Female-Minority Initiative

Final Report

February 17, 2009

Florida Center for Research
in Science, Technology, Engineering and Mathematics

Florida State University
Tallahassee, Florida
About FCR-STEM

The mission of the Florida Center for Research in Science, Technology, Engineering and Mathematics (FCR-STEM) is to engage in research, technical assistance, and dissemination that will (1) contribute to the scientific body of knowledge regarding how students learn science and mathematics, and how this learning is assessed; (2) improve teaching and learning in Florida’s STEM classrooms; and (3) increase students’ preparation for higher education and careers in the 21st Century. With a focus on improving classroom practice, the center aims to have an impact on the following outcomes:

- Improving student achievement in STEM
- Narrowing student achievement gaps in STEM
- Increasing student pursuit of STEM careers

Funded by the Florida Legislature, FCR-STEM is jointly administered by Florida State University’s College of Arts & Sciences, College of Education, and Learning Systems Institute in the Office of the Provost. The center was created in state statute in 2006 and competitively awarded by the Florida Department of Education to Florida State University in February 2007.

FCR-STEM extends sincere gratitude to the Female-Minority Initiative Work Group and Advisory Panel members for their generous contribution of time and expertise to this project and for their impressive dedication to advancing the opportunities and success of females and underrepresented minorities in science, technology, engineering and mathematics.
# TABLE OF CONTENTS

Overview .......................................................................................................................................................... 6

Recommendations of the Female-Minority Work Group ................................................................. 7

Actions Supported by Research ........................................................................................................... 21

Logic Models ............................................................................................................................................... 25

Next steps ..................................................................................................................................................... 28

References ................................................................................................................................................... 29

Appendices

- **APPENDIX A** - Summary of Trends in Female and Minority STEM Achievement and Attainment: K-12 through Post-secondary Schooling in Florida

- **APPENDIX B** - Gender and Racial Attainment Disparities in Science and Mathematics: A Review of the Literature

- **APPENDIX C** - Possible measures for Evaluating the Success of the Plan

- **APPENDIX D** - Advisory Panel and Work Group Members
OVERVIEW

Purpose of the Female-Minority Initiative
In April 2007, FCR-STEM created the Female-Minority Initiative to address the objective of narrowing student achievement gaps in science, technology, engineering and mathematics (STEM) and respond to authorizing legislation requesting the center to “develop a comprehensive plan, with input from school districts, to increase the number and percentage of females and minority students enrolling in and successfully completing mathematics and science courses” (Florida Statutes, Section 1004.86). FCR-STEM expanded the scope of the plan beyond course-taking to include participation, achievement, and persistence in STEM education and careers from kindergarten through post-secondary education (K-20).

Development of the Plan
In June of 2007, a group of 10 professionals were selected to serve as advisory panel members and recommend participants for a Female-Minority Initiative Work Group that would develop the final plan. Also, the FCR-STEM project team, led by Project Manager, Faye Jones, began preparation of two documents to guide the Work Group’s recommendations.

1. A summary of trends in female and minority STEM course-taking, achievement and degree attainment from K-12 through postsecondary education in Florida (See Appendix A).

2. A literature review, based on peer-reviewed journal articles, to aid in understanding the participation, choice, and persistence of females and underrepresented minorities in STEM from the elementary grades to postsecondary education (See Appendix B).

The Advisory Panel convened in Spring 2007 to help guide the process for developing the plan and identify K-20 education, research, and business stakeholders for the Work Group. Based on the Advisory Panel’s input, a diverse Work Group of 37 members was selected, including representatives of Florida’s school districts, community colleges, universities, businesses, Department of Education, and several STEM initiatives outside Florida (See Appendix D).

The Work Group held two 1-1/2-day meetings in Orlando. On November 13-14, 2007, members began to examine policies, programs and strategies that hold promise for increasing Florida’s female and minority representation in STEM courses and STEM fields. After being presented with a summary of the literature review and data trends, members were asked to examine and answer the following question: Which of the recommendations from the literature review and your own experiences show promise for increasing Florida’s female and minority representation
in STEM courses and STEM fields? This question was addressed in small groups first by region (North Florida, Central Florida, and South Florida) and then by school level (i.e., elementary, middle, high school, and post-secondary education). FCR-STEM small group facilitators digitally recorded all discussions and documented the recommendations in writing. The Work Group met again on May 22-23, 2008 to (1) examine Logic Models describing how Florida could close gender, racial, and ethnic gaps in STEM, (2) review and edit recommendations from the November 2007 meeting, and (2) identify potential measures of the plan’s success (see Appendix C).

Summary of the Plan

Goal 1: Increase student interest and awareness

Recommendation 1: Launch media and outreach campaigns to raise student awareness of STEM careers.

Recommendation 2: Strengthen STEM-related counseling and advising.

Recommendation 3. Increase awareness and access to financial aid for college, particularly in STEM majors.

Goal 2: Improve STEM instruction

Recommendation 4: Implement research-based instructional strategies in K-12 mathematics and science.

Recommendation 5: Increase the rigor and relevance of course offerings.

Recommendation 6: Reduce the overemphasis on textbooks and increase the diversity of instructional approaches.

Recommendation 7: Eliminate tracking of students into less rigorous coursework.

Recommendation 8: Help minorities enroll and succeed in advanced STEM courses.

Recommendation 9: Establish systems to monitor student progress and provide help to struggling students.
Recommendation 10: Implement strategies to increase STEM participation and success at the postsecondary level.

**Goal 3: Build school capacity to improve STEM education**

Recommendation 11: Attract quality STEM teachers to high-need schools.

Recommendation 12: Provide cultural competency training to K-20 teachers and administrators.

Recommendation 13: Identify and implement successful approaches to K-12 math/science teacher preparation and professional development.

Recommendation 14: Increase incentives for K-12 teachers to complete high-quality professional development.

Recommendation 15: Develop a STEM-focused alternative certification program.

Recommendation 16: Provide professional development to K-12 school leaders in order to improve their understanding of and support of high quality science and mathematics teaching.

**Goal 4: Engage business and the broader community**

Recommendation 17: Evaluate the success of existing out-of-school and afterschool programs focusing on STEM.

Recommendation 18: Identify possible roles for parents, communities, industry, and government in attracting students to STEM careers.

Recommendation 19: Develop more partnerships to strengthen K-12 instruction.

**Goal 5: Make Informed Policy Decisions**

Recommendation 20: Require “diversity impact studies” to guide budget reductions by school districts, community colleges and state universities.

Recommendation 21: Create a board of industry representatives for lawmakers to consult when making decisions that will affect workforce education and preparation specifically in STEM fields.
Goal 1: Increase student interest and awareness

Recommendation 1: Launch media and outreach campaigns to raise student awareness of STEM careers. With science literacy in mind, the group considered all students the target audience for this recommendation. Several different types of activities were suggested:

1. Identify existing promotional and marketing materials that positively portray young people, particularly females and minorities, in STEM careers. The campaign should be based on evidence of strategies that work. Possible media outlets and resources to consider include:
   - NASA materials, such as a film showing interviews with kids.
   - Short videos called “Futures” featuring females/minorities in STEM careers.
   - Hispanic and African American media outlets. Advertisement during events that are frequently viewed by women, minorities, and the general population might also be effective (i.e., Golf, Tennis, Tyler Perry, Football, American Idol, Dancing with the Stars).
   - U2 videos, the Design Squad, ipods, Internet, and other media that make it “cool” for students to pursue STEM.
   - The Southern Regional Education Board (SREB) and Southern Governors’ Association received a Gates Foundation grant several years ago to launch media outreach campaigns designed to motivate all students to complete high school well-prepared to enter postsecondary education or the workforce. One component of this initiative, SREB’s Go Alliance, helps member states share expensive media materials and run more effective campaigns promoting college awareness, access and attendance among underrepresented minorities (see http://www.collegeaccessmarketing.org/goalliance/default.aspx).
   - Existing organizations, such as Enterprise Florida, Space Florida, and Workforce Florida, Inc., to help organize or support media campaigns.
   - The ACT’s online program tools through Discover to aid in raising awareness of STEM jobs. See website at http://www.act.org/discover/overview/index.html
   - Public announcements, including a State of STEM address to increase public awareness and understanding of the importance of STEM, the consequences of low achievement in STEM, the gender and racial/ethnic disparities in STEM, and solutions for closing the gaps.
2. **Target outreach for specific groups** of students such as those eligible for free/reduced price lunch and first generation college students. Find ways to attract and sustain female interest in science and mathematics. The appeal of science and math for females needs to be addressed from kindergarten through the university level. For females, it appears to be a question of keeping interest in science alive, rather than a question of ability or academic achievement.

3. **Provide students time, materials and facilities** related to STEM education and exploration of STEM careers, taking advantage of field trips, interactive exhibits, videos, laboratory workshops, and other programs at venues outside the school setting such as:
   - The Orlando Science Center ([http://www.osc.org/Index.aspx](http://www.osc.org/Index.aspx))
   - Boston Museum of Science – materials to train counselors and teachers; career books for children ([http://www.mos.org/exhibits_shows](http://www.mos.org/exhibits_shows))
   - The National Center for Quality AfterSchool Training Toolkit which provides examples of how to engage students in science, technology, math, arts, and literacy programs after school ([http://www.sedl.org/afterschool/](http://www.sedl.org/afterschool/))

4. **Encourage STEM outreach at the postsecondary level.** Examine programs in Florida and other states that have been successful in attracting females and underrepresented minorities to STEM or STEM-related majors. Also, increase incentives and opportunities for tenured and tenure-track faculty to take a proactive role in recruiting and engaging students in STEM courses and majors, through teaching, research and service. Increase STEM faculty awareness of diversity by requiring them to report the number and percentage of female and traditionally underrepresented minority students engaged in their research projects.

**Recommendation 2: Strengthen STEM-related counseling and advising.**

1. **Staff schools with guidance or career counselors at all levels** (elementary, middle and high school) in ratios appropriate to the student population.

2. **Encourage universities to work with elementary and secondary school counselors.** For example, Florida International University’s College of Engineering provided workshops that exposed counselors to different engineering disciplines. The Florida Partnership for Minority and Underrepresented Student Achievement, a joint initiative of the College Board and the State of Florida, provides a forum to address how students could be better advised on coursetaking and prepared for postsecondary success. The partnership’s activities, which currently includes a counselor leadership conference, might be tailored or expanded to specifically address STEM.
3. **Increase use of career counseling tools and resources**, such as the electronic Personal Education Planner (ePEP) and other tools on the FLDOE career planning website, [www.facts.org](http://www.facts.org). Some tools are already in place but need to be used more widely. Career counselors, especially in high school, should be aware of financial resources and grants available to students pursuing STEM education. For example, the National Science and Mathematics Access to Retain Talent Grant, also known as the National SMART Grant (see [http://studentaid.ed.gov](http://studentaid.ed.gov)), provides up to $4,000 per year to full-time undergraduates, who are in their third and fourth years of study, are eligible for federal Pell Grants, and are majoring in physical, life, or computer sciences, mathematics, technology, or engineering.

