalWomenTech*, funded by the NSF, aimed to increase the number of women who enroll and succeed in a wide range of STEM fields – including computer networking and information technology, 3D animation and video game art, and geographic information systems at eight community colleges.[63,64] At the outset, each college was invited to identify one or two technology programs where women were underrepresented. Colleges joined the *CalWomenTech Project* in two phases: cohort one started in May 2007, cohort two in January 2008. The colleges used several strategies to achieve their aim, including:

- Customized recruitment tools with photographs of female graduates from the college's STEM programs along with program and labor market information.

[61] Hutchinson, Jo. 2014. 'Girls into STEM and Komm mach MINT': English and German approaches to support girls' STEM career-related learning.' Journal of the National Institute for Career Education and Counselling (32:1) 27-34

[62] Women in Nanotechnology PowerPoint Slides. University of Illinois at Chicago website. Retrieved from http://www.uic.edu/orgs/win/images/WINpowerpoint%5B1%5D.pdf

[63] Costello, C., 2012. Increasing opportunities for low-income women and student parents in science, technology, engineering, and math at community colleges. Washington, DC: Institute for Women's Policy Research.

[64] Milgram, D. (2009). The CalWomenTech Project: Increasing Recruitment and Retention of Female College Students in Technology Courses. In WEPAN 2009 Conference. Alameda, CA: Institute for Women in Trades, Technology and Science (IWITTS), pp. 1–5.

- Adoption of instructional approaches and curriculum appealing to female interests and support development of women's skills – for instance, using classroom examples based on women's learning styles, ensuring both women and men participate equally in labs, and increasing the number of collaborative projects.
- Leadership teams made up of a broad cross-section of leaders at each college to promote institutionalization of gender equity in STEM education at each institution.
- Annual recruitment and retention plan at each college, building on what was most effective in supporting women students during the previous year.
- Training for college faculty that includes information on women's learning styles and strategies for integrating women into the STEM classroom.

Of the four community colleges participating in the project's first research group, the two sites that implemented project recruitment strategies within the recommended timelines had an increase in female participation in their targeted programs of 10 to 15 percent. A college able to complete only one of the four strategies before the fall semester (posters) had a smaller increase of 5 percent, while the college not implementing any of the strategies had a decrease of 3 percent. The retention strategies implemented in the *CalWomenTech* Project led to a significant net increase in the completion rates of not only females, but also males in several of the colleges.[65]

Motivating Women to Pursue STEM-related Careers. One study exploring *motivation of women* asked why some physics departments are more successful at graduating female students than others, as well as at increasing the participation of women in physics.[66] Recruitment and retention of women in undergraduate physics was evaluated by conducting site visits to six physics departments in women's colleges. These departments were compared to one another and to the nine departments in coeducational schools studied in phase 1 of the project. Effective strategies included:

- Working to instill confidence in female students.
- Developing collaborative pedagogical methods that emphasize group work and exploratory labs.
- Providing individualized career information and networks for students.
- Providing female role models.
- Creating an open and informal as well as a female-friendly culture in physics departments.

The study noted that, while no one factor is essential, many small factors together can increase interest among female college students in pursuing physics careers.[67] Institutions, faculty members, and students all have roles to play in creating the new culture. Successful schools reach out to introductory students and integrate them into the department cultures.

[65] Ibid.
[66] Whitten, B.L., et al. 2007. What works for women in undergraduate physics and what we can learn from women's colleges. Journal of Women and Minorities in Science and Engineering, Vol. 13, pp. 37–75.
[67] Ibid.

While recruiting women for STEM oriented jobs, several studies have specially highlighted the benefit of advertising for positions using venues that target women. One suggests that by mandating that search committees post job openings in outlets specifically targeted to women scholars, affirmative action offices, college administrators, and department heads can take clear steps toward increasing the number of women who apply for faculty positions in STEM fields.[68]

A different approach was undertaken by a study that focused on exposing undergraduate female students to research opportunities in STEM fields – not only to show them examples of possible careers, but also to introduce them to possible mentors and role models who can help them in their decision process.[69] The program included women participating in a single-sex living and learning community (LLC) that focuses on women in STEM majors at a large research-focused university in the United States. These women lived together on the same floor of a dormitory on campus during their first university year. The shared living space promoted a supportive environment where participants could find mentors and support within their STEM majors. In addition, the students were encouraged to participate in research activities beyond the classroom and attend a weekly one credit course, typically given by female scientists in different STEM fields. Students also attended monthly lab visits as part of the women in STEM program. Participants in the program also had access to free tutoring throughout their university experience.

According to the participants interviewed, the program was highly influential in their decision to remain in STEM majors. All participants cited both their research opportunities and the mentors they found as a result of these opportunities as a positive influence on their STEM career choice. All participants also mentioned the positive effect of the social network they had within the program, and said they found the supportive environment crucial in helping them through the difficulties of the STEM major.

Another study conducted eight Appreciative Inquiry (AI) focus groups held with tenure-track and tenured faculty in the Colleges of Science and Engineering at Cal Poly Pomona's (CPP), with the goal of ascertaining current strengths in recruitment and career development efforts for new STEM female faculty.[70] The inquiry was part of the *CPP ADVANCE* program. The AI focus group findings recommend a series of best practices for improving the career development of women STEM faculty at CPP, including:

- Actively develop opportunities for women faculty to mentor and network with one another.
- Teach senior faculty how to effectively mentor junior, tenure-track faculty.
- Create equitable and standardized family-friendly policies and supportive services, such as maternity/paternity leave, tenure clock stoppage, and flexible hours.

[68] Glass, C., & Minnotte, K. L. (2010). Recruiting and hiring women in STEM fields. Journal of Diversity in Higher Education, Vol. 3, No. 4, pp. 218–229.
[69] Hughes, R. M. (2010). Keeping University Women in STEM Fields. International Journal of Gender, Science and Technology, Vol. 2, No. 3, pp. 417–436.
[70] Nemiro, J. E., Hacker, B., Ferrel, M. L., & Guthrie, R. (2009). Using appreciative inquiry as a tool to instigate transformational change in recruiting and developing women faculty in STEM disciplines. International Journal of Gender, Science and Technology, Vol. 1, No. 1, pp. 5–35.

Attracting and Retaining Women in Different NTO Sectors. One study shows that, while women are 83 percent of workers in middle-skill occupations - those paying less than $30,000 a year - they are only 36 percent in 'good' middle-skill occupations paying at least $35,000 a year.[71] The study also details the proportion of women in specific sectors, such as IT occupations (29 percent), construction (3 percent), and advance manufacturing (7 percent). Based on the premise that "women are an underutilized resource to address middle-skill job shortages, the study provides key steps for employers to attract and retain female workers:

- Reviewing recruitment and outreach materials to ensure the use of inclusive language and images.
- Ensuring that the channels for advertising vacancies and opportunities reach women as well as men.
- Reviewing recruitment and selection processes to ensure that they are free of gender bias and affirmatively encourage female talent.
- Ensuring that women, just as men, have adequate facilities, including protective gear that is appropriate to different body types and facilities that are sanitary and safe.
- Actively encouraging an inclusive environment and clearly communicate that hostile behaviors, such as harassment and discrimination, are not acceptable.
- Communicating that women as well as men are expected to advance and thrive in the company.
- Being deliberate: setting targets and measuring their company's progress to greater gender inclusiveness.

Other studies explored strategies for attracting and retaining women for a more specific sector: construction. Using a literature review, open-ended survey, follow up interviews, and a final brainstorming session, one study deemed the following strategies most effective in increasing female representation in construction management programs[72]:

- Mentoring.
- Targeting the audience and community while recruiting.
- Countering negative stereotypes by promoting positive images and role models.
- Hiring female faculty.
- Establishing women in construction clubs.
- Having recruitment efforts led by female faculty.

[71] Hegewisch, Ariane, Marc Bendick Jr, Barbara Gault, and Heidi Hartmann. 2016. Pathways to Equity: Narrowing the Wage Gap by Improving Women's Access to Good Middle-Skill Jobs. Washington, DC: Institute for Women's Policy Research. <http://www.iwpr.org/publications/pubs/pathways-to-equity-narrowing-the-wage-gap-by-improving-women2019s-access-to-good-middle-skill-jobs>

[72] Puerto, C., Guggemos, A, Shane, J., (2011). Exploration of strategies for attracting and retaining female construction management students. 47th ASC Annual International Conference Proceedings.

Another study listed successful approaches used in two construction projects that targeted high female representation in the workforce (the University of Massachusetts Boston and the Vikings Stadium):[73]

- Apprenticeship readiness programs expand entry points into the trades.
- Adapting apprenticeship programs to increase diversity.
- Targeted recruitment where low-income residents reside.
- Early start with outreach to schools.
- Advertisement.

Other successful measures listed in the report relate to effective compliance (including written commitments to the female inclusion goals, surveillance by watchdogs and the community, and effective compliance of subcontractors), and an approach of creating careers, and not jobs (including addressing hostile environment for women and discrimination, involving unions, and ensuring diverse core crews).

Minority Participation in NTOs and STEM-related Careers. Most programs oriented towards increasing participation in NTO and STEM related careers focus on women. However, *Duquesne University's School of Nursing, Pittsburgh* established a *Center for Health Care Diversity* to educate and train minorities to become nurses and/or allied health professionals; educate minority nurses in health policy; conduct nursing-focused research; and perform community service. The Robert Wood Johnson Foundation (RWJF) provided $50,000 to help support the center's activities from April 2000 to October 2003.[74] The project:

- Enrolled 43 students in the Health Careers Internship Program. Of these, 19 are still enrolled in high school, eight are working, and 16 are in higher education.
- Awarded minority education scholarships in 11 nursing schools to about 20 students each year beginning in 2000.
- Secured speakers for Black History Month programs in February 2001, 2002, and 2003.
- Held two town meetings for working nurses on eliminating racial and ethnic disparities.

Further, the National Institute for Health's *Research Initiative for Science Excellence (RISE)* program is an example of a program aimed at encouraging minority undergraduate students to pursue a research career in the biomedical sciences. The RISE programs typically receive around $600,000 per year to support about 25 undergraduates and five master's-level graduate students. Although each grant-receiving campus has flexibility in structuring its program, the programs typically include faculty mentoring of students, on-campus research opportunities, graduate school preparation, summer research internships, funding to attend and present at professional conferences, and substantial annual stipends.

[73] Johansson, Erin and Benjamin Woods. 2016. Building Career Opportunities for Women and People of Color: Breakthroughs in Construction. Jobs With Justice and North America's Building Trades Unions Tradeswomen Committee. <http://www.jwj.org/wp-content/uploads/2016/12/JWJEDU_NABTU_Report_2016_OnlineVersion_small.pdf>.

[74] Pittsburgh Center to Recruit and Retain More Minority Nurses to Improve Minority Health. Robert Wood Johnson Foundation website. Retrieved from http://www.rwjf.org/reports/grr/038365.htm.

One study examined the effectiveness of the *RISE* program using propensity score matching as well as hierarchical linear modeling approaches.[75] Their results provide strong evidence of the ability of the RISE program to sustain student intentions to pursue a research career. Importantly, the effect of research experience was not limited to students from a funded program. Although students from RISE funded programs were substantially more likely to show a sustained interest in science, non-funded students who engaged in research also showed more interest in science than did matched students without this experience.[76]

Summary of Targeted Recruitment Practices and Materials Strategy:

- Addresses the inaccurate perceptions of NTOs, mitigates the inhibitions of NTO populations regarding these fields and highlights the benefits of NTOs.
- Directed to women and minority populations in universities, colleges, and workplaces.
- Designed to increase employment, retention, and advancement in NTOs.
- Strategy examples:
  - *CalWomenTech* using comprehensive approaches such as customized recruitment tools, instructional approaches, and curriculums that appeal to female interests.
  - *RISE* program encouraging minority students to pursue science careers through on-campus research opportunities, summer research internships, and annual stipends.
  - *A construction management program* using a comprehensive approach including mentoring, targeting the audience and community while recruiting, promoting positive images and role models, establishing female only clubs and recruitment efforts led by female faculty.

Summary of Effectiveness:

- Evidence suggests that students undergoing such programs are more likely to show a sustained interest in science careers.
- Evaluations are largely quantitative, using semi-structured interviews and focus groups and recommending systematic recruitment strategies targeted at women and minorities.

3.1.4 Family-Friendly Policies and Supportive Practices

Family Supportive Practices (FSPs) tend to benefit women who more often are the primary caregivers for their parents and their children, thus enabling them to participate in training programs and/or the workforce.

Labor force participation rates demonstrate that mothers are more likely to be out of the workforce completely or work part-time than their male counterparts.[77] This pattern is also apparent in participation rates for training/apprenticeship programs. Enrollment rates for

[75] Schultz, P. W., Hernandez, P. R., Woodcock, A., Estrada, M., Chance, R. C., Aguilar, M., Serpe, R. T. 2011. Patching the pipeline: Reducing educational disparities in the sciences through minority training programs. Educational Evaluation and Policy Analysis, Vol. 33, No. 1, pp. 95–114

[76] Ibid.

[77] Dey, J, G., and Hill, C., (2007) Behind the pay gap. American Association of University Women Educational Foundation.

women in RA programs are lower than those for men and even lower in programs for the higher paying skill trades.[78] Women also complete RAs in the skilled trades less often than men.[79]

Family-friendly policies and supporting practices - such as subsidized child care, maternity leave, and elder care - enable women and minorities to obtain, retain, and be successful in NTOs.