4. **Help STEM teachers become more like advisors.** They need to be sufficiently knowledgeable to talk to students about college and STEM careers.

5. **Engage older students in mentoring younger learners.** For example, the National Science Foundation Graduate Teaching Fellows in K-12 Education (NSF GK-12) Program ([http://www.nsfgk12.org/](http://www.nsfgk12.org/)) provides fellowships and training to graduate students in STEM fields who work in K-12 schools in a mentoring or supportive role. The purpose is to improve their communication and teaching skills while enriching STEM content and instruction for their K-12 partners. With an NSF grant, the University of South Florida’s College of Engineering is creating learning communities for students through a three-tiered mentoring ladder involving faculty mentors, upper-level undergraduates, and graduate students (see [http://www2.eng.usf.edu/news/kumar-nsfrnr.asp](http://www2.eng.usf.edu/news/kumar-nsfrnr.asp)).

6. **Utilize workforce development (e.g., Workforce plus) counselors to familiarize students with careers.**

**Recommendation 3: Increase awareness of and access to financial aid for college, particularly in STEM majors.** Ensure that females and underrepresented minorities are aware of Bright Futures Scholarships, access to at least one free PSAT exam, and dual enrollment programs at universities. Consider a state-funded scholarship for university students seeking STEM degrees. For example, an extra $1500 per year in financial aid might lure more students. This strategy has been adopted in South Carolina, but no results have been reported to date. The University of Florida reportedly tried this approach at the institutional level but it was viewed as “giving other majors less.”

**Goal 2: Improve STEM instruction**

**Recommendation 4: Implement research-based instructional strategies in K-12 mathematics and science.** The Work Group recommended doing for math and science what *Reading First* did
for reading in the elementary grades. It was predicted that this would be more challenging in mathematics and science than in reading because of the number of different content areas (life sciences, physical sciences, etc.).

1. **Systematically study the effectiveness of STEM education in elementary, secondary, and postsecondary schools in Florida.** One approach is to conduct a *Beat the Odds Study* targeting high minority schools in Florida to answer the following question: *How do Florida schools where minorities "beat the odds" (i.e., perform at higher levels than predicted based on socioeconomic and other factors) differ from Florida schools where minorities do not "beat the odds"?* The intent of this study would be twofold: (1) to identify STEM-related policies and practices in Florida’s schools and school districts that appear to have promise in increasing the participation and success of minorities in STEM education, and (2) to subsequently test their effectiveness through rigorous evaluations. The initial focus would be mathematics achievement in elementary schools serving a substantial number of minorities underrepresented in STEM (i.e., Blacks and Hispanics). In later years, this study could be extended to middle and high school mathematics and to science at all levels. Similar studies have been conducted in other states such as Arizona and Washington.

2. **Examine key recommendations from national organizations serving females and minorities.** Two organizations of particular relevance are the (1) National Action Council for Minorities in Engineering (NACME) which has a number of suggestions on its website ([www.nacme.org](http://www.nacme.org)) and sponsors programs and events designed to attract minorities to engineering, (2) SECME which hosts programs beginning in the early grades that encourage minorities and underserved youth to study STEM in college. The following organizations also have provided recommendations: Ecological Society of America (ESA), The National Association of Multicultural Engineering Program Advocates (NAMEPA, Inc.), Student Conservation Association (SCA), The National Society of Black Engineers (NSBE), National Organization of Black Chemists and Chemical Engineers (NOBCHE), Society of Women Engineers (SWE), National Society of Hispanic Engineers (NSHE), and the National Association of Mathematicians (NAM).

3. **Support interdisciplinary collaborations.** Provide opportunities for student exposure to multiple STEM disciplines (e.g., chemistry and engineering). For example, at some universities, departments (e.g., chemistry and engineering) share graduate students as teaching assistants for STEM courses.

**Recommendation 5: Increase the rigor and relevance of course-offerings.**

1. **Determine the most feasible way to increase mathematics and science course-taking requirements** at the high school level so that students take at least four years each of math and science and reach at least Algebra II in mathematics by graduation. *Revisited*, a longitudinal study by the National Center for Education Statistics tracking the 1988 cohort of U.S. 8th graders through 2000 provides data on course-taking associated with
success in postsecondary education. The data, however, are primarily correlational; a cause-and-effect relationship between increased requirements and postsecondary success has not been established. Also, the feasibility of implementing such requirements needs to be carefully considered in order to minimize implementation barriers (e.g., lack of well-qualified teachers) and possible unintended consequences (higher drop-out rates).

2. **Offer capstone courses in high school** that illustrate the application of STEM in real world and career settings. These courses would be an option for students who think Advanced Placement (AP) courses aren’t “cool” or do not plan to attend college immediately after graduation. Hands-on experiential learning was suggested as a strategy to increase the relevance of instruction in grades K-12.

Recommendation 6: Reduce the overemphasis on textbooks and increase the diversity of instructional approaches (e.g., rotating students from large groups to laboratories and small problem-solving groups; use of manipulatives; and hands-on, minds-on activities, including science labs.) The Miami-Dade school district is preparing packets and laboratory activities to enhance science instruction, as a supplement to existing textbooks and guides. Other examples include: (1) Supplementary science and math resources such as Great Explorations in Math and Science or GEMS at the University of California-Berkeley, (2) I LOVE Science (Increasing Local Opportunities for Volunteers Enthusiastic about Science) created by a partnership between Gulf Power Company, Florida Institute for Human and Machine Cognition (IHMC), former state Rep Holly Benson, and the Escambia and Santa Rosa County School Districts, and (3) the MOVE IT Math (MIM) program by Project GRAD USA Mathematics.

Recommendation 7: Eliminate tracking of students into less rigorous coursework. Eliminate low track courses such as Informal Geometry and Algebra IA/IB. Identify “weed-out” courses and provide support to students struggling in these courses. Do not isolate students based on language. STEM courses and activities should be structured to remove barriers and include students with limited English Proficiency. Testing accommodations will help these students to some extent, but they also will need help in their native language with technical vocabulary in science and mathematics, which may be unfamiliar or confusing to their parents.

Recommendation 8: Help minorities enroll and succeed in advanced STEM courses.

1. **Evaluate existing programs in Florida and other states and identify those that might be scaled up.** Examples include:
   - **AVID** (Advancement Via Individual Determination): Miami-Dade is currently piloting this program, which begins in grade 4 and extends through middle and high school. It includes rigorous coursework school-wide, tutoring in Socratic
methods, writing as a tool for learning, study groups, and exposure to the wider world through attendance at stage plays, museums and places of professional employment. Although taught by different teachers, each middle school student has a single teacher responsible for him/her. A major target group for this program is “middling” or “C” students who regularly attend school and do not have serious discipline problems. Other Florida districts, such as Brevard and Hillsborough, also have been implementing this program. (See http://www.avidonline.org/)

• Dual community college and university degree programs: Florida International University (FIU) operates a program specifically for students who are not admitted to FIU immediately after high school graduation, but who would be automatically eligible for admission upon successful completion of an AA degree at a community college within 3 years. Upon entry to the community college, the program builds the student’s psychological connection with the university, for example, by giving them an FIU ID card, access to the FIU library, discounts for football game tickets. Findings to date indicate better results for these dual degree program participants compared to those students who were offered but did not accept this opportunity.

2. **Examine proper designation of advanced courses.** The Work Group raised concern about use of the terms “Pre-Advanced Placement (Pre-AP)” versus “Honors” in naming high school courses, and the differential impact these designations may have on student enrollment in AP courses. The term “pre-AP” may encourage students to enroll in AP courses, whereas the term “Honors,” by signifying excellence that may not be on par with AP courses, may deter students from taking AP courses. Proper designation and description of courses also is needed at the university level to help students pursue STEM careers, particularly in information technology.

3. **Encourage school administrators to monitor the number of females and minorities in higher level courses** and consult with teachers and parents about the possible reasons for low female and minority enrollments (if any) and how they might be increased.

**Recommendation 9: Establish systems to monitor student progress and provide help to struggling students.** Such a system would have academic interventions at mid-term for those with borderline or poor performance. For example, at the university level, University of South Florida students receive mid-term grades and are required to see an advisor and counselor if performance is below an acceptable threshold. Conduct surveys on student attitudes towards STEM that could identify school, home and peer factors that influence students’ STEM choice and persistence in high school and their transition into college and the workforce. The Michigan Study of Adolescent and Adult Life Transitions or MSALT provides a good model to follow.
Recommendation 10: Implement strategies to increase STEM participation and success at the postsecondary level.

1. **Implement research-based remediation strategies.** Recent studies by the Florida Legislature’s Office of Program Policy Analysis and Government Accountability (OPPAGA, Report No.07-31) and Association of State Colleges and Universities (*Enhancing college student success through developmental courses*) indicate that successful completion of college preparation programs and developmental coursework can improve degree attainment. The OPPAGA report notes that although research-based strategies exist, they are implemented unevenly by community colleges.

2. **Improve vertical integration of mathematics and science education from K-20.** To enhance student success and reduce the need for remediation, the workgroup advised better alignment of STEM coursework and instruction from K-12 to the postsecondary institutions and from community colleges to universities.

3. **Implement strategies to enhance attainment of bachelor’s and advanced degrees.** Consider pre-major STEM degrees (similar to pre-law or pre-med programs). Examine the possibility of extended five-year master’s degree programs in STEM fields that afford students the opportunity to increase their preparation for master’s level coursework.

4. **Increase research experiences** for grade 3-12 students and undergraduates in order to engage students in the work of scientists in various STEM fields.

5. **Find ways to retain STEM college and university majors in STEM or STEM-support fields.** When students drop a particular STEM major, provide a mechanism to redirect them to another STEM or STEM-support field for which they may be better suited. Encourage STEM learning and community living centers at universities to increase student experience with and exposure to STEM fields and facilitate interaction among students with similar STEM interests.

6. **Consider English proficiency courses for professors in STEM fields.** At Florida International University, accent reduction courses are given to professors when student evaluations indicate that teachers are difficult to understand.