In a qualitative study that examined the experiences of women in a registered apprenticeship program, women reported their limited access to child care as a major challenge to their participation in apprenticeship programs.[80] The respondents noted inflexible and demanding work schedules, difficulty paying for child care, and managers intolerant of absences and tardiness due to child care issues as specific barriers to their participation.[81]

Similar barriers have been cited by women in professional STEM disciplines. The demands of family and home life have also been cited as reasons why STEM women in academia are more likely to be employed in nontenured positions, take longer to achieve tenure, and are less likely to achieve tenure at all.[82]

In this regard, FSPs address negative training/occupational characteristics, such as inflexible work schedules and promotion practices that discourage mothers from entering and/or staying in an NTO due to competing family demands. FSPs aim to reduce work-family conflict and increase job retention and satisfaction. Training providers and employers are normally responsible for FSPs, and provider types, costs, and time involved depend on the specific FSP.

Common types of FSPs involve providing/subsidizing child care; facilitating flexible work schedules, including the provision of high-quality part-time opportunities; and making changes to the process and requirements associated with promotions.[83,84]

Based on interviews with apprenticeship stakeholders, one study recommends providing child care subsidies to participants and offering classes that better accommodate the schedules of single mothers, to increase women's success in apprenticeship programs.[85] It also reported that aiding mothers in developing a detailed child care plan may be helpful in ensuring their success in an RA program.[86]

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[78] Reed, D., Liu, A. Y.-H., Kleinman, R., Mastri, A., Reed, D., Sattar, S., & Ziegler, J. (2012). An effectiveness assessment and cost-benefit analysis of registered apprenticeship in 10 states (pp. 158). Washington, DC.
[79] Ibid.
[80] Ibid.
[81] Ibid.
[82] Wachs, F. L., & Nemiro, J. (2007). Speaking Out on Gender: Reflections on Women's Advancement in the STEM Disciplines. Journal of Women and Minorities in Science and Engineering, Vol. 13, No. 1, pp. 77–94.
[83] GAO (Government Accountability Office). 2004. Women's participation in the sciences has increased, but agencies need to do more to ensure compliance with Title IX. GAO Highlights. Available at www.gao.gov/cgi-bin/getrpt?GAO-04-639.
[84] Dey, J, G., and Hill, C., (2007). Behind the pay gap. American Association of University Women Educational Foundation.
[85] Reed, D., Liu, A. Y.-H., Kleinman, R., Mastri, A., Reed, D., Sattar, S., & Ziegler, J. (2012). An effectiveness assessment and cost-benefit analysis of registered apprenticeship in 10 states (pp. 158). Washington, DC.
[86] Ibid.

A web and telephone survey of predominantly four-year universities and colleges conducted by the Center for Education of Women at the University of Michigan found that institutions use a mix of policies and programs to help faculty members balance their family and professional responsibilities.[87] The practices reported to create the greatest potential benefit for faculty included stopping the tenure clock, modified duties, paid maternity leave, paid dependent care, and the existence of a unit or individual assigned to assist faculty with work-family issues.[88]

One study detailed innovative strategies that eight job-related programs have developed to assist their participants in a myriad of ways:[89]

- **Child care**, by either offering a staff member dedicated to this task, or helping participants apply for child care assistance.
- **Financial assistance** through emergency cash or in-kind assistance, such as books, uniforms, and tools.
- **Transportation**, from gas cards to free or reduced-cost public transportation passes.
- **Mental health counseling** through individual or group meetings with licensed mental health professionals.
- **Domestic violence services**, through trainings to program staff members that are tasked to assist participants in need.

In contrast to the relatively high number of papers proposing strategies, few papers provide evidence to support the effectiveness of FSPs. Furthermore, because some studies have evaluated the effectiveness of programs/approaches in combination with other strategies, it is challenging to isolate the effects of the FSPs.[90] Findings from a meta-analysis that examined the relationships between such policies and employee outcomes found that policies providing support for dependent care to employees had modest positive relationships with job satisfaction, affective commitment, and intentions to stay.[91] But even these findings are not specific to the outcomes of employees in NTOs.

Irrespective of the limited evidence supporting the effectiveness of FSPs in reducing barriers to NTOs, one study finds it "unlikely that market forces alone will lead to the widespread adoption of such programs."[92] Findings from this study suggest that organizations adopt different FSPs in

[87] Sullivan, B., Hollenshead, C., & Smith, S. (2005). Developing and implementing work-family policies. Retrieved from the Center for the Education of Women web site: http://www.cew.umich.edu/research/resnow.htm

[88] Sullivan, B., Hollenshead, C., & Smith, S. (2005). Developing and implementing work-family policies. Retrieved from the Center for the Education of Women web site: http://www.cew.umich.edu/research/resnow.htm

[89] Anderson, Julie and Cynthia Hess. 2017. Programs to Support Job Training Success: Innovations to Address Unmet Needs. Report, IWPR #C450. Washington, DC: Institute for Women's Policy Research. <https://iwpr.org/publications/programs-support-job-training-success-innovations-address-unmet-needs/>

[90] Bakian, A.V., Sullivan, K.A. 2010. The effectiveness of institutional intervention on minimizing demographic inertia and improving the representation of women faculty in higher education. International Journal of Gender, Science and Technology, Vol. 2, No. 2, pp. 29.

[91] Butts, M. M., Casper, W. J., & Yang, T. (2013). How important are work–family support policies? A meta-analytic investigation of their effects on employee outcomes. *Journal Of Applied Psychology*, Vol. 98, No. 1, pp. 1-25.

[92] A. Davis, A. Kalleberg. 2006. Family-friendly organizations? Work and family programs in the 1990s. Work and Occupations, Vol. 33, No. 2, pp. 191-223.

response to a range of economic and institutional pressures.[93] The increased legitimacy of these practices is likely to lead to more widespread adoption of FSPs as employer organizations appear especially responsive to institutional pressures when adapting such policies. Government mandates to adopt FSPs may help to fuel findings of increased efficacy.[94]

Summary of Family-Friendly Policies and Supportive Practices Strategy:

- Addresses negative training/occupational characteristics that discourage mothers from entering and/or staying in an NTO career due to competing family demands.
- Directed to training providers and employers.
- Designed to aid mothers in successfully balancing NTO and family obligations.
- Strategy Examples:
  - Providing child care subsidies to participants and offering classes that better accommodate the schedules of single mothers.
  - Aiding mothers in developing a detailed child care plan.
  - Female faculty friendly policies including stopping the tenure clock, modified duties, paid maternity leave, paid dependent-care, and the existence of a unit or individual assigned to assist faculty with work-family issues.

Summary of Effectiveness:

- Some evidence suggests that family supportive practices have positive impacts on employee outcomes.
- It is challenging, however, to isolate the effects of such policies as they have been implemented in combination with other interventions.

3.1.5 Professional Development for Career Counselors

Strategies associated with professional development for career counselors are designed to fight biased career materials, mechanisms, and practices that are part of some career counseling programs.[95] Internal and external barriers – such as early gender-role orientation, employment inequities, and family responsibilities – can complicate and restrict a woman's career choice and advancement. Career counselors who lack knowledge and sensitivity towards these issues will not be fully equipped to assist women in their career choices, and may be leading them away from NTO fields.[96,97] Another obstacle related to professional development concerns the lack of minority counselors in the field of career planning and placement, leaving minority students without the option of seeing a counselor that may be best suited to help them.

[93] Ibid.
[94] Ibid.
[95] Coogan, P. A. & Chen, C.P., 2007. Career development and counseling for women: Connecting theories to practice. Counseling Psychology Quarterly, Vol. 20, No. 2, pp. 191–204.
[96] Ibid.
[97] Francis, Valerie and Adele Prosser. 2014. "Exploring Vocational Guidance and Gender in Construction." International Journal of Construction Education and Research 10 (1): 39–57.

This strategy involves interventions – such as training programs, disseminating literature, among others – sensitizing counselors to the specific challenges and job trends facing women and minorities professionally, making sure counselors are aware of their own biases regarding gender/race and career development, having counselors challenge their own assumptions about career paths, and improving their students' self-efficacy to help women and minorities to consider NTOs. These strategies were mostly implemented in career counseling centers of universities, colleges, or workplaces.

Professional development for career counselors sensitizes them to the challenges women and minorities face in a professional environment.

The literature has shown that career counseling programs that focus on several key areas can help women find ways in which they feel more comfortable and confident exploring NTO options.[98] These include: providing information about reputable childcare facilities, developing knowledge and awareness of job trends affecting women, and helping the client recognize that NTO careers are real options for women. These interventions can also help career counselors provide accurate information to members of NTO populations that may change their negative perceptions.

Career Counseling Program Targeting Minorities. Ohio State University instituted a career counseling program targeting minorities. Staff at Ohio State University developed a training program that would not only introduce minorities to career planning and placement but also provide an additional professional development opportunity for minority staff within the university.[99] *Creating Options: A Career Development Program for Minority Staff* was delivered to five staff members selected from among an applicant pool of 22 existing staff members. The recruitment and outreach process followed specified principles for attracting nontraditional applicants. The outreach and training program included orientation sessions before having to commit to the program and an application process that allowed applicants to express their motivation and experience in a personal way.

The evaluation component of the program was only described in general terms. Individuals completed a self-assessment and personal development inventory both before and after receiving the intervention. However, no mention of the specific evaluation methodology makes the rigor of this study unclear. The authors concluded that the program was successful in increasing minority staff's career counseling skills because "one of the participants is now assistant director of Career Planning and Placement at another institution and another is enrolled in a master's program. All five participants reported that the program has contributed significantly to their professional development, both in their current positions as well as in their future plans. While this is a promising finding, the unclear evaluation methodology underlying it requires that it should be taken with caution.

[98] Coogan, P. A. & Chen, C.P., 2007. Career development and counseling for women: Connecting theories to practice. Counseling Psychology Quarterly, Vol. 20, No. 2, pp. 191–204.

[99] Campbell, N.K. & Hadley, G.B., 1992. Creating options: A career development training program for minorities. Journal of Counseling & Development, Vol. 70, No. 5, pp. 645–647.

One study suggested several different possible interventions to help *sensitize career counselors* to career development issues women face.[100] Each intervention teaches the career counselor a new technique to combat the problem. The first technique taught is to broaden a female counselee's experience by exposing her to a wide variety of roles and tasks in a workplace. The second technique is learning how to debunk and dispel gender-based perceptions of occupations. The final intervention teaches the counselor sensitivities to different levels of awareness and cognitive complexity. This study is purely theoretical, and there has been no evaluation of the interventions described.

Finally, another study described an intervention to help career counselors *encourage men to enter* NTOs.[101] The study emphasizes that gender role socialization is the root cause of many of men's misgivings and misconceptions about NTOs, and that career counselors are in a unique position to fight such fears. The authors suggest an intervention raising awareness and understanding of these challenges among career counselors through written or oral materials.

Summary of Professional Development for Career Counselors:

- Addresses bias communicated through career materials, mechanisms, and practices, and perceptions of and response to the characteristics of NTOs.
- Directed to career counselors in post-secondary schools and workplaces.
- Designed to increase employment, retention, and advancement in NTOs.
- Strategy examples include:
  - Ohio State University's career counseling program targeting minorities.
  - Exposing women counselee's experience to a wide variety of roles and tasks in a workplace.
  - Teaching the counselor sensitivities to different levels of awareness and cognitive complexity.

Summary of Effectiveness:

- Several publications posited different types of interventions, with claims that these interventions would have a positive effect on NTO entry.
- Only one publication (*Creating Options: A Career Development Program for Minority Staff*) implemented the intervention described and performed an evaluation of it. The evaluation was described in very general terms, however, leaving its rigor unknown.
- Little concrete evidence exists of this strategy's effectiveness or ineffectiveness.

3.1.6 Professional Mentoring Programs

Formal mentoring programs in the workplace are a strategy that seeks to help members of NTO populations overcome barriers related to biased career materials, practices, and mechanisms. New hires from NTO populations in NTOs are given a mentor, often with the same gender/race as the mentee, to guide their career development and provide support in miscellaneous ways.

[100] Bourne, D., & Özbilgin, M. F. (2008). Strategies for combating gendered perceptions of careers. Career Development International, Vol. 13, No. 4, pp. 320–332. doi:10.1108/13620430810880817

[101] Jackson, Z. V., Wright, S. L., & Perrone-McGovern, K. M. (2010). Work-family interface for men in nontraditional careers. Journal of Employment Counseling, Vol. 47, No. 4, pp. 157–166.

Mentors are meant to combat racist, sexist, and otherwise hostile work environments, fight the isolation often reported in NTOs, and give the mentee a sense of direction in the workplace.[102]

One example of such a program is the *Girl's E-Mentoring in Science, Engineering and Technology* (GEM-SET) initiated by DOL. Set up as a one-year program, this initiative was designed to connect women mentors in science, engineering, and technology (SET) with girls through a listserv. The purpose of the program was to encourage girls to explore the educational and career opportunities in SET and promote networking opportunities for women.

Professional mentoring programs guide career development and provide professional support to women and minorities in NTOs.

Another study addressed the challenges female faculty members face in attaining leadership roles on campuses. Three women faculty members from the Mississippi State University system started a leadership development program called WomenLEAD for female faculty members in the colleges in that system. The program advised and supported women faculty of all ranks to encourage them to assume leadership positions, including administrative appointments, and to serve on important decision-making bodies.[103] The program consisted of eight sessions but not all participants attended every one of them. In each session, WomenLEAD program leaders shared information with participants and led frank discussions among them.

Participants reported in a survey that the WomenLEAD program had helped elevate their professional confidence and provided them with a network of trustworthy, high ability, and accomplished women. They also commented in the survey that their communication skills and awareness of gender disparities had improved after participating in the program. However, the participants remained somewhat uncomfortable with suggestions to alter their behavior during negotiations.

One of the most successful strategies of the CPP *ADVANCE* program (noted in Section 2.2) involved pairing senior female faculties with their junior counterparts as mentors to provide guidance and support.[104] At the onset of the grant, there was no formal mentoring program for STEM women or any faculty at CPP. Informal mentoring for STEM women began in October 2007, when ADVANCE created JavaNet, weekly coffee and conversation sessions to encourage informal networking and mentoring among STEM women faculty. Later, a more formal mentoring program was established, which involved:

- Mentoring in pairs with senior faculty partnered with junior faculty.
- Mentoring circles that were small groups of mentoring pairs who gathered together informally (usually over lunch) once per quarter to share ideas and support.
- Mentoring face-to-face kick-off training that was a one-hour luncheon discussion of relevant skills for mentors and mentees.

[102] B. Byrd. 1999. Women in carpentry apprenticeship: A case study. Labor Studies Journal, Vol. 24, No. 3, pp. 3-22.
[103] Hodges, J., Pearson, A., & Reese, D. (2011). WomenLEAD: Leadership development for female faculty in business and engineering. International Journal of Gender, Science and Technology, Vol. 3, No.2, pp. 331–337.
[104] Nemiro, J., Hacker, B., Tucker, S., Ferrel, M. L., Prall, D., & Dejonghe, E. (2011). Evolution of a faculty mentoring program for stem women. International Journal of Gender, Science and Technology, Vol. 3, No. 3, pp. 644–658.

- Quarterly hot topic workshops and women's mentoring and networking lunches that included topics such as managing difficult working relationships, faculty burnout and stress, identification of gender bias, time management, and developing emotional intelligence.
- A full-day training seminar for all women faculty who were current or prospective participants in the ADVANCE mentoring program.

Anecdotal reports from participants indicated that involved faculty members felt a greater connection to the university community and were more willing to stay as a result of their experience in the mentoring program.

Another program called *UK Resource Centre for Women in Science, Engineering and Technology (UKRC)* was designed to increase the participation of women in SET-related public appointments.[105] The mentoring scheme was first launched in 2007 to support women interested in gaining a public appointment by helping to build confidence and knowledge in the recruitment process and to show the reality of public work once appointed. The Centre piloted a role model mentor scheme by pairing women who had an interest in public appointments with male and female mentors. The women mentees were to gain an insight into the workings of a public body and the process of application through their contact with the mentor and the public bodies they were part of. Women taking part were to get the information, advice, and encouragement they needed to feel confident about making a strong application. Each program was evaluated through questionnaires to both mentors and mentees.

According to the responses, the mentoring schemes had a positive impact on mentees' knowledge of public body applications and on their confidence when applying. While some mentees learned they need to develop their experience and knowledge further before applying for vacancies, all those participating reported that they were better placed to apply by the end of the program.

A qualitative study based on the mentoring experiences of nine male managers in the chemical industry sheds light on the male managers' mentoring perceptions and beliefs in mentoring females. The study revealed that, despite male managers' own experiences in being mentored, most were ambivalent as to whether being mentored was necessary for women to "get ahead." Most male managers thought mentoring was important for career advancement and did not believe the presumed benefit of mentoring varied for women as compared to men. However, the relatively few managers who did note mentoring as a strategy specific to advancing women in their companies were most often the same managers who recounted specific experiences in mentoring women.[106]

[105] Morton, P., & Tobell, R. (2011). Public body mentoring: Encouraging women to play a part in SET decision making. International Journal of Gender, Science and Technology, Vol. 3, No. 1, pp. 94–100.

[106] Paquin, J. D., & Fassinger, R. E. (2011). Male managers' perceptions of the role of mentoring in women's career advancement in the chemical industry. Journal of Women and Minorities in Science and Engineering, Vol. 17, No. 1, pp. 51–68.

Summary of Professional Mentoring Programs Strategy:

- Addresses barriers related to biased career materials, mechanisms and practices and combating racist, sexist, and otherwise hostile work environments.
- Directed to women and minorities with STEM related careers.
- Designed to increase employment, retention, and advancement in NTOs.
- Strategy Examples:
  - GEM-SET (initiated by DOL) connecting women mentors in science, engineering, and technology (SET) with girls through a listserv.
  - ADVANCE program pairing senior female faculty with junior female faculty.
  - UKRC's role model mentor scheme involving pairing women who had an interest in public appointments with male and female mentors.

Summary of Effectiveness:

- Several studies claimed that mentoring programs have a positive effect on entry as well as retention of a STEM related career.
- Evaluations are largely qualitative, use semi-structured interviews and focus groups, with most evaluations including self-assessments and based on self-reported measures on a survey.

3.2 EDUCATION-BASED STRATEGIES

This section covers strategies and barriers to NTO entry found in K-12, community/vocational college programs, bachelor's programs, and graduate programs. The NTOs targeted by these strategies exclusively relate to enrollment and persistence in STEM courses and to pursuing careers in STEM fields.

While the outcomes for these strategies do not generally include such things as increased participation or retention in NTOs, they are included in the literature review because STEM-related programs are highly correlated with NTO participation in fields such as engineering, physics, other physical sciences, and some technology fields.[107,108] These strategies mostly target women and minorities, with a large portion of the literature discussing barriers that individuals from disadvantaged groups face in educational settings. These barriers are as follows:

- **STEM Academic Proficiency.** Since academic skill gaps exist from the moment individuals enter elementary school, education programs must always be prepared to handle a wide range of academic skill levels.[109] Several publications revealed systematic gaps between the academic performance of certain minority groups and the general student

[107] Jacobs, J.E., 2005. Twenty-five years of research on gender and ethnic differences in math and science career choices: what have we learned? New Directions for Child and Adolescent Development, Vol. 110, pp. 85–94.
[108] National Science Foundation. Women, minorities, and persons with disabilities in science and engineering. Arlington, Va.: National Science Foundation, May 2004
[109] Crosnoe, Robert et. al. 2010. Instruction, teacher-student relations, and math achievement trajectories in elementary school. Journal of Educational Psychology, Vol. 102, No. 2, pp. 407-417.

population.[110,111,112] The literature provides significant evidence that these STEM skill gaps, if unaddressed, only widen as students' progress through the school system.[113]

- **Access to and Participation in STEM Education.** Access to and participation in STEM education, such as academic proficiency, varies dramatically from individual to individual irrespective of NTO status. However, the literature found that differences in access to and participation in STEM education may be systematically affecting women and minorities' ability to enter NTO occupations. According to one study, not only are women and minorities underrepresented in the population of initial enrollees, but minority and women students also drop out more frequently than the general population.[114] Several studies show that women and minorities, typically disproportionately underrepresented in STEM majors, suffer significantly lower graduation rates due to a wide number of problems stemming from suboptimal curricula and instructional styles.
- **Biased Curriculum Structure and Instructional Attitudes**. Curricula and instructional attitudes have the power to discourage completion of educational programs essential for entry into particular NTO fields. Some examples of these causes in the literature were the creation of feelings of isolation,[115] and the imposition of gender roles and expectations onto the students.[116] Two qualitative studies examining the attitudes of women in undergraduate and technical STEM programs arrived at several particularly pertinent conclusions regarding this barrier to NTO entry.[117,118] Through several rounds of classroom observations, instructors and curricula established the content material as a "male domain," using masculine forms of communication and cultivating an environment of male dominance. The same study identified that this curricula/instructional style contributed to female students' sense of isolation and feelings of being out-of-place.
- **Stereotype Threat**. The risk of realizing a negative stereotype associated with one's group has been shown to negatively affect the academic performance of women as well as their

[110] Santos, Silvia J.; Reigadas, Elena T, 2002. Latinos in higher education: An evaluation of a university faculty mentoring program. Journal of Hispanic Higher Education, Vol. 1, No. 1, pp. 40-50.

[111] Hagedorn, L.S. & D. DuBray. 2010. Math and science success and nonsuccess: Journeys within the community college. Journal of Women and Minorities in Science and Engineering, Vol. 16, No. 1, pp. 31-50

[112] Alexander, B.B., Burda, A.C., and Millar, S.B. 1997. A community approach to learning calculus: fostering success for underrepresented ethnic minorities in an emerging scholars program. Journal of Women and Minorities in Science and Engineering. Vol. 3, pp. 145-159.

[113] Crosnoe, Robert et. al, 2010. Instruction, teacher-student relations, and math achievement trajectories in elementary school. Journal of Educational Psychology, Vol. 102, No. 2, pgs. 407-417.

[114] Griffith, A.L. 2010. Persistence of women and minorities in STEM field majors: Is it the school that matters? Economics of Education Review, Vol. 29, pp. 911–922

[115] Johnson, A.C., 2007. Unintended consequences: How science professors discourage women of color. Science Education, Vol. 91, No. 5, pp. 805–821.

[116] H. Carlone. 2003. (Re) Producing good science students: Girls' participation in high school physics. Journal of Women and Minorities in Science and Engineering, Vol. 9, pp. 17-34.

[117] Gunter, R., 2009. The emergence of gendered participation styles in science-related discussions: Implications for women's place in science. Journal of Women and Minorities in Science and Engineering, Vol. 15, No. 1, pp. 53–75.

[118] Lester, Jaime, Aoi Yamanaka & Brice Struthers. 2016. "Gender Microaggressions and Learning Environments: The Role of Physical Space in Teaching Pedagogy and Communication." Community College Journal of Research and Practice (40:11) 909-926

motivation to improve.[119] Since "academic stereotypes […] serve as gatekeepers," altering them may increase women's interest to STEM learning.[120]

- **Lack of Self-Efficacy**. Confidence in one's ability to successfully achieve a certain goal or perform a specific task influences both academic performance and career decision making.[121]

In addition to strategies that address these education barriers, the family plays an important role in mitigating such barriers at home. While existing research demonstrates the connection between family/parental involvement and the pursuit of NTO or STEM fields,[122] there is limited evidence to support specific strategies that facilitate such parental/family involvement. Family involvement addresses many universal barriers to NTOs, such as career gender stereotyping, lack of occupational information and role models, and inadequate family support/encouragement. Moreover, parents influence adolescents' aspirations more than peers. Although parental influence does not decay over the adolescent years, the fact that peer influences are stronger among girls than among boys may explain some of the barriers girls face as a group.[123]

Exhibit 6 summarizes key characteristics of the *Education-Related Strategies* identified in the literature – providing summary information for consideration when identifying a promising strategy or set of strategies for demonstration and evaluation. More specifically, the remainder of this section examines in detail the barriers for individuals studying in fields that will lead to NTOs, identifies relevant programs and services from the literature review, and summarizes the strategies and their effectiveness from the evidence described in the studies.

Exhibit 6. Summary of Education-Related Strategies

Target Age Group	Target Population Group	Setting of Intervention/ Strategy	Target Outcomes	Description
Strategy: Supplemental Education Programs				
K-12, College students	Women, Minorities	Universities, colleges	Increased interest in STEM subjects among participants.	Extracurricular activities and supportive services that encourage women and minorities to take an interest in STEM fields through community-based and interactive exercises.
Strategy: Curriculum Development				

[119] Fogliati, V. J., & Bussey, K. (2013). Stereotype threat reduces motivation to improve: Effects of stereotype threat and feedback on women's intentions to improve mathematical ability. *Psychology of Women Quarterly*, Vol. 28, No. 3, pp. 310–324.

[120] Cheryan, Sapna, Allison Master, and Andrew N. Meltzoff. 2015. "Cultural Stereotypes as Gatekeepers: Increasing Girls' Interest in Computer Science and Engineering by Diversifying Stereotypes." Frontiers in Psychology 6. <http://journal.frontiersin.org/article/10.3389/fpsyg.2015.00049/full>

[121] Quimby, J. L., & O'Brien, K. M. (2004). Predictors of student and career decision-making self-efficacy among nontraditional college women. *Career Development Quarterly*, Vol. 52, No. 4, pp. 323–339.

[122] Turner, R., Steward, S., Lapan, J. Family factors associated with sixth-grade adolescents' math and science career interests. The Career Development Quarterly, Vol. 53, No. 1, pp. 41.

[123] Davies, M. and D.B. Kandel (1981). Parental and peer influences on adolescents' educational plans: some further evidence. American Journal of Sociology, Vol. 87, No. 2, 363-387.