**Goal 3: Build school capacity to improve STEM education**

Recommendation 11: Attract quality STEM teachers to high-need schools.

1. **Review and evaluate the effectiveness of incentive programs** in Florida and other states which aim to attract and retain practicing teachers at Title I or other low SES schools.
2. **Utilize incentives to attract pre-service teachers to high need schools.** Examples include (1) federal Teacher Education Assistance for College and Higher Education (TEACH) Grants that provide up to $4,000 per year to students who agree to teach in a public or private elementary or secondary school that serves students from low-income families, and (2) the Florida Fund for Minority Teachers, established in 1999 by the Florida Legislature, which provides $4,000 scholarships to eligible African-American, Hispanic-American, Asian-American, and Native American juniors enrolled in a teacher education program at one of Florida’s public or private universities. These scholarships can be repaid by being employed as a Florida public school teacher for one year for each year the scholarship was received.

3. **Broaden teacher recruitment efforts for high need schools** via local universities such as Colleges of Education, Arts and Sciences, and Engineering. Expand efforts to recruit career changers with STEM backgrounds into mathematics and science teaching. Arrange more internships for pre-service teachers in high-need schools and at schools with critical shortages of mathematics and science teachers.

**Recommendation 12: Provide cultural competency training to K-20 teachers and administrators.** It is important for teachers to be aware of actions that may unfairly track minority/female students or restrict them from getting into upper level classes. Also, leaders must be able to foster cultural competency among teachers and create a comfort zone that will enable people to have open conversations about race. Both teachers and administrators must understand the unique cultural aspects of minority populations that may dissuade students from pursuing STEM careers. For example in the Hispanic culture, females may have deeply rooted roles that differ from those of males. Parents may be reluctant to encourage their children to enter unfamiliar fields or to live far away from home. The Anchin Center at the University of South Florida (USF) has incorporated cultural competency training into professional development for science educators. The National School Reform Faculty Protocols provide guidance on how to have difficult conversations with faculty about race and other issues. Some school districts, such as Hillsborough and Pinellas, have provided cultural competency training on a broad scale. At the university level, cultural competency training (like sexual harassment training) could be required for faculty.

**Recommendation 13: Identify and implement successful approaches to K-12 math/science teacher preparation and professional development.** Both content and pedagogy (strategies for teaching content) need improvement at all levels. With grants from the National Math and Science Initiative, two Florida universities (University of Florida and Florida State University) are replicating and evaluating the impact of the UTeach teacher preparation program at the University of Texas-Austin. This program was designed to dramatically increase the number of well-qualified mathematics and science teachers at the secondary level. For practicing teachers,
the Work Group suggested that professional development follow a professional learning community model and engage teachers in Lesson Study (an approach in which teachers are convened to discuss how to teach a particular lesson, develop a script, observe each other teach, and refine the lesson accordingly).

**Recommendation 14: Increase incentives for K-12 teachers to complete high-quality professional development.** One option is to examine in-service points for recertification and place greater emphasis on STEM content. Incentives could be provided for teachers to complete courses/degrees at universities. Some universities, such as Florida State University, offer practicing science teachers the option of earning a master’s degree online and summer programs, such as Research Experiences for Teachers (RET) that pay teachers stipends to work with scientists.

**Recommendation 15: Develop a STEM-focused alternative certification program,** possibly integrated with other programs, such as MINT (Mentoring and Induction for New Teachers) directed by the Miami-Dade County School District.

**Recommendation 16: Provide professional development to K-12 school leaders** in order to improve their understanding and support of high quality science and mathematics teaching.

**Goal 4: Engage business and the broader community**

**Recommendation 17: Evaluate the success of existing out-of-school and after-school programs focusing on STEM.** The Northwest Regional Educational Laboratory published a literature review on the importance of afterschool literacy programs for the National Partnership for Quality Afterschool Learning. It was suggested that a similar literature review be conducted on STEM afterschool and outreach programs incorporating the programs below.

**Examples:**
- **SECME.** Established in 1975 as the Southeastern Consortium for Minorities in Engineering by the engineering deans at seven southeastern universities, this organization sponsors programs for students, teachers and parents with the aim of increasing the numbers of underrepresented and underserved students who want to study science, mathematics, engineering and technology in college. SECME’s programs start as early as pre-kindergarten and extend through high school (see [www.secme.org](http://www.secme.org)). The Georgia Institute of Technology would have data on the success of this program. The Miami-Dade school district, University of Miami and Florida International University also have been involved in SECME initiatives.
FCR-STEM
Female-Minority Initiative

- **California MESA** (Mathematics Engineering Science Achievement). Established in 1970 and administered by the State of California, MESA is an academic development program that supports educationally disadvantaged students in math and science studies at the university level and their attainment of math-related degrees in engineering, science and technology. The program is funded by the state legislature, corporate contributions and grants (see [http://www.ucop.edu/mesa/home.html](http://www.ucop.edu/mesa/home.html)).

- **Upward Bound Math-Science (UBMS).** In 1990, the U.S. Department of Education established a math and science initiative within Upward Bound, designed to provide disadvantaged high school students with skills and experiences to help them succeed in college. The UBMS initiative awards grants to colleges and universities to provide (1) hands-on experience in laboratories, computer facilities, and at field sites, and (2) opportunities to learn from mathematicians and scientists at host institutions. An evaluation of student transcripts collected between 1998 and 1999 and again from 2001 to 2002 indicated that UBMS improves several student outcomes in high school and college, and increases the odds of majoring in math or science (Olsen et al, 2007).

- **Summer STEM programs and academies for students.** These experiences appear to increase students’ interest in STEM. A variety of these programs are offered by Florida’s universities. Examples include “Expanding Your Horizons” a STEM-related program for middle school girls sponsored by the University of Central Florida’s College of Engineering and Computer Science, “Saturday-at-the-Sea” sponsored by Florida State University’s College of Arts & Sciences, and “Science Students Together Reaching Instructional Diversity & Excellence” (SSTRIDE) sponsored by Florida State University’s College of Medicine. At Florida International University, the College of Engineering conducts outreach programs during the school year and summer months to prepare young students in science, technology, engineering, and mathematics.

  Although the following programs are not STEM-specific, they offer opportunities for promoting STEM education and careers to female and minority students.

- **Engaging Latino Communities for Education (ENLACE).** Launched nationally by the W.K. Kellogg Foundation in 1999, ENLACE (Engaging Latino Communities for Education) builds educational partnerships to identify and eliminate the barriers to educational success in higher education for diverse under-represented students. The W. K. Kellogg Foundation has funded a joint proposal by Florida International University, University of South Florida, Florida Atlantic University, and the University of Central Florida over three years to support ENLACE FLORIDA. This project will develop and implement solutions eliminating barriers to educational success, examine best practices in Florida and the nation and advocate for policies designed
to improve educational achievement for Hispanic students and other underrepresented groups in Florida’s K-20 system. (See http://www.cec.fiu.edu/news/CEC_News_ENLACE.htm)

- **College Reach-Out Program (CROP).** Funded by the Florida Department of Education, this program has served over 112,000 students since 1990. Blacks comprise the largest group served (72%); also, females (61%) outnumber males. The program starts at 6th grade and runs through graduation. Results to date show that 85% of seniors in the program graduate from high school with a standard diploma and 72% of graduates enter postsecondary institutions. Most of the state’s community colleges and state universities plus 4 private institutions participate. Districts sign agreements with participating postsecondary institutions. For more information see http://www.fldoe.org/eeop/crop.asp.

- **“High Schools That Work.”** High Schools That Work is the largest and oldest of the Southern Regional Education Board’s school improvement initiatives for high school and middle grades leaders and teachers. More than 1,200 HSTW sites in 32 states participate. (See http://www.sreb.org/programs/hstw/hstwindex.asp.) This national academy model is being implemented in all high schools in Miami-Dade, which have focused on the following themes: Health Sciences, Finance, Law, Digital Technology, among others.

- **GEAR UP (Gaining Early Awareness and Readiness for Undergraduate Programs).** This federally-funded grant program is designed to increase the number of low-income students who are prepared to enter and succeed in postsecondary education. It provides six-year grants to states and partnerships to provide services to students at high-poverty middle and high schools. Entire cohorts of students are followed from middle to high school. GEAR UP funds also provide college scholarships to low-income students. There are four GEAR UP projects in Florida (See http://www.ed.gov/programs/gearup/index.html.

In examining and assessing the effectiveness of these programs, the Work Group suggested comparing them on a given set of characteristics (e.g., parental support) and looking for common characteristics that define successful programs, recognizing that no one particular model should be expected to work in all contexts.

The Work Group also suggested examining programs designed to help students develop skills and coping strategies (persistence, time management, study habits) necessary for the transition from high school to college and graduate school. Examples of these programs are freshman First Year Experience (FYE) courses, the Ronald E. McNair Post-baccalaureate Achievement Program (a federal TRIO program) for underrepresented minorities, the National Science Foundation’s Louis Stokes Alliance for Minority Participation or AMP program to help underprivileged minorities in STEM, and summer bridge programs.
Recommendation 18: Identify possible roles for parents, communities, industry, and government in attracting students to STEM careers.

1. **Help students find mentors or supportive adults** who can guide their education and development. The national Hispanic Dropout Project established by the U.S. Department of Education in 1995 identified the importance of social networks and supports: Students must have parents who know what it takes to succeed or a supportive relationship with a member of the school staff.

2. **Disseminate information to parents about how to support their children’s STEM education and choice of STEM careers.**
   The Work Group noted that parents are a huge lever for Hispanic students. Hispanic families are very close-knit (70% to 80% of Florida International University students live at home) and are reluctant to see their children leave home for employment elsewhere. These concerns should be addressed in communications with parents and students about STEM careers, for example, by describing where people with STEM degrees work locally. Family-centered math and science activities also were mentioned as options for communicating with parents about STEM education and careers. Examples include the (1) Everyday Mathematics Center funded by the NSF to support educators, parents, and students who use Everyday Mathematics, (2) Figure This! Math Challenges for Families, (3) MAPPS (Math and Parent Partnerships) in the Southwest, and (4) STEM Family Nights.

3. **Examine various avenues for outreach** such as churches, community centers, fraternities and sororities, neighborhood functions, ethnic festivals, Math/Science at the Mall, Spanish language talk shows, the Miami-Dade parents academy, parent resource rooms (currently at all Miami-Dade schools), 100 Black Men, and town hall meetings hosted by Miami-Dade school board members (which typically have a large turnout). Providing outreach to American Indian students and families would require building trust, perhaps through meetings with tribal leaders, and a message that resonates with their culture, including a connection to the land.

4. **Better inform parents of financial aid options for college,** such as Bright Futures Scholarships, free PSAT exams for students, the Florida International University’s dual enrollment program with community colleges (described on pp. 12-13). The poor are less willing to take on debt than middle and upper income families. The subprime mortgage crisis and economic downturn is likely to exacerbate this problem.
4. **Engage school administrators, school board members and business/industry in outreach.** Prepare a kit with data and materials that will equip them to tell the story. Develop relationships with organizations such as Disney, Scripps, NASA, and the National High Magnetic Field Laboratory.

5. **Find out what businesses are doing to attract females and minorities into STEM education and STEM fields.** The group discussed two related activities: (1) setting up a database for matching students with business internships, and (2) starting a state recognition program for business initiatives. It also was suggested that Workforce Florida target STEM Education as one of its target industries and partner with K-12 and postsecondary institutions to align STEM education with industry needs.

**Recommendation 19: Develop more partnerships to strengthen K-12 instruction.** Involve business and industry in providing professional development for K-12 teachers for example, by sponsoring a teacher or engaging teachers in R&D activities. Some corporations in Florida, such as Lockheed-Martin, have been involved in these efforts. Florida PROMiSE is an example of a statewide professional development partnership of universities and school districts recently funded by the Florida Department of Education with federal monies. Partnerships in other states, regions or districts might inform how partnerships can accomplish different purposes and meet local or regional needs. The state should consider (1) competitive funding of partnerships among one of more districts and a university, and (2) tax and other incentives for STEM-related industries in Florida to recruit and mentor female and minority students.

**Goal 5: Make Informed Policy Decisions**

The Work Group believed that increasing and sustaining policymakers’ support for STEM education is critical to any plan to increase the participation and success of females and minorities. They suggested enlisting the support of female and minority legislators and involving STEM-related businesses and industry in lobbying for improving student financial aid, programs, and initiatives.

**Objective 20: Require “diversity impact studies” to guide budget reductions by school districts, community colleges and state universities.** The purpose of these studies would be to assess the expected impact of budget cuts under consideration on females and minorities before the decision is made. The Work Group’s concern was that administrators or decision-makers, in response to state budget cuts, are eliminating or reducing funding for specific programs or services without awareness of the differential impact these actions will have on female and minority students. For example, decreasing the number of community college transfers to a university could have a disproportionate impact on the admissions of females, Blacks and Hispanics.
Objective 21: Create a board of industry representatives for lawmakers to consult when making decisions that will affect workforce education and preparation, specifically in STEM fields.
FCR-STEM
Female-Minority Initiative

ACTIONS SUPPORTED BY RESEARCH

It is imperative that policymakers and educators at the state and local level are aware of evidence-based solutions to improve the educational outcomes of female and minority students. These outcomes include participation, achievement, choice, and persistence in STEM courses, majors, and careers -- including narrowing of the gender and racial gaps in these areas. The purpose of this section is to outline interventions (i.e., programs, policies and other strategies) that target these outcomes and are supported by research in mathematics and science education, sociology, economics, and psychology.

The interventions fall into two categories: (1) universal interventions intended for all students, and (2) targeted interventions focused on specific student populations. According to Willms (2006), universal and targeted interventions are critical to improve the educational outcomes of all students while narrowing the inequalities between female and male students, minority and white students, and students from low and high socioeconomic status (SES) households.

Levels of evidence

 Educators are faced with a wide variety of options when choosing interventions to implement in their schools and classrooms. Before investing time and resources in a course of action, however, it is important to consider the weight of the evidence supporting an intervention’s effectiveness. Some, despite widespread use, have not been tested at all. Others have been evaluated or researched but with varying levels of scientific rigor.

According to the Coalition for Evidence-Based Policy (2003), randomized controlled trials, in which program participants are randomly assigned to treatment (intervention) and control groups, provide the strongest evidence of effectiveness. Random assignment maximizes our ability to eliminate factors other than the intervention as an explanation for a program’s effect. It gives us a high degree of confidence that the groups vary in only one respect -- the intervention -- not in prior levels of achievement, demographics or other characteristics that we are not able to observe or measure. Without random assignment, it would be very difficult to separate the effect of the intervention from the characteristics of the participants.

Studies with well-matched control and comparison groups, although not as conclusive, can provide a moderate level of evidence. For example, students in treatment and control groups might be matched on prior achievement, race, and socioeconomic status. Matching, however, cannot eliminate rival explanations of a program’s effect that might be attributable to other factors or individual characteristics, such as personal motivation or family encouragement, that are difficult to measure.
Correlational research describes the direction and strength of a relationship between two variables. For example, the number of advanced mathematics courses taken in high school is positively correlated with postsecondary success. High levels on the first variable are associated with high levels on the second. However, correlation is not causation. Higher student achievement could be due to factors other than course-taking. For example, advanced mathematics courses may tend to be offered in high schools where students’ parents have high incomes and educational levels. Also, students encouraged or motivated to enroll in advanced mathematics courses are likely to be high achievers. Correlational research can help design interventions that can be subsequently tested through causal research, but it cannot be the basis for cause-and-effect conclusions.

When discussing interventions, this report will distinguish between findings that are supported by causal versus correlational research. The latter are abundant in the research literature, and must be interpreted with caution.

*Universal Interventions*

The objective of universal interventions is to improve the educational outcomes (i.e., participation, achievement, choice, and persistence) of all students within the schooling system regardless of race, gender, SES, level of achievement, or other individual characteristics (Willms, 2006). Universal interventions are system-wide reforms applied uniformly and consistently within all school districts and across all schools. Typically, these reforms either modify the curriculum, instructional techniques of teachers, or the structure of the school (Willms, 2006). In the context of the aims of the Female-Minority Initiative, universal interventions represent reforms that specifically occur in the classroom and modify teacher behavior and classroom instructional practices related to STEM. These reforms benefit all students including females and minorities. Below is a list of universal interventions based on causal and correlational research as well as recommendations from the Female-Minority Initiative work group.

**Praise the STEM effort of students.** Causal research indicates that students have positive beliefs about their STEM abilities when teachers praise their efforts instead of praising their abilities, and when teachers help students understand that intelligence is incremental and malleable based on their efforts and learning. Students with these beliefs maintain stronger learning goals, use effort-based strategies to respond to challenges or failure (e.g., persist on challenging tasks), exhibit higher STEM achievement, take more STEM courses, and are more likely to choose STEM majors in college (Mueller & Dweck, 1998; Blackwell et al., 2007).

**Use instructional activities that arouse greater student interest in STEM.** Causal research indicates that students have greater interest and achievement in STEM when teachers contextualize, personalize, and diversify instruction with multimedia,
technology-assisted instruction, hands-on inquiry, project-based learning, and small within-classroom student groupings that facilitate learning (Parker & Lepper, 1992; Cordova & Lepper, 1996; Renninger et al., 2002; Schneider et al., 2002; Turner & Lapan, 2005; Bottge et al., 2007; Randler & Hulde, 2007).

Provide motivational support and feedback to students. Correlational findings suggest that motivational support and frequent, elaborative, positive, and helpful feedback from teachers has a strong and positive relationship with increases in student motivation in STEM (Turner et al., 2002; Schweinle, Turner, & Meyer, 2006).

Targeted Interventions
Targeted interventions are policies, programs and other activities designed to improve the educational and non-educational outcomes of specific and selected populations, such as females, minorities, students with disabilities, students with limited English proficiency, and students from low-income families. There are three types of targeted interventions (Willms, 2006). In some circumstances, they overlap in terms of selected population or desired outcomes.

- **SES-targeted interventions** provide specialized instructional resources to improve the educational outcomes of students from selected households (e.g., minority, low-income)
- **Performance-targeted interventions** seek to improve the educational outcomes of students by providing special instruction, curriculum, or resources to targeted students based on their levels of academic achievement.
- **Compensatory interventions** indirectly improve the educational outcomes of students by providing economic resources directly to the household.

Below is a list of targeted interventions that show promise based on correlational research. No causal research evidence on targeted interventions was found.

Create incentives for the hiring and retention of experienced, effective mathematics and science teachers in low-performing schools that often serve a high proportion of minority and low-income students. Correlational findings indicate that minority, low SES, or low achieving students are more likely to have inexperienced and ineffective mathematics and science teachers (Sanders & Horn, 1998; Clotfelter et al., 2005).

Provide more gift aid to minority and low SES students, and better inform these students of available financial aid. Correlational research suggests that student selection, participation, and persistence in STEM courses and majors correlate with the amount of gift aid available at higher education institutions (Bettinger, 2004; Hu, 2008).
Encourage parents of minority students to have greater involvement in the STEM education of their children. Correlational findings suggest that minority students with parental involvement, despite coming from lower income households, have STEM achievement as high as White students with similar levels of parental involvement (Yan, 1999; Jeynes, 2003).
LOGIC MODELS

Logic models identify the contexts, inputs, outputs, and activities and how they are expected to produce desired outcomes:

- Increased STEM learning and achievement
- Increased selection of STEM majors and careers
- Greater persistence in STEM majors and careers
- Narrowed gender and racial/ethnic achievement gaps

For this project, two logic models were prepared. The practitioner model thinks theoretical elements supported by the Female-Minority Initiative Work Group. The research-based logic model shows linkages between elements that are supported by causal research.

The Practitioner-Based Logic Model presents the perspective of practicing teachers, administrators, university faculty and other Work Group members on inputs, activities and outputs that will lead to desired outcomes. The inputs (i.e., stakeholders, major players, or guidelines) that affect the overarching goal to improve outcomes for females and students of color in STEM or STEM-Support (e.g., health) courses and careers include:

- **Student.** Refers to females and under-represented minorities with an interest and aptitude for STEM or STEM support fields. At the postsecondary level, both traditional (full-time) and non-traditional (part-time, older) students are included.
- **Policies and Guidelines.** Includes laws, policies, procedures, and processes that affect the creation, resources, monitoring, assessment, and evaluation of STEM activities.
- **Resources.** Includes federal, state, local and private monies for funding activities in the systems logic model.
- **Programmatic Infrastructure.** Includes current STEM programs/providers/and capacity to provide quality services and resources. Also includes schools districts, institutions of higher education and professional organizations.
- **Business/Community.** Includes STEM employers, foundations, and other non-profit or faith-based organizations.
- **Neighborhood/Family Support.** In-home parent assistance, family time and resources, supports provided by parent-teacher organizations, and neighborhood resources supporting high expectations.
- **Educators.** Refers to principals, assistant principals, teachers, guidance counselors, district, state, and local representatives, department chairs, deans and other key position holders that direct or impact schools, colleges, and universities.
- **Support Infrastructure.** Refers to leadership, research, and other resources that can be used to: (1) set policies, goals, and priorities, (2) inform decision-making, and (3) make systemic improvements.
One, several, or all of the inputs can affect the activities (i.e., programs and other efforts) designed to produce desired outputs. Example of these activities include after school, out of school, and outreach programs, professional development for educators in mathematics and science content and cultural competence, preparation of highly skilled guidance counselors and mentors, and initiatives to increase access to student financial aid.