Target Age Group	Target Population Group	Setting of Intervention/ Strategy	Target Outcomes	Description
K-12, College students	Women, Minorities	STEM departments in universities and colleges	Increased enrollment, retention, and graduation rates in STEM fields among target populations.	Altering curricula within an educational program to create a more favorable classroom environment for women and/or minorities in STEM programs.
Strategy: Student Mentoring Programs				
K-12, College students	Women, Minorities	STEM departments in universities and colleges	Increased enrollment, retention, and graduation rates in STEM fields among target populations.	In these programs, women and minority students in STEM were assigned a mentor to provide academic counseling and support.
Strategy: Professional Development for Educators				
K-12, College students	Women, Minorities	STEM departments in universities and colleges	Increased enrollment, retention, and graduation rates in STEM fields among target populations.	Programs seeking to alter the way teachers teach students STEM subjects to be more sensitive to the needs and perceptions of women and minorities.
Strategy: Self-Affirmation Techniques				
K-12, College students	Women, Minorities	STEM departments in universities and colleges	Increased retention and graduation rates in STEM fields among target populations.	Programs that build on existing skills and abilities to build confidence early in the career decision-making process.

3.2.1 Supplemental Education Programs

Provides encouragement to women and minorities in STEM through community-based and extracurricular activities.

Supplemental Education Programs encompass a common approach to address the barriers of self-efficacy, stereotype threat, and lack of access to and inadequate participation in STEM courses and careers. These strategies are extracurricular activities and supportive services that mostly focus on middle school students, especially girls, racial minorities, and the visually impaired. Supplemental Education Programs typically involve workshops, summer camps, conferences, and after-school and summer programs, often STEM-specific.

Sometimes such supplementary programs operate for several years along with regular school work. They use a blend of different strategies, such as hands-on experiences, specific course-related information, and role models, as well as translation services for students with limited English proficiency and other targeted supportive services for low-income, racial minority, and visually impaired students, among others.

Although most of the programs identified in the literature review pertain to middle school students and may not be programs that DOL plans to address, they illustrate strategies that influence the cognitive processes of middle school students, especially in the context of STEM

disciplines, and therefore potentially STEM careers. We discuss below several types of supplemental education programs revealed by the literature review.

Interactive Workshops. Interactive workshops involving hands-on experiences constitute a common approach to improve middle-school girls' engagement in and pursuit of careers in STEM fields. These workshops illustrate the real-world aspects of science, engineering, and technology.

Residential Summer Camps. The residential summer camp is another type of supplemental education program to help girls become more comfortable with math. While such summer camps vary in length, scope, and intensity, most focus on collaborative work among participants. For example, students at a five-day residential summer math camp in Northern Nevada worked in groups. The principal pedagogical strategies of this camp include: mixed-ability cooperative team work, hands-on activities, real-world applications, and problem solving in a supportive learning environment. Participants reported an increase in confidence in math after attending this Math camp. [124]

Another math and technology program operated as a five-day residential summer camp focused on problem solving, geometry, spatial skills, data analysis and probability, algebra, and more powerful uses of computers, such as software tools.[125] Similarly, several science camps expose middle school girls to real world problems in the areas of physical anthropology, chemistry, physics, geology, and biology to increase their interest in professional science fields and instill greater respect for female scientists.[126,127]

Targeted and Focused Conferences. Targeted and focused conferences outside the realm of formal schooling constitute yet another type of supplemental programs. For example, the Expanding Your Horizons (EYH) conference has been held biennially at Humboldt State University in northern California since 1986. These one-day conferences, serving a lower-socioeconomic, rural community, aim to develop girls' confidence and interest in STEM professions through hands-on workshops on DNA experiments and cloning plants, exposure to role models in STEM professions, and attending informal discussions about STEM professions. Studies indicate that conference participation contributed to pipeline persistence, since taking courses and career planning are significant early STEM pipeline persistence measures.[128] An especially effective strategy involved providing information about gender discrimination.[129]

After-School Programs. After-school programs, especially for girls, aim to foster awareness, interest, and motivation in STEM content, increase STEM knowledge and skills, and support

[124] Frost Hart, Janet and Lynda Wiest. 2007. Listening to the girls: Participant perceptions of the confidence-boosting aspects of a girls' summer mathematics and technology camp. The Mathematics Educator 2007, Vol. 17, No. 2, 31–40

[125] Wiest, Lynda R., 2004. Impact of a summer mathematics and technology program for middle school girls. Journal of Women and Minorities in Science and Engineering, Vol. 10, pp. 317-339.

[126] Donna Farland-Smith, 2009. Exploring middle school girls' science identities: Examining attitudes and perceptions of scientists when working "side-by-side" with scientists. Journal of School Science and Mathematics, Vol. 109, No. 7, pp. 415-427.

[127] Watermeyer, R. and Stevenson, V. 2010. Discovering women in STEM: Girls into science, technology, engineering, and maths. International Journal of Gender, Science and Technology, Vol. 2, No. 1, pp. 25–46.

[128] Virnoche, M.E. 2008. Expanding girls' horizons: strengthening persistence in the early math and science education pipeline. Journal of Women and Minorities in Science and Engineering, Vol. 14, pp. 29–48.

[129] Weisgram, E.S. and R.S. Bigler (2007), Effects of learning about gender discrimination on adolescent girls' attitudes toward and interest in science. Psychology of Women Quarterly, Vol. 31, No. 3, pp. 262-269.

progress into more rigorous STEM course work. Accordingly, an effective after-school program must have supportive relationships and provide emotional/moral support, create a sense of belonging, provide exposure to positive morals/values/norms, encourage active participation, and help develop academic and social skills. For high-quality STEM experiences, the program should have high-quality staff, successful mentors and role models for students, ample opportunities for leadership and engagement with concerned adults and students, and awareness of gender, race, and class issues.[130]

For example, the **Girls Creating Games (GCG)** is an after-school and summer program for girls in sixth through eighth grade. This program addresses barriers girls face in participating in information technology (IT).[131] Similarly, *Techtronics* is an after- school engineering enrichment program for middle school students. It aims to attract both male and female students while actively encouraging at-risk middle school students to pursue careers in engineering and science.[132] *Build IT* is a two-year after-school and summer youth-based curriculum also for middle school girls. It emphasizes collaborative activities and connects girls to real users and IT professional female role models, in addition to programming/coding. Studies show that girls who participated for two years experienced greater gains in conceptual understanding than girls who participated for one year or less.[133] The *FEMME8* program aims to develop eighth grade girls' interest in biomedical engineering by relating it to aspects of health and medicine to which girls are traditionally attracted. [134]

Minority Programs. Several supplemental education programs specifically focus on helping minority students attain crucial math and science proficiency. For example, to increase the mathematical academic achievement among individuals of Hispanic descent and African Americans, school staff members nominate to the Mathematics Workshop Program (MWP) minority students who indicate an interest in a career requiring math. Students are divided into groups and meet for two hours twice a week to solve unusually difficult problems. Participants attained much higher grades and graduation rates than those who did not participate, suggesting that the MWP is a success.[135] Another program to improve quantitative academic skills for African American freshmen consists of two-hour tutorial sessions held on Sunday evenings, weekly critical thinking workshop series, and three one-hour interactive learning laboratories per week.

[130] Fancsali, B.C. & Froschl, M., 2006. Great science for girls: Gender-equitable STEM & afterschool programs. science books and films. (May/June), pp. 99–105.

[131] Denner, J. et al., 2005. The girls creating games program. Frontiers, Vol. 26, No. 1, pp. 90–99.

[132] Kelly, G., Klenk, P., Ybarra, G., & Cox, L. A. (2007). Assessment of gender differences on ratings of engineering learning modules in middle-school youth in an after-school setting. In 2007 Annual Conference & Exposition. Washington, DC: ASEE- American Society for Engineering Education.

[133] Koch, Melissa; Gorges, Torie, 2012. Inspiring girls and their female after school educators to pursue computer science and other stem careers. International Journal of Gender, Science and Technology, Vol. 4, No. 3, pp. 295-312.

[134] Koppe, N.B. et al., 2003. Pre-college biomedical engineering program for girls. In 2003 IEEE 29th Annual Bioengineering Conference. Newark, NJ: New Jersey Institute of Technology, pp. 296–297.

[135] Robert E. Fullilove and Philip Uri Treisman, 1990. Mathematics achievement among african american undergraduates at the University of California, Berkeley: An evaluation of the mathematics workshop program. The Journal of Negro Education, Vol. 59, No. 3 (Summer, 1990), pp. 463-478.

Those who participated had higher retention rates and GPAs compared to the non-participants.[136]

The Wisconsin Emerging Scholars (WES) program is a "non-remedial, multicultural" approach to learning calculus in college. The program emphasizes the importance of community and collaboration and is designed to increase the participation of underrepresented ethnic minority students. The program consists of two-hour workshops three times a week instead of the standard 50-minute college calculus class once a week. Participants reported a reduced sense of isolation and lack of support in the midst of large calculus lectures in a predominantly white university.[137]

Programs for Teachers/Graduate Students. Some supplemental education programs focus on teachers and graduate students rather than middle school students. For example, the one-day Science Spark workshop aims to make teachers sensitive to the need for their classroom environment to be more gender-neutral. The workshop provided hands-on experiences for participants and allowed time for discussion among participants and facilitators. The classroom environment can potentially counter the stereotypic image of science and science-related careers that students, especially girls, experience outside school, implying that teachers should encourage girls toward science and science-related careers. [138]

Co-Curricular Support Programs. One study pointed to the benefits of co-curricular support programs for undergraduate STEM students in terms of degree retention.[139] Using propensity score matching, the authors show that participating students were more likely to "pursue a career in the biomedical sciences" than non-participants. These programs usually include research experience and mentorship. Additionally, researchers show that these programs create engaging environments that "can be effective in retaining interest and persistence in a variety of contexts."

Incentives. Using a pretest-posttest quantitative design, one paper shows that students may persist through engineering programs when provided with a loan repayment award upon degree completion. In other words, students that otherwise could have given up on their degrees end up graduating when offered a cash benefit. The authors affirm that these findings can shed light on a potential strategy to increase the graduation rate among minority groups, including women.[140]

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[136] Good, Jennifer; Halpin, Glennelle; Halpin, Gerald, 2002. Retaining black students in engineering: Do minority programs have a longitudinal impact? Journal of College Student Retention, Vol. 3, No. 4, pp. 351-364.

[137] Alexander, B.B., Burda, A.C., and Millar, S.B. 1997. A community approach to learning calculus: Fostering success for underrepresented ethnic minorities in an emerging scholars program. Journal of Women and Minorities in Science and Engineering. Vol. 3, pp. 145-159.

[138] Mason, Cheryl L.; Kahle, Jane Butler (1989). Student attitudes toward science and science-related careers: A program designed to promote a stimulating gender-free learning environment. Journal of Research in Science Teaching, Vol. 26, No. 1, Pg.s 25-39

[139] Estrada, Mica. 2017. "Ingredients for Improving the Culture of STEM Degree Attainment with Co-Curricular Supports for Underrepresented Minority Students." National Academy of Sciences.
<http://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_088832.pdf>

[140] Yang, Yang and Bette Grauer. 2016. "The Effect of Financial Support on Academic Achievement and Retention of Female Engineering Students." In 2016 ASEE Annual Conference & Exposition. New Orleans, LA. <http://krex.k-state.edu/dspace/handle/2097/32940>

Summary of Supplemental Education Programs Strategy:

- Addresses the barriers of self-efficacy; stereotype threat; and lack of access to, and inadequate participation in, STEM courses and careers.
- Targets mostly middle school children, after-school hours, and/or during school breaks.
- Increases interest in STEM subjects among participants.
- Strategy examples:
  - Interactive Workshops.
  - Residential Summer Camps.
  - Targeted and Focused Conferences.
  - After-School Programs.
  - Minority Programs.
  - Programs for Teachers/Graduate Students.

Summary of Effectiveness:

- The literature revealed evaluations of several of these strategies that vary in their rigor.
- The few rigorous evaluations find that some of these strategies are effective in achieving their goals. For example, a rigorous evaluation of the ***Expand Your Horizons*** conference concludes that providing gender discrimination information was the most effective strategy of the conference.

3.2.2 Curriculum Development

Curriculum development alters curricula within an educational program to create a more favorable classroom environment for women and minorities in STEM programs.

When not properly implemented and/or containing biases, curriculum can have an adverse effect on a disadvantaged group's propensity to enter certain NTOs.[141] As such, curricula play a critical role in shaping students' choice of postgraduate occupation. These strategies aim to alter curricula within an educational program to create a more favorable classroom environment for women and/or minorities in STEM programs.

A prime example of altering a curriculum for NTO purposes is the *Integrated Basic Education and Skills Training (I-BEST)* program developed by the Washington State Board for Community and Technical Colleges.[142] The Board recognized that low-income women, especially single mothers, were a struggling population within the Washington Community and Technical College system. One of the reasons this population struggled was the lack of basic reading, math, and writing skills. I-BEST integrated basic skills instruction with professional technical courses in fields linked to career pathways. Targeted fields included computer and information systems, engineering, and engineering technology. This approach provided low scoring remedial students an opportunity to jump-start their education because they could acquire occupational skills while

[141] Knight, M. T., & Cunningham, C. M. (2004). Building a structure of support: An inside look at the structure of women in engineering programs. Journal of Women and Minorities in Science and Engineering, Vol. 10, No. 1, pp. 1–20.
[142] Costello, C. 2012. Increasing opportunities for low-income women and student parents in science, technology, engineering, and math at community colleges. Washington, DC: Institute for Women's Policy Research.

also learning the reading, math, and writing skills necessary to succeed in college and in the workplace. The intent of these changes is to level the playing field in these programs for disadvantaged female students by giving them an equal opportunity to complete the programs and graduate.