The goal of activities is to produce outputs, individually or in combination which, in turn, would be expected to produce the ultimate impacts or outcomes that the State of Florida is trying to achieve. The model provides STEM-related outputs for (1) students, (2) administrators, faculty, and guidance counselors, as well as (3) an “other” category which includes increased workforce alignment, STEM legislation, strategic planning and management, adult and peer support, and the research base on STEM issues.

Finally, there are three main impacts of this initiative, which refer to the desired results of the program, a combination of programs, or targeted efforts:
1. to increase STEM learning and achievement,
2. increase the number of students who chose STEM majors, and
3. increase the number of students that persist in STEM majors and careers.

If these targeted outcomes are achieved at a high rate for females and underrepresented minorities, the ultimate goal of narrowing and eliminating gender, racial, and ethnic gaps in STEM will be achieved. In order to examine both intended and unintended impacts, the Work Group strongly suggested that all efforts (activities, outputs and impacts) be monitored through a well structured assessment, evaluation, and feedback system. The Work Group brainstormed possible measures that could be used by the state, districts or individual schools for this purpose. A list is provided in Appendix D.

The Logic Model Supported by Rigorous Causal Research reflects the same desired impacts as the practitioner-based model and how they would be achieved. However, this model diagrams only those connections between context, inputs, outputs, and impacts that are supported by causal research. By definition, this model is constrained by the limited amount of research that has been conducted in the field and the fact that most of the available research is correlational rather than causal.

The context refers to the primary stakeholders within the educational system and their roles in addressing the female and minority STEM disparity. The stakeholders include the following: (1) Florida Department of Education, (2) Public and private universities and community colleges, (3) Florida’s school districts, and (4) schools. It is suggested that these entities and their associated personnel provide the policies, rules and regulations, resources, and training (pre-service and in-service) to support STEM teachers as they work to decrease the female and minority STEM
disparity. The research suggests that the interactions between teachers and students, parents and other stakeholders further improve teacher practice and, in turn, educational benefits to students.

Teacher activities refer to the research-based and school-based interventions that have an effect on the female and minority STEM achievement: (1) Teachers praise the STEM efforts of female and minority students; (2) Teachers contextualize instruction by embedding it in interesting and relevant contexts, such as fantasy, sports, real-world problems, etc.; (3) Teachers use technology-assisted instruction, such as web-based, animated, and video-based presentations of STEM content; and (4) Teachers use hands-on inquiry, project-based learning, and small within-classroom student groupings that facilitate learning.

The results of these research-based and school-based interventions by teacher are the following student outputs:

- Female and minority students have a positive self-concept of STEM achievement.
- Female and minority students endorse or establish stronger learning goals or expectations.
- Female and minority students choose effort-based learning strategies when struggling with STEM (e.g., persisting on challenging tasks).
- Female and minority students have greater situational interest and curiosity concerning STEM.
- Female and minority students have greater motivation.
- Female and minority students participate or enroll in more STEM courses.

The ultimate impacts for females and minorities are increased STEM learning and achievement, choice of STEM majors and careers, and persistence in STEM fields. The research indicates that approaches based on this model are likely to narrow gender, racial/ethnic gaps in STEM.
Practitioner-Based Logic Model

Inputs/Stakeholders
- Students
- Policies & Guidelines
- Resources (federal, state, local, & private)
- Programmatic Infrastructure (programs & organizational capacity)
- Business & Industry
- Neighborhood/Family
- Educators (culturally competent)
- Support Infrastructure

Activities
- Student Financial Aid
- Curriculum Development
- Multicultural Media Campaign
- Counseling/Advising
- Afterschool/Out-of-School/Outreach Programs
- Mentors/Role Models
- Remediation
- Public/Private Partnerships
- Technical Innovations
- Research
- Evaluation & Assessment
- Vertical Alignment
- Strategic Management
- Policy Making & Prioritization

STEM Related Outputs
- Students
  - Access/Opportunity
  - Career Awareness
  - Engagement
  - Individual Attributes
- Administrators, Faculty & Guidance
  - Content & Pedagogy
  - Cultural Competence
  - Guidance Career/Advising Skills
- Other
  - Academic & Workforce Alignment
  - Adult & Peer Student Support
  - Research Base
  - K-20 Pipeline
  - STEM Benchmarks
  - STEM Resources
  - STEM Accountability
  - STEM Policies
  - Increase

Student Impacts
- STEM Learning & Assessment
- Selection of STEM Majors & Careers
- Persistence in STEM Majors & Careers
- Eliminate STEM Achievement Gap
- Assessment, Evaluation & Feedback
- Participation in STEM Courses
NEXT STEPS

Currently, the limited amount of research, particularly causal research, constrains the development of a definitive road map for improving the participation and success of females and minorities in STEM fields. More research is needed to provide policymakers and educators with the solutions to improve the STEM educational outcomes of female and minority students.

When feasible, randomized controlled trials should be conducted to determine the effectiveness of interventions; at the very least studies with well-matched treatment and control groups should be conducted. Correlational and qualitative studies could be used to design promising interventions that subsequently can be tested through university research projects or local evaluations.

Researchers should use Florida’s rich education data to increase understanding of STEM-related trends and patterns beyond descriptive reports published by the Florida Department of Education.

School districts, colleges, universities and other organizations in Florida are conducting STEM-related programs, policies and activities within and outside K-20 educational institutions. These interventions need to be evaluated for impact and cost-effectiveness.

Some schools may be effectively addressing the educational outcomes of female and minority students. However, we know very little about these schools, what they are doing, and what Florida can do to duplicate their success in struggling schools. To achieve this end, FCR-STEM suggested, and the Female-Minority Initiative Work Group supports, a “Beat the Odds“ study. This study would address what programs, policies and other interventions differentiate schools where minorities succeed in mathematics and science versus schools where they do not. Findings would inform the design of interventions that could be evaluated by local school districts or rigorously tested through randomized control trials conducted by universities.

Prior to executing any of this report’s recommendations on a large scale, it is necessary to consider existing efforts and their impacts, associated costs, unanticipated consequences, and private and public returns. The current economic recession has increased the urgency to improve STEM educational outcomes of females and underrepresented students of color. Achieving this goal will require long-term investment of public resources in cost-effective and scalable solutions.
REFERENCES


FCR-STEM
Female-Minority Initiative


FCR-STEM
Female-Minority Initiative


APPENDIX A

Summary of Trends in Female and Minority STEM Achievement and Attainment: K-12 through Post-secondary Schooling in Florida

I. Florida STEM Education PK-12

PK-12 Student Demographics

- Over 50% of students in Florida’s public schools are minorities, primarily Hispanics (24%) and Blacks (23%).

K-12 Science Achievement by Race/Ethnicity

- The majority of Florida’s students do not score at or above grade level (Level 3 and above) on FCAT-SSS Science. This finding is consistent for every grade level tested (5, 8 and 11).

- Performance on the FCAT-SSS Science declines across the grade levels (highest in 5th grade and lowest in 11th grade).

- Significant racial/ethnic disparities exist on FCAT-SSS Science and persist across all grade levels tested.
  - In 2007, Blacks (44% to 52%) and Hispanics (32% to 39%) had the highest percentage of students scoring at the lowest level; Whites had the smallest percentage (14% to 18%).
  - Conversely, White students had the highest percentage (49% to 56%) scoring at or above grade level (level 3 and above). Hispanics (27 to 32%) and Blacks (15% to 19%) had the lowest percentages.
  - The percentage of White students at or above grade level is almost twice as high as the percentage for Hispanic students and about triple the percentage for Black students in the same grades.

- Students of all races/ethnicities are showing progress in FCAT-SSS Science. However, the rate of progress varies in the lower grades (5 and 8). From 2005 to 2007, Black students had the greatest decrease in the percentage of students scoring at the lowest level (level 1), while White students had the greatest increase in the percentage of students scoring at higher levels (3 and above).

K-12 Math Achievement by Race/Ethnicity

- Overall, Florida’s students perform better on FCAT-SSS Mathematics than Science. The relative superiority of math over science performance is substantial, particularly for Hispanics and Blacks.
Despite the favorable comparison to Science, Mathematics performance remains low for many students.

Significant racial/ethnic disparities exist on FCAT-SSS Mathematics in grades 5, 8 and 10.

In 2007, Blacks (23% to 37%) and Hispanics (16% to 26%) had the highest percentage of students scoring at the lowest level; Whites had the smallest percentage (8% to 13%) – about half the percentage for Hispanics and one-third the percentage for Blacks.

Conversely, White students had the highest percentage (69% to 77%) scoring at or above grade level (level 3 and above). Hispanics (51% to 63%) and Blacks (37% to 49%) had the lowest percentages.

The percentage of White students at level 1 is about half the percentage for Hispanic students and about one-third the percentage for Black students in the same grades. Similar gaps between Whites and Blacks/Hispanics also exist in the percentage scoring 3 and above but are smaller in size.

In Florida, students of all races/ethnicities are showing progress in FCAT-SSS Mathematics.

- From 2005 to 2007, Blacks followed by Hispanics showed the greatest decrease in the percentage of students scoring at level 1 in middle and high school. Neither Whites, Blacks nor Hispanics showed much decline in the percentage of level 1 students in the upper elementary grades (grades 3-5).
- Blacks followed by Hispanics also had the greatest increase in the percentage of students scoring at or above grade level (3 and above) – unlike science where Whites showed the greatest gain.

**K-12 Math Achievement by Gender**

- Male and female students in Florida show disparities in performance on the FCAT-SSS Mathematics, but the differences tend to be small in magnitude.

- Slightly more males than females score at level three and above; females have a slightly lower percentage of students scoring at the lowest level (Level 1).

- At the upper elementary and middle grades, females and males in Florida show similar gains in the percentage of students scoring at level 1 and at levels 3 and above. In high school, females continue to show progress, while males do not.

**Advanced Placement Examination by Gender**

- In 2006, Females accounted for the majority (59%) of Florida’s 11th and 12th graders taking AP examinations.
However, males took more exams per student and obtained higher scores on average than females.