A different approach, based on "*course contract*," was to offer students in an undergraduate physical science class a contract at the beginning of the class.[143] By accepting it, the students agreed to stricter requirements to attend discussion sessions that accompanied the class and, should their grade dip below a certain level, to attend regular tutoring from volunteer tutors. In exchange, students were guaranteed at least a "C" grade. The philosophy behind this strategy – which was especially aimed at improving academic achievement among minority groups who traditionally had the low grades and poor attendance – was to provide an additional incentive to attend class for those who struggle with the material.

Another effective strategy to attract women into science and engineering disciplines and careers involves a change in the mode of instruction away from traditional methods that emphasize stringent technical content. Extensive use of *Information and Communication Technologies (ICT)* to provide both content and context of the material being learned by the student facilitates a more comprehensive use of resource-based learning, flexibility in learning, and the possibilities of individual communication and networking – factors that are particularly attractive to women. Some universities introduced new courses to encourage more women to enter technical fields – after newly designed methods to assign students to groups for tutoring and mentoring as well as enhanced networking for women students across campus proved that women prefer a broader approach to technical education.[144] Other strategies include developing gendered teaching modules, introducing changes to improve how the university is presented and represented to prospective female students, changing didactic instruction for faculty, avoiding gender stereotypes in curricula, and improving the content of science curricula.[145]

The organizations sponsoring these strategies/evaluations were largely academic institutions. For the most part, the strategies were implemented in a wide variety of upper education settings, including vocational, community colleges, four-year colleges, and universities. But some strategies were implemented in elementary, middle, or high schools.

The target outcomes were usually changes in enrollment, retention, and graduation of women and/or minorities. The scale of curriculum changes in the literature varied from changing the teaching methods of an instructor for a single class to changing statewide community college curricula, the costs varying greatly with the scope of the changes, and the extent of the overhaul. The time frame for implementing these strategies was relatively short; most were implemented and evaluated over the course of a semester or an academic year.

[143] Khan, Samia, 2005. Teaching strategies designed to change the undergraduate experience for college. Journal of Women and Minorities in Science and Engineering, Vol. 11, pgs. 365-387.

[144] Alha, K. & Gibson, I., 2003. Using ICT to improve the gender balance in engineering education. European Journal of Engineering Education, Vol. 28, No. 2, pp. 215–224.

[145] Knoll, Bente; Ratzer, Brigitte, 2009. 'Gender-into-teaching' at the Vienna University of Technology. Experiences and reflections on an Austrian project. European Journal of Engineering Education, Vol. 34, No. 5, pp. 411-418.

Summary of Professional Development for Educators Strategy:

- Addresses bias associated with curricula development and implementation.
- Is directed to STEM departments within colleges and universities.
- Is designed to increase enrollment rates in STEM fields among target populations.
- Strategy examples:
  - I-BEST providing disadvantaged, minority females with integrated, basic skills training.
  - Course "contract" improving academic achievement for minority group participants with low grades and attendance.
  - Changing mode of instruction for science and engineering-based curriculum to incorporate resource-based learning, flexibility in learning and possibility of individual communication and networking.

Summary of Effectiveness:

- Evaluations of these strategies typically identify the programs as effective. However, many of the evaluations include self-assessment and are often sponsored by the institution implementing strategy.
- Most of these evaluations, with or without self-assessments, are not rigorous enough to provide conclusive evidence of effectiveness.

3.2.3 Student Mentoring Programs

Student mentoring programs match partnerships with females and minorities to support STEM-related academic achievement.

Academic barriers to NTOs may include the effects of a chilly academic climate on a targeted population. The objective of student mentoring programs is to assist students in improving their academic performance by creating an environment that is welcoming and supporting, and that increases retention and graduation rates in STEM-related disciplines.

Colleges and K-12 settings are almost equally likely to implement strategies associated with mentoring programs. Such programs usually matched mentors and students by ethnicity or gender. Several studies, as detailed below, found strong evidence that this strategy increases the effectiveness of a mentoring program.

One example is a well-structured mentoring program found in several U.S. universities and targeting minority students in engineering programs.[146] Participation in the mentoring program was associated with higher student retention. Another example is a mentoring program implemented in the University of Lincoln's computer engineering department.[147] This department saw a dramatic increase in the third-year retention rate of female students in the department in just two years, jumping from the 2004 rate of around 25 percent to 100 percent in 2006. Several sources within the university attributed this achievement to a gender-matched,

[146] McCullough, Matthew, Stephanie Luster-Teasley, Clay Gloster, Jr., Leotis Parrish, Marcia F. Williams, and Ronnie S. Bailey. 2014. "ENGAGE 2Be Engineers Mentoring Program for Minority Students." In 121st ASEE Annual Conference & Exposition. Indianapolis, IN. <http://www.asee.org/file_server/papers/attachment/file/0004/5121/ENGAGE2BE_ASEE_2013_Finalb.pdf>

[147] Cornelia Boldyreff and Elizabeth M. Massey, 2009. "Evolution of a Cross-Year Mentoring Scheme." International Journal of Gender, Science, and Technology, 2009, Vol. 1, No.1, pp. 138-144.

cross-year mentoring program, in which female engineering graduate students would take on female engineering undergraduates as mentees. The two would meet regularly, and the graduate students would provide guidance and support to their mentees.

Another study disagreed with this finding as to whether it was more beneficial for college women to receive mentoring from both male and female faculty.[148] This study administered a survey to 207 female students across colleges enrolled in a science major. The students were asked questions regarding characteristics of staff they considered their mentors, role models, and/or sponsors. The responses indicated that these female students actually ascribed more influence to male staff in these roles than to female staff. The authors do not interpret these findings to mean that female students should only have male mentors. Rather, they suggest it is important to pair female students with mentors of both genders.

One study provided a strong example of the value of ethnicity-matched mentoring programs. The studied program assigned students to a mentor of the same ethnicity who followed the students throughout their academic careers at the university. The effectiveness of these matched mentor programs was demonstrated in an evaluation of the *Faculty Mentoring Program (FMP)* at an unspecified west coast university. Participants in the mentoring program showed statistically significant improvements in the college adjustment areas of self-efficacy and goal definition. Further, Latino students matched with a Latino mentor showed statistically significant higher gains in several measures of college adjustment compared to the gains shown by Latino students not matched with a Latino mentor. A related study conducted with African-American students was evaluated based on qualitative interviews,[149] which identified common traits of strong mentors these students encountered. The results were supportive of the idea of ethnicity-matched mentoring.

Effective mentoring of graduate students from multicultural backgrounds is also touted as one of the factors that can improve such students' experience in graduate school and prepare them for postdoctoral careers.[150] Effective mentoring by faculty to improve understanding of a student's cultural background and experiences was found to enhance the multicultural competency of white members, making it unclear whether same-race mentoring partnerships are, in fact, the essential component.

Another study of a four-week residential science summer camp attended by a younger group of students from diverse ethnic backgrounds cast further doubt on the importance of ethnicity/race matching.[151] Even within a formal mentoring program, the mentoring activities replicated the type of mentoring that occurs naturally in high school. The students participated in several interactive, hands-on research experiences in university laboratories and facilities while engaging

[148] Downing, R. a., Crosby, F. J., & Blake-Beard, S. (2005). The perceived importance of developmental relationships on women undergraduates' pursuit of science. Psychology of Women Quarterly, Vol. 29, No. 4, pp. 419–426

[149] Freeman, K. (1999). No Services Needed? The case for mentoring high-achieving african american students. Peabody Journal of Education, Vol. 74, No. 2, pp. 15–26.

[150] Davidson, M. N., & Foster-Johnson, L. (2001). Mentoring in the preparation of graduate researchers of color. Review of Educational Research, Vol. 71, No. 4, pp. 549–574.

[151] Syed, Moin; Goza, Barbara K; Chemers, Martin M; Zurbriggen, Eileen L. (2012). Individual differences in preferences for matched–ethnic mentors among high-achieving ethnically diverse adolescents in STEM. Child Development, May/June 2012, Vol. 83, No. 3, pp. 896-910

with several faculty members, graduate students, residential staff, and high school teachers, irrespective of their ethnicity. The students were not even assigned to a specific faculty mentor, as in the case of a formal mentoring program.[152] The results of this study illustrate the importance of an individual-centered approach to mentoring vis-à-vis pairing with a matched-background mentor. The authors conclude that common mentor background may not be important to all students for STEM or more broadly.

Another study discusses collective mentoring as yet another strategy whereby senior colleagues and the academic department as a whole develop and maintain a mentoring team. A mentoring team strategy signals that effective mentoring and progress of graduate students is top priority for the department.[153] Academic advising also plays an important role in supporting graduate students and adult students.[154]

Yet another strategy to address the "chilly climate" women encounter in male-dominated engineering programs or careers involves structured e-mentoring programs such as *MentorNet*.[155] Such programs help address environmental and societal barriers by pairing industry professionals who volunteer to serve as mentors with female STEM undergraduate and graduate students. For such a technologically comfortable group of mentors and students, the e-mail mediated mentoring works quite well. The mentees reported they were quite comfortable asking questions and developing a relationship over e-mail, and that they would recommend *MentorNet* to friends.

One study randomly assigned engineering students to one of three groups with different proportions of women: 75, 50, and 25 percent.[156] The authors show that first-year female students that participated in majority-female groups felt less anxious than their peers in the minority-female group. However, gender composition in the groups did not seem to be associated with the level of anxiety of older female students.

Focusing on summer research experiences, one study shows that most high school and undergraduate students that participated in such programs at a specific university later graduated from college with a STEM degree (67 and 90 percent, respectively).[157]

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[152] Syed, Moin; Goza, Barbara K; Chemers, Martin M; Zurbriggen, Eileen L. (2012). Individual Differences in Preferences for matched–ethnic Mentors among High-achieving Ethnically Diverse Adolescents in STEM. Child Development, May/June 2012, Vol. 83, No. 3, pp. 896–910.

[153] Chesler, N. C., & Chesler, M. A. (2002). Gender-informed mentoring strategies for women engineering scholars : On establishing a caring community. Journal of Engineering Education, Vol. 91, No. 1, pp. 49–55.

[154] Reisinger, W.A. (1999). Academic advising services for women in higher education. Dissertation submitted to Widener University in Partial Fulfillment of the Requirements for ED 693; Women, Learning and Leading in Education.

[155] Single, P.B., et al. (2002). A three year analysis of the benefits accrued by women engineering and science students who participated in a large-scale e-mentoring program. American Society for Engineering Education Annual Conference & Exposition.

[156] Dasgupta, Nilanjana, Melissa McManus Scircle, and Matthew Hunsinger. 2015. "Female Peers in Small Work Groups Enhance Women's Motivation, Verbal Participation, and Career Aspirations in Engineering." Proceedings of the National Academy of Sciences 112 (16): 4988–93.

[157] Salto, Lorena M., Matt L. Riggs, Daisy Delgado De Leon, Carlos A. Casiano, and Marino De Leon. 2014. "Underrepresented Minority High School and College Students Report STEM-Pipeline Sustaining Gains After Participating in the Loma Linda University Summer Health Disparities Research Program." PLOS ONE 9 (9): e108497.

Summary of the Student Mentoring Strategy:

- Addresses challenges associated with different academic experiences due to culture or gender.
- Is directed to STEM departments within colleges and universities.
- Is designed to increase enrollment, retention, and graduation rates in STEM academic areas.
- Strategy examples:
  - Gender-sensitive approaches including University of Lincoln's gender matched mentoring of female engineering undergrads and both male and female faculty mentoring of female science majors.
  - Ethnic/culturally-sensitive approaches of the Faculty Mentoring Program, and similar programs, addressing the need to understand the student's cultural background and experiences by matching ethnically-similar faculty and students.
  - Technologically sensitive approach of MentorNet uses e-mail to connect professional mentors to females in engineering disciplines.

Summary of Effectiveness:

- Evaluations of these strategies identify them as effective at achieving target outcomes.
- While these studies provide some evidence to suggest effectiveness, no decisive conclusions can be drawn due to the studies' low level of rigor.

3.2.4 Professional Development for Educators

Professional development for educators targets the behaviors and instructional styles of teachers to reduce gender role and cultural biases.

These strategies address biases associated with instructional attitudes such as stereotypical gender role bias and reinforcement, among others,[158] by improving the professional development of educators. Professional development programs seek to alter the way teachers teach students STEM subjects to be more cognizant of the needs and values of women and minorities. These programs target the behaviors and instructional styles of educators at various levels of the educational system.

As discussed earlier in Section 3.1.3, leadership teams of eight to 10 educators at each participating college provide extension services as part of *CalWomenTech* project.[159] Colleges received training in recruitment and retention best practices of female students and faculty. The project also aided colleges develop strategic plans related to recruitment and retention.

To address the paucity of women in nontraditional careers, several interventions aimed at educators (classroom educators and school leaders/administrators) who can, in turn, encourage diverse secondary and community college female students to major in STEM fields. The *STEM Equity Pipeline* (the Pipeline), for example, focuses on training and educating teachers and faculty

[158] Hodges, J., Pearson, A., & Reese, D. (2011). WomenLEAD: Leadership development for female faculty in business and engineering. International Journal of Gender, Science and Technology, Vol. 3, No. 2, pp. 331–337.