*Advanced Placement Examination by Race/Ethnicity*

In 2006, White, Hispanic and especially Asian students were overrepresented among Florida’s 11th and 12th graders sitting for AP examinations, while Blacks were underrepresented.

Whites, Hispanics and especially Asians took more examinations per student than Blacks. They also obtained higher scores (45 to 50% of examinations were scored 3 or higher – about twice the percentage as Black students (24%)).

**II. Florida STEM Education Post-Secondary**

*SAT and ACT Scores by Race/Ethnicity*

Minorities comprise an increasing percentage of SAT and ACT test takers in Florida.

A substantially higher percentage of minorities take the SAT and ACT in Florida, compared to the nation. In 2006, Blacks represented 21.4% of ACT test takers in Florida, compared to 12.9% in the nation. Hispanics comprised 17.3% of ACT test takers in Florida, compared to 8.0% in the nation.

Florida Hispanics score above their national peers; Whites, Blacks and students of other races/ethnicities (i.e., Asians) score below their national peers.

*SAT and ACT Scores and Course-taking*

Taking higher level courses in mathematics (e.g., calculus) and science (e.g., physics) is correlated with higher SAT and ACT scores.

Course-taking is similar among males and females for lower level math courses, but a larger percentage of males take higher level math courses, such as calculus.

Black test takers are less likely to take higher level math and science courses than Asians, Whites and Hispanics.

*SAT and ACT Score Trends by Gender*

As in Florida’s AP examinations, females comprise the majority (55%) of students taking the SAT. However, males consistently outscore females by 30 to 39 points in mathematics. A similar gender difference – smaller in size – exists on the ACT.
The gender gap is evident for students of all races and ethnicities.

*Florida’s Community Colleges*

- Two-thirds of Florida’s community college students are enrolled in AA degree programs. 35% of AA degree enrollees are minorities. Of these, Hispanics are the largest minority (53%) followed by African Americans (37%), Asians (9%), and American Indians (1%).

- 36% of Florida’s AS degree enrollees are minorities. Among AS enrollees and completers, African Americans are the largest minority.

- Females comprise a greater percentage of Florida’s community college enrollees and completers than males in all racial/ethnic groups.

*Under-represented Racial/Ethnic Groups in STEM Degree Attainment*

- In Florida, White and Asian groups are overrepresented in state university degree attainment across all STEM fields, while Blacks and Hispanics are underrepresented (relative to their representation in the K-12 student population).

- Blacks are most underrepresented in mathematics, engineering, and engineering technology. Hispanics are most underrepresented in mathematics, physical sciences, and information technology.

*Under-represented Gender Groups in STEM Degree Attainment*

- In terms of STEM degree attainment at state universities in Florida, there has been a continual decline since 2000 in the number of both males and females completing degrees in information technology.

- Females are under-represented in the physical sciences, information technology, engineering, engineering technology, and mathematics, but are overrepresented in the life sciences.

- Females are making gains in the attainment of STEM degrees in engineering, engineering technology, and most notably, the physical sciences. However, a substantial gap still exists because males already overrepresented are also increasing their attainment of STEM degrees, although at a slower rate.

- Physical sciences is the STEM field in which females are making the greatest progress toward closing the gender gap. Although females are still underrepresented, degree attainment in the physical sciences is accelerating at a faster rate for females than males.
APPENDIX B
LITERATURE REVIEW

GENDER AND RACIAL ATTAINMENT DISPARITIES IN SCIENCE AND MATHEMATICS: A REVIEW OF THE LITERATURE

February 15, 2009

Faye R. Jones
W. Joshua Rew
Laura Hassler Lang

Female and Minority Initiative
Florida Center for Research in Science, Technology, Engineering, and Mathematics (FCR-STEM)
Florida State University

Acknowledgements:
The authors wish to thank Christine Johnson, Hong Gao, Jian Gao, Danielle Sherdan, and the members of the Female and Minority Initiative Advisory Panel and Work Group for their helpful suggestions and insightful comments on previous drafts.

Corresponding Author:
Faye R. Jones
Female and Minority Initiative
FCR-STEM
Florida State University
C4600 University Center
Tallahassee, FL 32306
Email: fjones@admin.fsu.edu
GENDER AND RACIAL ATTAINMENT DISPARITIES IN SCIENCE AND MATHEMATICS: A REVIEW OF THE LITERATURE

Abstract

The authors review the literature with respect to the gender and racial attainment disparities in the fields of science and mathematics. Substantial disparities are evident in the science and mathematics attainment (opportunities, achievement, choices, and persistence) of female and minority students at the elementary, secondary, and post-secondary education levels. The authors identify the behavioral and social variables that explain the gender and racial attainment disparities. These variables include individual attributes (attitude, commitment, interest, self-concept, and self-efficacy), school features (school resources; teacher quality, distribution, and socialization practices; course-taking; instructional practices; and financial aid), and societal forces (socio-economic status, discrimination, and parental involvement and expectations). Their synthesis of the literature indicates that the evidence supporting the effectiveness of the majority of the variables is mixed and inconsistent, and only a few variables receive support from rigorous causal research. They conclude by identifying limitations in the literature and offering recommendations for future research.

Key Words: Females, minorities, science, mathematics, achievement, participation, persistence.
Introduction

Disparities in female and minority attainment in the fields of science and mathematics have profound economic and social implications. The disparities affect global economic competitiveness by weakening our nation’s ability to meet the increasing demands for a labor force with skills, expertise, and literacy in science and mathematics. With females and minorities being underrepresented among those entering and remaining in science and mathematics fields (National Science Foundation, 2007), meeting the nation’s workforce demands and, in turn, maintaining the global competitiveness of the U. S. economy will depend on solutions that reverse this trend (Gordon, 2007). An increasing demand for proficiency in science and mathematics, paired with a decreasing supply of females and minorities in those fields, suggests that females and minorities will have difficulty contending for employment and competitive wages in these fields (Neal & Johnson, 1996; Antecol & Bedard, 2004; Graham & Smith, 2005; Holzer, Offner, & Sorensen, 2005). Furthermore, attainment disparities exacerbate gender and racial income inequalities (Raudenbush & Kasim, 1998; Kerckhoff, Raudenbush, & Glennie, 2001; Finnie & Meng, 2002; De Anda & Hernandez, 2007) and, in turn, may even compromise individual psychological and physical health (Reynolds & Ross, 1998). Increasing the attainment of females and minorities in science and mathematics addresses national concerns related to the competitiveness of our labor force and economy, and the elimination of economic and social inequalities. Accordingly, it is imperative that policymakers, at the national, state, and local levels, fully comprehend the conditions that impact the plight of females and minorities in order to effectively address and ameliorate the disparities in science and mathematics.

The objective of our review is to summarize the findings from current literature that pertain to female and minority attainment disparities in the fields of science and mathematics.
We elect to pattern our review after the review by Oakes (1990) titled, “Opportunities, Achievement, and Choice: Women and Minority Students in Science and Mathematics.” Despite its year of publication, the review by Oakes continues to be one of the most cited reviews of gender and minority attainment in the fields of science and mathematics. Additional narrative and meta-analytic reviews, such as those by Frost, Hyde, and Fennema (1994), Li (1999), Clewell and Campbell (2002), Ferguson (2003), Herzig (2004), Lee (2005), Jacobs (2005), Stinson (2006), and Wiggan (2007), also represent important works that contribute substantially to the literature. Rather than extensively covering the field, each of these reviews examined a specific phenomenon within the literature. However, we view Oakes’ review as the appropriate model given its coverage and comprehensiveness.

We acknowledge that Oakes’ review summarizes the literature conducted prior to 1990 on the attainment disparity by gender and race. Our review extends and builds upon her findings and valuable suggestions. Similar to Oakes’ review, our review will address the following topics: female and minority opportunities, achievement, choice, and persistence in primary, secondary, and post-secondary schooling; the behavioral and social variables that explain the racial and gender disparity in science and mathematics; and suggestions for policy interventions and further research.

**Literature Review Process**

We began the literature review process by searching for existing reviews of literature and empirical studies that specifically discuss females and minorities in science and mathematics during the last 18 years. Our search for literature required the use of multiple search engines and databases, such as *Google Scholar, PsycINFO, ERIC, JSTOR*, and *ISI Web of Science*. We used several descriptors in our database search (female, minority, mathematics, science, achievement,
participation, and persistence). Following the database search, we searched for additional manuscripts in the volumes and issues of major journals, such as the *Review of Educational Research, Journal of Research in Science Teaching, American Educational Research Journal, Journal for Research in Mathematics Education, Science Education, Sociology of Education, Economics of Education Review*, and *International Journal of Science Education* among many others. Furthermore, we searched the reference lists of the manuscripts we found from either the databases or from the journals. Our search produced over 260 related manuscripts and reports from approximately 80 peer-reviewed journals and several research and governmental institutions, such as the National Science Foundation and the Institute of Education Science. The manuscripts used a variety of research methods (qualitative, correlational, quasi-experimental, and experimental) from various disciplinary perspectives (psychology, anthropology, sociology, and economics) to study the female and minority attainment disparity in mathematics and science.

**Background**

Oakes (1990) asserted that “three factors are critical to attainment: (a) opportunities to learn science and mathematics; (b) achievement in those subjects; and (c) the decision to pursue them” (p. 154). We add persistence as the fourth factor because of its salience at post-secondary education and occupational levels for females and minorities (Rayman & Brett, 1995; Fenske, Porter, & DuBrock, 2000). Therefore, we can attribute the female and minority attainment disparities within the fields of science and mathematics to differential opportunities, achievement, choice, and persistence at various levels of schooling including primary, secondary, and post-secondary (Oakes, 1990; Catsambis, 1994; Lee & Luykx, 2007).
Interestingly, Oakes (1990) stated that, coupled with encouragement, females and minorities respond to mathematics and science opportunities with competitive achievement and continued participation in those fields. Their response is equivalent to the response from White male students. The fact that females and minorities have similar responses when supportive conditions (encouragement and opportunity) are equivalent provides hope. It appears that the elimination of the attainment disparity rests upon, at a minimum, ensuring the provision of similar supportive conditions. However, the remedy is not that simple, as the literature suggests that female and minority students generally receive less encouragement (Browne & Rife, 1991; Lareau & Horvat, 1999; Yan & Lin, 2005) and have a smaller number of mathematics and science opportunities. Furthermore, minorities (including female minorities) attend racially segregated (Borman et al., 2004) and poor quality schools (Roscigno, 2000; Ainsworth, 2002), and possess inferior school resources (Duncombe & Yinger, 2005). Goldsmith (2004) added that Black and Hispanic students are more likely to come from low socio-economic and single parent households, and live in high poverty neighborhoods as compared to White students.