[159] Milgram, Donna; Severs, Daniella, 2010. CalWomenTech project: Recruiting and retaining women in technology programs. 2010 Annual Conference & Exposition.

to improve gender equity in nontraditional/STEM career technical education (CTE).[160] The Pipeline is a project of the National Alliance for Partnerships in Equity Education Foundation (NAPE-EF). Examples of successful strategies include:

  - Faculty and staff training in gender equity and nondiscrimination in STEM education.
  - Hands-on activities to engage students and illustrate real world STEM problems.
  - Activities such as counseling, career guidance, and exploration in STEM fields for the diversity of men and women.
  - Introducing students to role models and mentors in STEM careers.
  - Engaging the industry and community in STEM programming.

- Cohort-based activities to develop educators as "scientists in the classroom" to create a positive school environment for STEM education.

Summary of Professional Development for Educators Strategy:

- Addresses barriers in STEM instruction related to gender role and cultural biases.
- Is directed to STEM departments within colleges and universities.
- Increases enrollment, retention, and graduation rates in STEM fields among target populations.
- Strategy examples:
  - *CalWomenTech* provides female student recruitment and retention best practices training.
  - *STEM Equity Pipeline* trains and educates teachers and faculty to improve gender equity in nontraditional/STEM career technical education (CTE).

Summary of Effectiveness:

- The literature review revealed a lack of studies evaluating any of these strategies. This significant gap in the literature leaves the field in complete ignorance of the effectiveness or lack thereof of any of these strategies.

3.2.5. Self-Affirmation Techniques

Self-Affirmation techniques seek to overcome such barriers as low self-confidence in ability to perform and/or anxiety about performing in specific areas, the gender typing of careers in specific fields, stereotype threat, low expectations about career satisfaction, and lack of support in pursuing an NTO career. Research shows that individuals' confidence in their ability to perform influences their performance as well as the career decisions they make.[161,162]

Self-affirmation techniques address these barriers by identifying and building upon one's existing skills and abilities to perform. Strategies that involve the use of self-affirmation techniques are designed to address barriers to NTOs that begin early in the career decision-making process.

[160] Costello, C., 2012. Increasing opportunities for low-income women and student parents in science, technology, engineering, and math at community colleges. Washington, DC: Institute for Women's Policy Research.
[161] E. Cech, B. Rubineau, S. Silbey, C. Seron. 2011. Professional role confidence and gendered persistence in engineering. American Sociological Review, Vol. 76, No. 5, pp. 641-666.
[162] Huguet, P. and Regner, I. 2007. Stereotype threat among schoolgirls in quasi-ordinary classroom circumstances. Journal of Educational Psychology, Vol. 99, No. 3, 545-560

Teaching professionals and their students typically implement and use self-affirmation techniques in a classroom environment. Evidence suggests that these strategies can also be effective in professional environments.[163] The literature presents strong evidence to support the effectiveness of one specific self-affirmation technique in particular. Two randomized control trials evaluated the effectiveness of a self-affirmation technique that involves writing about a value or characteristic that is important to the writer prior to taking a test. Several studies found that the use of this self-affirmation technique improved the performance of women under stereotype threat.[164, 165]

Self-affirmation techniques build on existing skills and ability to increase confidence among women and minorities early in the career decision-making process.

One randomized-controlled trial tested two interventions targeting female engineering students: (i) the social-belonging intervention provided students with a nonthreatening narrative aimed to help women interpret adversity, (ii) the affirmation-training intervention incorporated various aspects of women's self-identity in their daily academic lives.[166]

In both cases, women that received the training had a higher GPA than those who did not, even eliminating GPA differences between women and men. However, while the first intervention promoted friendship between students of both genders, the second one promoted social marginalization as women increased their identification with their gender group.

Summary of Self-Affirmation Techniques Strategy:

- Addresses the barriers of low self-confidence in ability to perform and/or anxiety about performing in specific areas, the gender typing of careers in specific fields, stereotype threat, low expectations about career satisfaction, and the lack of support in pursuing an NTO career.
- Is directed to teaching professionals and their students.
- Strategy examples:
    - Women's performance on a math test improving after writing about an important value or characteristic prior to taking a test. This self-affirmation exercise addressed the stereotype threat that women encounter in math.

Summary of Effectiveness:

- The literature revealed a few rigorous evaluations of the effectiveness of self-affirmation techniques.
- Most of the evaluations, however, focused only on immediate effects.

[163] Taillandier-Schmitt, Anne; Esnard, Catherine; Mokounkolo, René, 2012. Self-affirmation in occupational training: Effects on the math performance of french women nurses under stereotype threat. Sex Roles, Vol. 67, No. 1-2, pp. 43-57.
[164] Martens, Andy; Johns, Michael; Greenberg, Jeff; Schimel, Jeff, 2006. Combating stereotype threat: The effect of self-affirmation on women's intellectual performance. Journal of Experimental Social Psychology, Vol. 42, No. 2, p. 236-243.
[165] Taillandier-Schmitt, Anne; Esnard, Catherine; Mokounkolo, René, 2012. Self-affirmation in occupational training: Effects on the math performance of french women nurses under stereotype threat. Sex Roles, Vol. 67, No.1-2, pgs. 43-57.
[166] Walton, Gregory M., Christine Logel, Jennifer M. Peach, Steven J. Spencer, and Mark P. Zanna. 2015. "Two Brief Interventions to Mitigate a 'Chilly Climate' Transform Women's Experience, Relationships, and Achievement in Engineering." Journal of Educational Psychology 107 (2): 468–85.

CHAPTER 4: SUMMARY OF LITERATURE REVIEW FINDINGS

DOL defines NTOs as occupations for which individuals from one gender or minority group comprise less than 25 percent of the individuals employed in such occupations. Barriers associated with entry into NTOs can prevent these groups from accessing employment in certain occupations and from realizing the economic benefits of such employment. These barriers are particularly harmful when they prevent entry into NTOs with a strong demand for workers and/or prevents access to employment with high earning potential.

This report discusses a number of barriers to entering NTOs in the identified literature, broken into two major groups: career- and education-related barriers. Career-related barriers discourage participation and retention rates in NTOs. The major career-related barriers discovered were: bias communicated through career materials, mechanisms, and practices; perceptions of and response to the characteristics of occupations; and lack of supportive services. Education-related barriers inhibit enrollment, retention, and graduation rates in education programs linked to NTOs (particularly STEM occupations). The major education-related barriers identified were: STEM academic proficiency; access to and participation in STEM education; biased curriculum structure and instructional attitudes; stereotype threat; and lack of self-efficacy.

This report provides a high-level review of strategies that have been implemented to address an individual's barriers to entering NTOs. More specifically, the report addresses an important objective for the literature review – to help guide decision-making related to implementing a demonstration that can increase opportunities to employment in NTOs. Related and rooted within this objective is the identification of "evidence-based" strategies or programs that have been tested to provide evidence of program effectiveness. Below, we provide a discussion of these issues and its implication for informing a demonstration.

4.1 STRATEGIES TO REDUCE BARRIERS ASSOCIATED WITH NTOS

Two main types of strategies were identified as a result of the review: *Workplace- and Career-Related Strategies* and *Education-Related Strategies*. While both are critical for inclusion in a thorough review of this kind, strategies most relevant to the purview of the DOL objectives are drawn most heavily from the literature on *Workplace- and Career-Related Strategies*. These strategies are typically implemented by career guidance professionals, training providers and employers. Outcomes typically include such things as increased NTO employment among women and minorities, increased access to and retention and advancement in NTOs. These strategies generally address barriers associated with bias found in career materials, mechanisms, and policy as well as individual perceptions and responses to the characteristics of NTO and lack of support services.

In contrast, *Education-Related Strategies* are typically implemented by education professionals. While highly correlated with addressing barriers associated with NTOs, outcomes for these strategies typically include increased enrollment, retention and graduation rates in STEM fields, rather than employment-related outcomes. These strategies typically address barriers related to the delivery of academic material as well as student proficiency, academic interest, and self-efficacy to pursue STEM-related academics.

4.2 EVIDENCE BASE FOR IDENTIFIED NTO STRATEGIES

As mentioned above, important to the main objective for this review is the level of evidence associated with evaluations of NTO-related strategies as defined by the evidence rating guidelines (e.g., DOL's Clearinghouse for Labor Evaluation and Research and the Institute for Education Science's What Works Clearinghouse standards). These methods are supported by government recommendations articulated through reports from the U.S. Government Accountability Office and standard setting institutions such as the Coalition for Evidence-Based Policy.[167] While scales of this type reflect a spectrum of evidence, and until recently most government agencies defined "evidence-based" research as research which uses the most rigorous methods available, such as well-conducted, randomized controlled studies. As a result, the level of evidence associated with the strategies articulated in this report was assessed with a mind to this guidance.

Still, these rating systems do acknowledge that evaluations using methods other than the most rigorous (e.g., qualitative studies) provide results which fall within a broader range of evidence. It is within this continuum that the majority of strategies on barriers to NTOs lie. More specifically, quantitative studies using the rigorous evaluation methods were rare. In fact, the literature review did not reveal any studies using a randomized control trial design to evaluate the impact of *Workplace- and Career-Related Strategies*. Most evaluations were generally qualitative in nature, relying on case-studies, semi-structured interviews and focus groups. However, a few studies did use quasi-experimental designs indicating positive impacts on some measured outcomes. For example, one study examined the effectiveness of the RISE program using propensity score matching methods. The program was aimed at encouraging minority undergraduate students to pursue a research career in the biomedical sciences. The results of the study provide strong evidence of the ability of the RISE program to sustain student intentions to pursue a research career.[168] Nonetheless, these findings may provide opportunities for more rigorous testing since the results of these studies cannot be definitive due to the studies' utilized methods.

In addition, the review identified several other relevant and promising strategies that may be used to develop a demonstration designed to increase women and minority employment and earnings' in NTOs. For instance, the *Ground Zero Initiative: Building a Pipeline of Women for the Skilled Trades,* the *Helmets to Hard Hats* program, the *Regional Center for Next Generation Manufacturing (RCNGM)* and the *Construction Management Program* provided extensive job readiness training, an introduction to the trades, a flexible work schedule, supportive services (e.g., child care facilities and transportation), tutoring, mentoring and established women and minority clubs.

More specifically, the RCNGM's strategies included on-campus child care at all 12 community college campuses the program was being implemented, scholarships, including those funded by the National Aeronautics and Space Agency (NASA) and emergency funds at each community

[167] U.S. Government Accountability Office. Program Evaluation: A Variety of Rigorous Methods Can Help Identify Effective Interventions (Publication No. GAO-10-30). Nov, 2009. Retrieved from https://www.gao.gov/products/GAO-10-30.

[168] R., Woodcock, A., Estrada, M., Chance, R. C., Aguilar, M., Serpe, R. T. 2011. Patching the pipeline: Reducing educational disparities in the sciences through minority training programs. Educational Evaluation and Policy Analysis, Vol 33, No. 1, 95–114

college to assist students with unanticipated costs, academic advising and supports, including basic skills testing, developmental programs and English as a Second Language (ESL) courses, tutoring (including on-line) , career planning and placement counselors and a Facebook page with chat rooms where students can communicate with each other about school projects and connect with mentors from industry and professional associations to ask questions.

Using the findings from this report, the research team further investigated strategies for demonstration and testing. This investigation was the basis for development of Feasibility Memo summarizing these strategy options and the implications of implementation. The preparation of this memo involved discussions with DOL staff, the project's Technical Working Group (TWG) and the research team to provide objective information to facilitate the prioritization of appropriate strategies of interest.

APPENDIX A. DOL INITIATIVES

Increasing the employment of women in NTOs (i.e., those related to science, engineering, and careers in construction and the trades) became the focus of the Women's Bureau (WB) during the 1990s.[169] Several DOL programs were designed to encourage the development and implementation of innovative practices to encourage women's success in the labor force.

Training in Non-Traditional Occupations and Career Pathway Development. Reflective of seeking to enhance representation of women in non-traditional occupations, the following initiatives encourage and support non-traditional career options for women:

- ***Women in Apprenticeship and Nontraditional Occupations (WANTO) Program***. To address training of women in NTOs, the WB and ETA's Office of Apprenticeship provided $1.8 million of funding in 2010 to support community-based organizations to assist employers and labor unions in recruiting, hiring, training and retaining women in apprenticeships and nontraditional occupations. WANTO grants support efforts for employment in advanced manufacturing, transportation, and construction.[170]
- ***Women in Nanotechnology (WIN)***.[171] This WB pilot demonstration was designed to encourage and support women with an interest in nano-scale sciences and technology. The WIN program, implemented in partnership with the University of Chicago, College of DuPage, and Truman College, prepared interested students to continue their education and pursue careers in these fields through internships, dissemination of information, and discussion.
- ***Green Jobs for Women Initiative***.[172] To help create career pathways leading to higher pay in NTOs and reduce poverty among women, this Initiative combined several approaches to assist women in identifying, obtaining, and retaining employment in the green jobs industry, including: 1) community discussion and partnership development to identify practices for hiring and retaining women in green jobs, 2) development of resource materials to educate women in opportunities and hiring practices associated with the green job industry, and 3) engaging and training women for a variety of high-growth and emerging green jobs by providing both technical and remedial job skills training.
- ***Pathways Out of Poverty Grant Program***.[173] This ETA grant program provided $150 million in 2010 to assist women and other underprivileged populations obtain

[169] Our History: an Overview 1920 – 2012. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/info_about_wb/interwb.htm

[170] Women in Apprenticeship Act (WANTO) Grant. U.S Department of Labor Women's Bureau website. Retrieved from See: http://www.dol.gov/wb/federalregister3-30-2010.htm

[171] Women in Nanotechnology PowerPoint Slides. University of Illinois at Chicago website. Retrieved from http://www.uic.edu/orgs/win/images/WINpowerpoint%5B1%5D.pdf

[172] Women's Bureau Initiatives in FY 2010. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/previousinitiatives2010.htm

[173] American Recovery and Reinvestment Act of 2009: Pathways Out of Poverty Grants. U.S Department of Labor website. Retrieved from http://www.doleta.gov/pdf/Pathways_Poverty_grants.pdf

employment in growing industries, including those typically underrepresented by women such as construction, energy and transportation.