Ladson-Billings (1997) and Lee (2000) suggested that gender and racial disparities in mathematics and science are incredibly complex. Spelke (2005) stated that the disparities likely reflect the intersection of multiple and complex social, behavioral, and cultural variables and contexts. Thus, equalizing supportive conditions alone will not be sufficient; interventions will need to take into account the social, behavioral, and cultural contexts of the students, schools, curriculum, classrooms, and teachers (Ladson-Billings, 1995; Loving, 1998; Lee & Fradd, 1998). Oakes acknowledged the complexity, and stated, “our knowledge of the causes of low achievement and participation and our understanding of what policies and programs will improve them remains limited” (1990, p. 154). To resolve the lack of understanding, she suggested that
“we need considerable research to determine what programs will be the most successful” (p. 154).

Opportunities, Achievement, Choice, and Persistence

From the elementary to the post-secondary school level, prior mathematics and science achievement influences the opportunities, choices, and persistence of female and minority students (Oakes, 1990; House, 1993; Tate, 1997; Lucas & Berends, 2002). Particularly, prior achievement impacts the assignment of students to gifted programs in elementary school, pre-high school mathematics courses (i.e., pre-algebra, algebra, and geometry) in middle school, and academic curriculum tracks and college preparation courses in high school (Oakes, 1992). Schools typically assign low achieving students to low-ability and remedial courses, vocational and non-academic tracks (Braddock & Dawkins, 1993; Kao & Thompson, 2003), and to special education programs (Artiles & Trent, 1994; Harry & Anderson, 1994; Oswald, Coutinho, Best, & Singh, 1999; Eitle, 2002; Artiles, Harry, Reschly, & Chinn, 2002; Blanchett, 2006). This is especially the case for minority students; however, as schools do not necessarily assign females over males to specific courses or tracks. In most cases, females choose to enroll in courses or tracks according to their attitude, interest, and self-concept (Eccles, 2005; Jacobs, 2005). Nonetheless, without exposure to an advanced and high quality mathematics and science curriculum either through tracking or self-selection, female and minority students lose interest and participate less in mathematics and science opportunities. This has a negative impact on their opportunities, achievement, choices, and persistence.

Literature also cites specific examples of differential opportunities, choices, and persistence by race and gender. First, Black students participate at disproportionately lower levels in gifted education programs than White students (Ford, 1998), and participate more than
White students in special education programs, such as emotional/behavioral disability programs (Harry & Anderson, 1994; Patton, 1998; Coutinho & Oswald, 2000; Mandell, Davis, Bevans & Guevara, 2008). The greater participation of Black students in special education programs over White students is known as disproportionality, and is due to overidentification (Oswald, Coutinho, Best, & Singh, 1999). Second, Black and female students participate less in mathematics and science advanced placement (AP) programs than White and male students (Benbow, 1992; Stumpf & Stanley, 1998; Klopfenstein, 2004). Third, Black and female students persist less than White males in science and mathematics majors at the post-secondary level, such as chemistry, engineering, mathematics, and physics (Jacobs, 1996; Leslie, McClure, & Oaxaca, 1998; Simpson, 2001; Smyth & McArdle, 2004).

Lower levels of participation in gifted education and AP programs, and disproportionately higher levels of enrollment in emotional/behavioral disability programs can severely limit the opportunities, achievement, and choices of minority students. Less persistence in science and mathematics majors at the post-secondary level reduces the likelihood of occupational and income prestige (Simpson, 2001). It is important to note that disproportionality by gender does exist in terms of the placement of students in special education programs, such as emotional/behavioral and learning disability programs (Coutinho & Oswald, 2005). However, unlike minority students, male students represent a disproportionately greater number of students placed in special education programs than female students (Oswald, Best, Coutinho, & Nagle, 2003; Coutinho & Oswald, 2005; Oswald, Best, & Coutinho, 2006).

A substantial body of literature discusses the achievement gaps by race (Hanushek, 2001; Lubienski, 2002; Lee, 2002; Fryer & Levitt, 2006) and gender (Nowell & Hedges, 1998; Schreiber, 2002; Gonzales et al., 2004; Hyde & Linn, 2006). The large number of studies that
address gaps specifically in mathematics and science achievement examine nationally representative datasets, such as Project Talent, Equality of Educational Opportunity (EEO), the National Longitudinal Study of the High School Class of 1972 (NLS: 1972), the National Longitudinal Study of Youth (NLSY), High School and Beyond (HS&B), the National Educational Longitudinal Study of the Eight Grade Class of 1988 (NELS: 1988), the National Assessment of Educational Progress (NAEP), the Third International Mathematics and Science Study (TIMSS), and the Early Childhood Longitudinal Study Kindergarten Cohort (ECLS-K).

According to these studies, the differences in mathematics and science achievement between White and minority students extend from elementary to high school, and are relatively large. Analyzing the ECLS-K dataset, Fryer and Levitt (2004) discovered, from a sample of over 20,000 children, that Black and White children entering kindergarten have similar achievement according to a subjective teacher assessment of general knowledge and controlling for observable characteristics, such as age, birth weight, and socio-economic status. However, a .20 standard deviation gap in achievement emerged between Black and White children once they progressed to the first grade. They concluded that, if the trend continues, the achievement gap would increase to .50 of a standard deviation by the fifth grade. According to Tate (1997), White students exhibited higher mathematics achievement than Black and Hispanic students in elementary, middle, and high school as measured by the NAEP between 1973 and 1992, NELS: 1988, and the HS&B. However, substantial improvements in mathematics achievement for Black and Hispanic students during the 1980s and 1990s reduced, but did not eliminate, the mathematics achievement gap.

Hedges and Nowell (1999) confirmed Tate’s findings after examining the same and additional datasets. They analyzed mathematics, reading, vocabulary, and science achievement
using the EEO, NLS: 1972, NLSY, HS&B, NELS: 1988, and the NAEP. They found that, for each dataset and at all grade levels, the mean achievement for White students exceeded that for Black students. Furthermore, the effect sizes (standardized mean difference $d$) ranged from medium to large even after an adjustment for socio-economic status, family, and community variables. Like Tate (1997), they observed a narrowing of the Black-White achievement gap in mathematics over time from $d = .75$ in 1960 to $d = .60$ in 1992. However, the science achievement gap increased from $d = .63$ in 1980 to $d = .76$ in 1992. Despite the decline in the mathematics achievement gap, the differences between White and Black students are still relatively large in both mathematics and science achievement. Based on their findings, Hedges and Nowell (1999) predicted that the mathematics and science achievement gaps would require more than 100 years to close according to the trends from the non-NAEP datasets and 75 years to close based on the NAEP dataset.

Mathematics and science achievement differences between male and female students are substantially smaller in magnitude compared to the differences between White and minority students. Hedges and Nowell (1995) and Nowell and Hedges (1998) analyzed the achievement differences by gender for several academic and vocational subjects including reading, vocabulary, mathematics, science, social studies, electronics, and auto and shop. Analyzing several nationally representative datasets, such as Project Talent, EEO, and NLS: 1972, NLSY, HS&B, and NELS: 1988, and the NAEP, they discovered that male students exhibited higher mathematics and science achievement than female students. The effect sizes for mathematics and science from non-NAEP and NAEP datasets are relatively small and appear to narrow over time. Tate’s (1997) results support these findings based on analyses of the NAEP dataset between 1973 and 1992 and the NELS: 1988 dataset. Tate (1997) also found that the mathematics and
science differences between male and female students are very small at each grade level tested but noted that “mathematics achievement differences when they exist between genders emerge in secondary school” (p. 670). Hyde and Linn (2006) confirmed that gender differences do emerge in high school with males outperforming females on mathematics problem-solving ($d = .29$); however, there were no gender differences on mathematical computation and concepts. Recent evidence from state assessment data contradicts earlier research, and indicates that gender differences in mathematics are trivial in high school ($d < .10$) (Hyde et al., 2008). Furthermore, Hyde et al. (2008) suggested that gender differences on difficult mathematics items, such as mathematics problem-solving, are small and practically insignificant (average $d = .07$).

**Behavioral and Social Variables**

Oakes (1990) identified and grouped the most influential behavioral and social variables affecting the mathematics and science outcomes of females and minorities into three categories: individual attributes, schooling features, and societal forces. In most instances, studies find that the opportunities, achievement, choice, and persistence of either females or racial minorities depend on a combination of variables and not exclusively on a single variable (Volet, 1997; Singh, Granville, & Dika, 2002; Moore, 2006; Halpern et al., 2007). For instance, Hebert and Reis (1999) interviewed high-achieving students from diverse cultural backgrounds enrolled in an urban high school. They identified a range of variables that correlate with success, including motivation (individual attributes), challenging courses (schooling features), and parental and adult support (societal forces). The next three sections describe the findings of studies that focus on the influence of individual attributes, schooling features, and societal forces on the opportunities, achievement, choice, and persistence of females and minorities.
Individual Attributes

Individual attributes represent the affective, aptitude, and motivation of the student. They include cognitive and non-cognitive traits, such as ability, attitude, commitment, interest, self-concept of ability, and self-efficacy (Singh, Granville, & Dika, 2002; Alsop & Watts, 2003). Current literature finds that individual attributes influence the schooling outcomes of females and minorities (Andre, Whigham, Hendrickson, & Chambers, 1999; Bleeker & Jacobs, 2004; Bhanot & Jovanovic, 2005; Jacobs, 2005). For instance, Schreiber (2002) examined a sample of U.S. 12th grade students from TIMSS (N = 1,839), and noted that positive attitudes towards mathematics were positively correlated with advanced mathematics achievement. Schreiber’s (2002) findings support evidence from Farenga and Joyce (1998), Utsumi and Mendes (2000), and Hammouri (2004). On the other hand, Ma (1997) suggested that attitude and achievement may have a reciprocal relationship. Furthermore, Ma and Xu (2004) and Georgiou, Stavrinides, and Kalavana (2007) contended that mathematics achievement is a stronger predictor of attitude than attitude is of mathematics achievement. However, in a review of five studies from Japan, Minato and Kamada (1996) discovered that attitude is a stronger predictor of achievement. Although the relationship between attitude and mathematics achievement remains unclear, attitude is an important individual attribute regardless of whether it is a predictor or an outcome of mathematics achievement.