- ***Working Women in Transition***.[174] Working Women in Transition (WWIT), a WB initiative, was a multi-regional project focused on women making a transition in their work lives. WWIT used a unique strategy of combining both "high tech" and "high touch" components (online and interpersonal resources) to assist women in finding employment, increasing their earnings, and/or entering career education/training opportunities. Participants were provided with access to online mentors ("e-mentoring"), online employment tools, and distance learning resources while also working with local service providers.
- ***Military Spouse Resource Center***.[175] A collaborative effort between DOL's WB, ETA, and the Office of the Assistant Secretary for Policy, in cooperation with the Department of Defense (DOD), this online learning tool and resource guide offered military spouses access to training and placement opportunities, community resources, and their local workforce development systems.
- ***Group E-Mentoring – Nursing.***[176] Group E-Mentoring in Nursing (GEM-Nursing) was a multi-regional project implemented through a partnership between the WB and the University of Michigan School of Nursing. This initiative was designed to increase awareness of the benefits of a career in nursing for men and women through provision of information on the nursing profession as well as an online mentoring component. The online mentoring component was available to young men and women ages 15 to 21 interested in considering nursing as a career. Volunteer nurse mentors from a variety of nursing fields provided guidance and support to young people by answering questions and sharing career experiences.
- ***Women with Disabilities Entrepreneurship Project***.[177] This was a two-year project hosted in four WB regions to train women with disabilities to become entrepreneurs. Participants were educated and guided through business start-up process, including exploring viable options, developing a business plan, and securing funding.
- ***Group E-Mentoring – Science, Engineering, & Technology.***[178] Initiated in fiscal year (FY) 2002 by the WB, Girls' E-Mentoring in Science, Engineering & Technology (GEM-SET) is a multi-regional project that links girls ages 13 to 18 with volunteer women mentors in the fields of science, engineering, and technology via e-mail and a website, to help increase the awareness of the economic benefits and the career options available in these fields.

[174] Strengthening the Family Initiatives 2008. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/family1.htm.
[175] Ibid.
[176] Ibid.
[177] Ibid.
[178] Ibid.

- ***Women in the 21st Century Workplace: "Skill Development through On-Line Learning" Demonstration Project.***[179] The On-Line Learning Demonstration project was a collaborative effort between DOL's WB and ETA, as well as the New Jersey Department of Labor (NJDOL). This demonstration project offered under-employed single mothers of children under 18 years of age with the opportunity to earn computer certifications or an Associate's degree through online courses designed to prepare participants for high skilled jobs in their local communities.
- ***The Ground Zero Initiative: Building a Pipeline of Women for the Skilled Trades in Metropolitan New York (Construction Trades Prep).***[180] Through the WB, this initiative provided extensive job readiness training, an introduction to the trades, a review of trades' math, and a hands-on shop component to working women who wanted to increase their earnings by participating in skilled apprenticeship programs. The classes were offered during evening and weekend hours to accommodate work schedules.

Workplace Flexibility. Helping to create flexible and accommodating work environments is another aspect of increasing the employment of underrepresented groups, especially women, in NTOs. Enhancing workplace flexibility is being addressed within DOL in the following ways:

- ***A National Dialogue on Workplace Flexibility***. Initiated by the WB, this Initiative was designed to increase awareness and encourage a flexible work environment by creating dialogue among employers, business owners, government agencies, advocates, and researchers.
- ***Flex-Options***. This program was also designed to help businesses bring work/life balance to the workplace. Implemented within each of the 10 WB regions, the goal of this mentoring program was to bring together executives and employers to design and implement flexible work options.
- ***Wage and Hour Division (WHD) Enforcement and Guidance***. The WHD supports WB priority areas of creating a flexible workplace in several ways. For example, the WHD enforces the provisions of the Patient Protection and Affordable Care Act of 2010. This act requires that employers provide nursing mothers the necessary break times and private space to continue this practice should they choose to do so when returning to work. In addition, the WHD provides guidance on provisions associated with the FMLA, to assist employees requiring parental or family leave for caregiving purposes.

Reducing the Wage Gap and Financial Security. DOL has engaged in the following activities to reduce the wage gap between men and women and provide women with the services and tools to address financial challenges:

- ***Equal Pay Research Summit***. This WB summit was designed to discuss the best data approaches to collect data for better understanding the scope of the gender pay gap and

[179] Women in the 21st Century Workplace: "Skill Development through On-Line Learning" Demonstration Project. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/distance.htm

[180] Strengthening the Family Initiatives 2008. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/family1.htm

improve enforcement efforts. In an FY 2010 collaborative effort with the Department of Justice, the Office of Personnel Management, and the Equal Employment Opportunity Commission, DOL enforced measures to ensure equal opportunity and pay.

- ***Economic Stimulus Forums***. Hosted by the WB, these FY 2010 forums addressed financial challenges faced by women, women's organizations, and women business owners hurt by the recession, and helped educate women about provisions of the American Recovery and Reinvestment Act (ARRA).
- ***Homeless Women Veterans Listening Sessions***. In FY 2010, the WB designed and implemented "listening sessions" in states spanning six of the Bureau's 10 regions to gather information for improving the delivery of services and resources to this population. Sessions included both current and formerly homeless women veterans and active service providers.
- ***Wi$eUp Program***. For those rebuilding their lives and/or managing their family budgets for the first time, the Wi$eUp[181] program teaches women how to develop financial security through household budget management, saving, and wise use of credit.
- ***Project Replication***. To help more women prepare for better job opportunities, the WB supported the replication or expansion of successful program models. Such replication or expansion represented in efficient way to serve more than 2,200 participants from 25 supporting organizations in 2008.[182]

[181] Opening Doors for Women. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/media/newsletter/e-news11artl-02.htm

[182] Women's Bureau Initiatives in FY 2010. U.S Department of Labor Women's Bureau website. Retrieved from http://www.dol.gov/wb/programs/previousinitiatives2010.htm

APPENDIX B. METHODOLOGY

The methodology for conducting the literature review involved an extensive two-stage process. The first stage involved performing a systematic search and review of all relevant sources for studies related to NTOs. The second stage involved analyzing the information collected during the review. Appendix B details the methodology on which the literature review process was based.

B1. SEARCH & REVIEW METHODOLOGY

B1.1 Search Methodology

The first step in the search and review stage involved identifying relevant literature. This included 1) quantitative and qualitative evaluations of strategies for overcoming barriers to entry into NTO fields, 2) materials on barriers to entry into NTO fields, and 3) materials on strategies to overcome these barriers. The research team developed a Literature Search Protocol to guide the literature search process and ensure that it was conducted consistently, thoroughly, and efficiently by all team members. The Literature Search Protocol presented in Appendix C provided literature sources, search parameters, and instructions for conducting the search, as well as screening guidelines.

Sources searched included publications from peer-reviewed journals identified through internet search engines (e.g., Google Scholar) and literature databases (e.g., EBSCO, Wiley Online Library, JSTOR) as well as relevant non-academic materials such as federal reports, conference proceedings, and career counseling materials.

As shown in the Literature Search Protocol, the research team used a categorized list of search terms to enable the team to conduct a systematic search by using search terms from different categories in combination. The categories included general search terms, population-specific terms, subject-specific terms, outcomes-related terms, and implementation terms. The search protocol included instructions for how best to use the search terms in each category. In addition, the protocol provided descriptions of the different types of literature relevant for this review to guide the team in screening literature as it was identified.

After the search protocol was finalized, the research team began conducting the search. During the search, the team queried all relevant literature sources using the search terms specified in the Search Protocol. The results of each query were then closely examined for potentially relevant publications. All relevant publications were uploaded into Mendeley, a reference management tool. The reference lists of identified publications were also reviewed for additional relevant materials to ensure a comprehensive approach. Special attention was paid to meta-analysis publications during this step.

B1.2 Literature Review Methodology

In tandem with the literature search process, the research team developed an Information Gathering Protocol and Template to systematically extract the most pertinent information from each publication reviewed.

The Information Gathering Template is a data gathering tool that provides the reviewers with descriptive fields in which to enter relevant information from each piece of material. The Protocol, presented in Appendix C, provides detailed descriptions of the fields included in the template. As show in the protocol, the research team collected general information on each publication reviewed, as well as specific information on the barriers and strategies discussed and any quantitative/qualitative evaluations of strategies conducted.

The research team created the Information Gathering Template using a Microsoft Access database which facilitated data storage and analysis. This tool allowed the team to organize and analyze the data according to the template categories. Using these tools, the researchers reviewed all identified literature and extracted the relevant information.

The research team piloted the Information Gathering Template and Protocol with 10 publications. The pilot results were then used to refine and enhance the protocol and template before gathering information on a much wider scale. Each reviewer received comprehensive training on how to use the Template and Protocol before they began to review publications.

The Information Gathering Protocol, like the Literature Search protocol, ensured internal consistency of standards during the literature review process. After the search was complete, each team member was assigned a group of publications to analyze in detail. For each publication identified, a team member populated the Access database with relevant information from the material in question.

B2. ANALYSIS METHODOLOGY

The second stage in the literature review process involved analyzing the recorded characteristics of the strategies. In so doing, the team first grouped similar strategies together into categories. We next organized the categories into two major topic areas:

- **Workplace- and Career-Related Strategies:** These strategies are typically implemented by career guidance professionals, training providers, and employers. Generally, these strategies are associated with workplace and career decision-making, and outcomes typically include increased NTO employment among women and minorities, increased retention and advancement in NTO employment, and increased earnings. These strategies typically address barriers associated with 1) bias communicated through career materials, mechanisms, policies, and practices; and 2) individual perceptions and responses to the characteristics of NTO occupations.

- **Education-Related Strategies:** These strategies involve STEM-based programs implemented by educational professionals, including instructors and administrators, in educational settings. While highly correlated addressing barriers associated with NTO's, outcomes for these strategies typically include increased enrollment, retention and graduation rates in STEM fields. These strategies typically address barriers related to the delivery of academic material as well as student proficiency, academic interest, and self-confidence to pursue STEM-related academics.

The text Exhibit 3, reproduced here as Exhibit 7 for reader convenience, illustrates the result of linking the 11 identified strategy categories to the two strategy topics areas (Workplace & Career and Education). In addition, this exhibit provides a description of each category. It should be noted that throughout this process there was, in some cases, overlap in the characteristics of strategies across strategy topics, and in some cases, across the strategy categories within the same topic, making it challenging to identify the appropriate category for discussion. Below are several scenarios in which this situation was found and its resolution:

- Some strategies used multiple approaches to addressing barriers to NTO, requiring a decision as to placement of the strategy within one category over another. In some cases we mention different aspects of the same strategy in more than one category. In most cases, the strategy is discussed in the category most closely aligned with the strategy's main objective. For instance, while the NSF ADVANCE Institutional transformation grant program is discussed under "Institutional Changes in NTOs," monitoring strategies specific to the NSF ADVANCE program are discussed under "Professional Mentoring Programs."
- While some strategies may be thought to align with more than one category, each category is unique. For instance, a strategy related to the provision of childcare without a concurrent change in organizational policy or procedures is discussed under "Family-Friendly Workplace Policies" rather than "Institutional Changes in NTOs."

  In some cases, the environments within which some strategies are implemented obscure the strategy's key objective and, therefore, the appropriate strategy category assignment. An example of this includes one strategy implemented in an educational environment that addresses biases associated with the advancement of female, college professors in STEM-based disciplines. In this case, this strategy is discussed under *Workplace- and Career-Related Strategies* as the strategy's outcomes include advancement of female college professors in NTO-related disciplines.
- While pre-apprenticeship and apprenticeship programs may seem intuitively aligned with education-related strategies, since the key outcome of such programs is to increase NTO employment-related outcomes, they are more accurately described under Workplace- and Career-Related Strategies.

Exhibit 7. Strategy Categories and Topic Areas

Category	Description
Workplace- and Career-Related Strategies	
Apprenticeship/Pre-Apprenticeship Programs	Paid on-the-job learning generally resulting in a nationally recognized credential which offer job seekers immediate employment opportunities in high wage, high skilled occupations. Pre-apprenticeship programs provide exposure to a wide variety of high skill, high wage careers.
Institutional Changes in NTOs	Changes that reshape organizational structure and policy to create a culturally responsive environment for one or more NTO populations.
Targeted Recruitment Practices and Materials	Targeted recruitment materials and practices tailored specifically to women's and minorities' workplace issues and needs.
Family-Friendly Policies and Supportive Practices	Policies such as subsidized child care and maternity leave that encourage parents to stay in the workforce.
Professional Development for Career Counselors	Interventions sensitizing counselors to the specific challenges and job trends facing women/minorities professionally.
Professional Mentoring Programs	New hires from NTO populations are given an equity-trained mentor, often with the same gender/race as the mentee, to guide their career development and provide support in various ways.
Education-Related Strategies	
Supplemental Education Programs	Extracurricular activities that encourage women and minorities to take an interest in STEM fields through community-based and interactive exercises.
Curriculum Development	Expanding the cultural lens of educational curricula to create a warmer classroom environment for women and/or minorities in STEM programs.
Student Mentoring Programs	In these programs, women and minority students in STEM were assigned a mentor to provide academic counseling and support.
Professional Development for Educators	Programs seeking to alter the way teachers teach students STEM subjects to be more sensitive to the needs and perceptions of women and minorities.
Self-Affirmation Techniques	Programs that build on existing skills and abilities to build confidence early in the career decision-making process.

APPENDIX C. LITERATURE SEARCH PROTOCOL

Criteria	Strategy
Literature Sources: Sources listed should be used as a guide there are a wide range of journals and databases that may contain relevant publications.	
Suggested Databases	EconLit, ERIC, Cochrane Database for Systematic Reviews, Ebscohost, Social Science Abstracts, and JSTOR, Academic Search Premier
Suggested Journals	Journal of Career Development; Sex Roles: A Journal of Research; Journal of Labor Economics; Journal of Human Resources; the National Bureau of Economic Research; Journal of Social Welfare and Family Law, Education + Training; Journal of Vocational Education & Training; Feminist Economics; Work & Occupation; Work, Employment, and Society; International Journal of Gender, Science and Technology; Equity & Excellence in Education; Diversity and Democracy
Suggested Organizations & Associations	American Educational Research Association; Organization for Economic Co-operation and Development; International Labor Organization; Federal and state governments
Unpublished literature	Expert recommendations
Literature Search Parameters: Begin search by systematically using General Search Terms in combination with Population, Topic Area, Outcomes, and Implementation Search Terms. Not all combinations of search terms will retrieve relevant results. Combining fewer terms will result in the retrieval of a wider range of publications. Prioritize searches that include each Topic Area term in combination with each General Search Term.	
General Search Terms	Non-traditional occupations, career barriers, discrimination, gender, gender differences, preferences, attitudes, stereotypes, bias, occupational segregation, equity, diversity
Population Search Terms	Women, Men, Minorities, Individuals with disabilities, Veterans, LGBT populations, Single parents, Working mothers, Individuals pursuing non-traditional careers, Low-income individuals
Topic Area Search Terms	See list below
Outcomes Search Terms	Participating in Education/Training, Employment, Wages, Enrollment, Participation, Graduation, Retention
Implementation Search Terms	Requirements, Staffing, Cost, Cost Effective, Cost Analysis, Cost-Benefit Analysis
Screening & Organizational information	
If the study uses **quantitative methods** to determine the effectiveness of a strategy or set of strategies that intend to increase the participation of individuals in non-traditional occupations, include the study in the Quantitative Evaluations folder under the most appropriate topic area.	
If the study uses **qualitative methods** to determine the effectiveness of a strategy, include the study in the Qualitative Evaluations folder under the most appropriate topic area.	
If the publication **describes a barrier** or set of barriers to gaining employment in a non-traditional occupation, include the publication in the Barriers folder under the most appropriate topic area.	
If the publication **describes a strategy** or set of strategies but does not evaluate the strategy, include the publication in the Strategies folder under the most appropriate topic area.	
If the publication is a **Meta-analysis/Literature Review/Book Chapter** that reviews findings from multiple studies, include the publication in the Meta-analysis folder. If you identify literature that falls into this category, review the reference list, identify all relevant references and include them in the appropriate folders/subfolders. Please scan any relevant book chapters and add them to the library.	

Subject Specific Search Terms

Education, Training, & Apprenticeship	Career	Family	Internal/ Individual	Societal Issues
▪ Academic Proficiency ▪ Access to and Participation in Math, Science, and Technology ▪ Curriculum ▪ Instructional Strategies ▪ Science/Math Performance ▪ School/Classroom Environment ▪ Screening ▪ Referrals ▪ Teach ▪ Teacher/Trainer ▪ Professional Development ▪ Hiring ▪ Hands-on ▪ After-school ▪ Camp ▪ Clubs ▪ Visual-Spatial Skills ▪ Tutoring ▪ Support Groups ▪ Child Care ▪ Transportation ▪ Tuition Assistance ▪ Occupational/ ▪ Career Training ▪ Apprenticeship ▪ Technical Education ▪ Career and Technical Education ▪ Vocational Education ▪ Technology Education ▪ Job Training ▪ Informal Education	▪ Materials and Practices ▪ Early Intervention ▪ Characteristics of an Occupation ▪ Career Counselors ▪ Recruitment ▪ Referral ▪ Career Guidance ▪ Elementary School ▪ Middle School ▪ Workplace Policies ▪ Employment Counseling ▪ Choices ▪ Gender Neutral ▪ Work/Life Balance	▪ Family Characteristics ▪ Family Role ▪ Gender Neutral ▪ Parental Education ▪ Parental Involvement ▪ Guardian ▪ Foster care ▪ Role of siblings (huge in some cultures) ▪ Single parents (both for having children and being raised by a single parent	▪ Self-Efficacy ▪ Attribution ▪ Stereotype Threat ▪ Self-Affirmation ▪ Teaching Strategies ▪ Professional Development ▪ Supportive Learning Environments ▪ Expressive Traits ▪ Instrumental Traits	▪ Media (Negative & Positive) ▪ Peers ▪ Role Models/Mentors ▪ Role Model/Mentor Training ▪ Collaboration ▪ Critical Thinking ▪ Support Groups ▪ Peer Counseling ▪ Support Systems ▪ Leadership ▪ Sex discrimination

APPENDIX D. INFORMATION GATHERING PROTOCOL

Directions/Instructions

As you read through the publications please complete the Information Gathering Template in accordance with the category explanations below. Please include all relevant information in a clear and concise manner. **Do not leave any fields blank, mark fields as "Not Applicable" or "Not Available."**

General Information

ID - This is an auto-generated ID number. This field does not need to be altered.

Title of Publication

Citation - Author, A. A., Author, B. B., & Author, C. C. (Year). Title of publication. Title of Periodical, volume number, issue number, pages.

Publication Type – Enter the type of publication you are reviewing. Mark all that apply.

- **Barrier(s) –** A publication that describes a barrier to NTO entry.
- **Strategy(ies) –** A publication that describes a strategy(ies) to overcome a particular barrier(s) to NTO entry.
- **Qualitative Evaluation of Strategy –** A publication that describes a qualitative evaluation of a strategy to overcome a particular barrier(s) to NTO entry.
- **Quantitative Evaluation of Strategy –** A publication that describes a quantitative evaluation of a strategy to overcome a particular barrier(s) to NTO entry.

Purpose of the Publication – Brief description of publication objective, 3-5 sentences. This can often be found in the Introduction or Abstract.

Barrier Description

Barriers– The barrier(s) that this publication describes.

Target Age Group – Youth (17 and under), Adults (18-50), Older Adults (50+). Describe if other. ***Check all that apply.***

Target Population – Women, Men, African Americans, individuals of Hispanic descent, Individuals with Disabilities, LGBT. Describe if other. ***Check all that apply.***

Extent of Barrier's Effect – Estimated number of individuals affected, and any given description of the scope of the barrier's effect.

Strategy/Intervention Description

Strategy/Intervention Name – Include a specific program name and/or a more general name for the strategy being implemented if available. Examples of general strategy names: math camps, career counseling, train-the-trainers. Examples of specific program names: AJC career counseling, ABC Math Camp.

Description of Strategy/Intervention – A high level description of the strategy/intervention, and how it has been implemented.

Target Outcomes – This category refers to the outcome(s)/skill(s)/behavior targeted by the Strategy/Intervention. For example, creating a flexible work schedule, improving visual spatial skills, or enrolling in math/science courses.

Geographic Area of Implementation – The area(s) where the Strategy/Intervention evaluated was implemented. If in the U.S., provide the state/region. If outside of the U.S., provide the country.

Duration of Strategy/Intervention – The length of time the Strategy/Intervention is made available to participants during the entire intervention period (not just the study period.)

Intensity of Strategy/Intervention– The number of hours per day and/or days per week the Strategy/Intervention was administered.

Setting of Strategy/Intervention – The physical setting in which the Strategy/Intervention was administered. For example, a classroom or the workplace.

Cost of Implementation – Any information regarding the cost of implementation. For example, total cost of intervention, cost per person treated, etc.

Provider Details

Organization Type – The type of organization(s) administering the Strategy/Intervention. For example, a community college, a union/apprenticeship organization, or an American Job Center. Specify which organization(s) is actually delivering the intervention to participants.

Instructor Type & Qualifications – The occupation/role, skill sets, and/or qualifications of the person or group of individuals who were instructors in the program.

Instructor to Subject Ratio

Evaluation Description

Research Questions – The key research questions the evaluation sought to answer.

Sample size – The number of subjects included in the study.

Gender of Subjects – The distribution of gender in the sample. Complete separately for comparison and treatment groups, if available.

Age of Subjects – The age range, mean, and standard deviation (SD) for the sample. Complete separately for comparison and treatment groups, if available.

Race of Subjects – The distribution of race/ethnicity in the sample. Complete separately for comparison and treatment groups, if available.

Other Subject Characteristics - Other relevant demographic information such as disability status, veteran status, and/or family position/role. Complete separately for comparison and treatment groups, if available.

Qualitative Designs Only –

Data Collection Methods – Provide a description of the methods used for data collection. This may include interviews, focus groups, surveys, document review, or observations.

Study Biases/Limitations – Provide a description of the study biases and/or limitations. This includes those discussed in the study as well as any identified by the reviewer.

Summary of Findings – A summary of the study findings.

Quantitative Designs Only –

Research Questions

Data Collection Methods – Provide a description of the methods used for data collection.

Length of Study Period

Length of Follow-up Period

Study Design – The research methodology that was used to assess the effectiveness of the Strategy/Intervention. This will involve reviewing the publications to find out how the group membership (Treatment group vis-à-vis Control/Comparison group) was established. For example, was random assignment (randomization) used to select program participants into the Treatment group and Control group. If not (non-randomization), how was the assignment into each group determined. In this regard, the following represent different types of research designs that provide evidence for interventions. *Select the research design that was used by the researchers to evaluate the effectiveness of the* Strategy/Intervention*.*

Comparison Group/Condition – The group or condition that the results of the treated group are compared against. The treated group may be compared to a different group of subjects or to the same group pre-intervention.

Outcomes – List the specific outcomes measures in the study, including Pre/Post or Group Mean Scores, and any measures used to assess these outcomes. Also standard deviations or effect sizes when available. Outcomes could include education/training enrollment/ attainment, employment, retained employment, and/or wages.

P-value of Outcomes – Statistical significance of the main outcome(s).

Investigator Background – Was the study conducted by investigative teams independent of the program developers? The Strategy/Intervention can be provided by the program developers as long as the investigative team who evaluated the Strategy/Intervention was independent.

Limitations – Shortcomings of the research study. For example, inadequate sample size, selection bias, and weaknesses of the study design.

Summary of Findings

Design	Description
Randomized designs	
Randomized, controlled trial (including group randomized designs)	An experimental design that studies the effect of an intervention or treatment using at least two groups: one that received the intervention and one that did not; participants are randomly assigned to a group.
Group randomized trials with discrepant units of analysis, or with an inadequate number of aggregate units assigned to condition	A randomized design study where different outcome measures used for the groups (i.e., discrepant units of analysis) or where there is an insufficient sample size in one or more of the groups (i.e., an inadequate number of aggregate units assigned to the conditions).
Quasi-experimental designs	
Propensity Score Matching	Comparison group is matched to the treatment group to ensure that the individuals not receiving the intervention are very similar to the individuals receiving the intervention. Matching can be done using nearest-neighbor, radius, kernel, Gaussian, and several other methods
Difference-in-Differences	Measure the change in outcome experienced by the treatment group as compared to the comparison group over a period of time.
Interrupted time series (ITS) designs	ITS designs are multiple observations over time or rates that are 'interrupted' usually by an intervention or treatment. The investigators must indicate a specific point in time when the intervention occurred. A control group may or may not be present. [Cochrane Collaborative, EPOC Methods Paper, "Including Interrupted Time Series (ITS) Designs in a EPOC Review"]
Regression discontinuity designs	Assignment to the treatment group or comparison group is determined partly on a cutoff score on a measured covariate
Pretest-posttest non-equivalent comparison group designs	Comparison group is selected that is as similar as possible to the intervention group so can fairly compare the treated one with the comparison one. But it cannot be determined if the groups are comparable.
Cohort design studies (e.g., prospective cohort study, retrospective cohort study)	Group of exposed individuals and group of non-exposed individuals are selected and followed to compare the incidence of intervention in the two groups
Other designs (i.e., case study, case series, descriptive analysis)	Any non-causal study; no control group