Goal and institutional commitment are salient predictors of post-secondary and career persistence according to Leslie, McClure, and Oaxaca (1998), Leppel (2001), Davis et al. (2003), Mäkinen, Olkinuora, and Lonka (2004), and Strauss and Volkwein (2004). Goal commitment refers to the student’s commitment to educational goals, while institutional commitment is the
student’s commitment to her or his institution of higher education (Tinto, 1993). Grandy (1998) longitudinally studied the persistence of a sample of minority students in science and engineering careers (N = 2,557) and found that student institutional commitment was the strongest predictor of career persistence, more so than socio-economic status, prior achievement, or other predictors. Sandler (2000) had similar findings and noted that institutional commitment is a significant predictor of the persistence of a sample of adult and nontraditional undergraduate students (N = 469). However, Nora and Cabrera (1996) studied the persistence of a sample of college freshmen (N = 831) and found that goal and institutional commitment did not have a significant direct or indirect relationship with the persistence of minority students, while goal and institutional commitment had both a significant direct and indirect relationship with the persistence of non-minority students. Social integration, perceptions of prejudice, parental encouragement, and prior achievement were also found to be significant predictors of minority student persistence (Nora & Cabrera, 1996).

Interest and self-concept of ability, and their relationship with schooling outcomes, have received ample attention in the literature (Schiefele & Csikszentmihalyi, 1995; Greenfield, 1997; Marsh & Yeung, 1998; Jones, Howe, & Rua, 2000; Haussler & Hoffmann, 2002; Caleon & Subramaniam, 2007). For example, Jayaratne, Thomas, and Trautmann (2003) evaluated an intervention designed to improve the science persistence of a sample of eighth grade minority and non-minority females (N = 211). They found that non-minority females had greater interest in science and a greater self-concept of science ability than minority females. Linver and Davis-Kean (2005) studied a longitudinal sample of students (N = 1,651) from the Michigan Study of Adolescent Life Transitions (MSALT). They reported that higher interest and self-concept of math ability for honors female students correlated with a slower decline of math grades from the
seventh to the 12th grade, and had a greater influence for female students than male students. Awad (2007) examined the relationship between racial identity, self-concept of ability, self-esteem, and grade point average (GPA) and test scores for a sample of Black students (N = 313). Those findings indicated that self-concept of ability is a significant predictor of GPA but not of test scores. Thus, despite differences between minority and non-minority students, and low and high achieving students, it is apparent that interest and self-concept of ability have an important relationship with mathematics and science achievement (Ma & Kishor, 1997; Haussler & Hoffmann, 2002; Matson, DeLoach, & Pauly, 2004; Linver & Davis-Kean, 2005). Differences in the self-concept of ability and interest by race also predict differences in educational outcomes, such as participation and persistence (Jayaratne, Thomas, & Trautmann, 2003). However, similar to findings concerning attitude, the relationships between self-concept of ability and educational outcomes are reciprocal (Wang, Oliver, & Staver, 2008) with achievement (or other educational outcomes) as the stronger predictor (Hoge, Smit, & Crist, 1995).

Several studies examined the relationship between self-efficacy and mathematics and science outcomes (Pajares, 1996; Pajares & Graham, 1999; Bong, 2001; Nasser & Birenbaum, 2005; Stevens, Olivarez, & Hamman, 2006). Pajares and Miller (1994) compared the influence of self-efficacy and self-concept of ability on the mathematical problem solving of a sample of undergraduate students (N = 350). They noted that self-efficacy was a stronger predictor of problem-solving when compared to self-concept, and self-efficacy mediated the relationships of gender and prior experience with self-concept and mathematical problem-solving. Stevens et al. (2004) studied the relationship of self-efficacy and motivational orientation with the mathematics achievement and further participation in mathematics courses of a sample of ninth and 10th grade students (N = 358). They observed that self-efficacy is a significant predictor of mathematics
achievement as well as motivational orientation. Furthermore, they discovered a significant difference between Hispanic and White students in terms of the relationship between prior mathematics learning and self-efficacy. O'Brien, Martinez-Pons, and Kopala (1999) examined the relationships of gender, ethnicity, and mathematics self-efficacy with the career interests in mathematics and science of a sample of 11th grade students (N = 415). They indicated that gender and self-efficacy have a direct relationship with mathematics and science career interests. Interestingly, achievement, ethnicity, and socio-economic status are predictors of self-efficacy. Therefore, self-efficacy mediates the relationships of achievement, ethnicity, and socio-economic status with career interests in mathematics and science. Although the relationship between self-efficacy and achievement is not completely clear, the importance of self-efficacy as an individual attribute remains. In light of the vague relationship between individual attributes and educational outcomes (see Baumeister et al. (2003) concerning self-esteem), we put forward the possibility that attitude, self-concept of ability, and self-efficacy may act as mediators between prior and future educational outcomes. If these assertions were substantiated, they would not only clarify the promising role of individual attributes, but also provide an explanation of the importance of prior mathematics or science achievement as an antecedent predictor of future achievement.

School Features

School features have an intuitive relationship with mathematics and science opportunities, achievement, choice, and persistence. It is evident that certain school features, such as school resources and teacher quality, represent the foundation upon which all other school features rest. Female and minority students, and all students for that matter, would not have access to the spectrum of schooling opportunities without the foundational school features. Although the effectiveness of school resources is debatable (Greenwald, Hedges, & Laine, 1996;
Hanushek, 1997; Figlio, 1999), literature overwhelmingly acknowledges the critical importance of teacher quality (Goldhaber & Brewer, 2000; Rowan, Correnti, & Miller, 2002; Wayne & Youngs, 2003; Hill, Rowan, & Ball, 2005). We elect not to dedicate a discussion to school resources or teacher quality beyond the citations above due to the enormity of the literature, the ambiguous influence of school resources, and the relatively clear relationship between teacher quality and student educational outcomes. However, with respect to teacher quality, we will briefly discuss the distribution of effective teachers and teacher socialization practices with students, as well as course-taking, instructional practices, and financial aid.

While recent research points to the strong relationship between teacher quality and student outcomes (Rockoff, 2004; Rivkin, Hanushek, & Kain, 2005; Aaronson, Barrow, & Sander, 2007), the distribution of quality teachers is also of critical importance with respect to the racial science and mathematics attainment disparity. Recent findings from Clotfelter, Ladd, and Vigdor (2005) indicated that Black seventh grade students in North Carolina were more likely to have a novice mathematics teacher when compared to White students. They argued that the disproportionate assignment of Black students to novice teachers might not completely explain the Black-White achievement gap, but certainly had the potential to perpetuate it. Sanders and Horn (1998) noted in Tennessee that “black students were disproportionately assigned to the least effective teachers. Regardless of race, students who are assigned disproportionately to ineffective teachers will be severely academically handicapped relative to students with other teacher assignment patterns” (p. 254). However, Sanders and Horn (1998) indicated that Black students and White students had comparable levels of achievement when they had similar levels of prior achievement and quality teachers.
Teachers, as socializing agents, also have a strong relationship with the formation of science and mathematics interests and beliefs (Linver & Davis-Kean, 2005), achievement (Li, 1999), and the choices (Dick & Rallis, 1991) of females and minorities. Teachers socialize their students via expectations and beliefs, gender-stereotyping, and communication and feedback. According to Ferguson (2003), “racial biases can exist in teachers’ perceptions, expectations, and behaviors, or in any combination of the three” (p. 493). Additionally, Tinto (1993) suggested that institutional and departmental cultures, an aggregated form of socialization, can work in favor or against student integration and involvement in post-secondary institutions. Many other studies have addressed expectations and beliefs (Jussim & Eccles, 1992; Eccles et al., 1993; She, 2000; Garrahy, 2001; Garrahy, 2003), gender-stereotyping (Tiedemann, 2000, Ferguson, 2003; Diamond, Randolph, & Spillane, 2004; Gray & Leith, 2004), and communication and feedback (She, 2000; Patrick et al., 2001). For instance, Linver and Davis-Kean (2005) examined several predictors of mathematics grades for a sample of male and female students (N = 1,651) using data from the MSALT. They noted that teacher expectations of students’ abilities in seventh grade mathematics, along with prior achievement and parental expectations, are important predictors of the performance of high-ability seventh grade females. However, they also found that “males’ grades did not depend on the expectations of their teachers, unlike for girls in the high-ability tracking group” (p. 59). Tiedemann (2000) reiterated these results, and also stated that teacher beliefs and expectations “for future achievement show a clear gender-stereotyped perceptual bias that could be more detrimental to girls' achievement than to boys” (p. 204). Furthermore, Tiedemann (2002) studied teacher gender-stereotyping and student mathematics achievement with a sample of elementary school students (N = 288), and reported that gender-
stereotyping by teachers distorts their impression of the mathematics achievement of students with prior low and average mathematics achievement.

The Institute of Education Science (2007) reviewed evidence from several studies concerning the teacher’s role in modifying the self-concept of mathematics ability of female as well as minority students. Two experimental studies cited in the review found that communication in the form of praise from teachers to students (especially females and minorities), indicating that mathematics abilities can improve through effort and learning, assists students to gain confidence in their abilities (Mueller & Dweck, 1998; Blackwell, Trzesniewski, & Dweck, 2007). Moreover, Blackwell, Trzesniewski, and Dweck (2007) discovered that students in junior high school, including females and minorities, who indicate that they believe intelligence is incremental and malleable through effort and learning are more likely to “endorse stronger learning goals, hold more positive beliefs about effort, and make fewer ability-based, ‘helpless’ attributions” (p. 258). Consequently, students with these beliefs “choose more positive, effort-based strategies in response to failure, boosting mathematics achievement over the junior high school transition” (p. 258). Both Mueller and Dweck (1998) and Blackwell, Trzesniewski, and Dweck (2007) affirmed that the key to mathematics achievement for both female and minority students is the communication from teachers that praise their efforts. However, Mueller and Dweck (1998) noted that praising the abilities of students instead of their efforts “could lead to even more detrimental achievement beliefs and behaviors” (p. 50) among female and minority students.

The Institute of Education Science (2007) also suggested that teachers should provide motivational support and feedback to students. The primary aim of motivational support and feedback is to enhance the beliefs of students concerning the reasons why they did or did not
exhibit high mathematics performance, and how to correct it (Turner et al., 2002; Schweinle, Turner, & Meyer, 2006). Turner et al. (2002) examined a sample of sixth grade elementary school students (N = 1,197), and noted that students “reported lower incidences of avoidance strategies in classrooms in which teachers provided instructional and motivational support for learning. In those classrooms, teachers helped students build understanding, gave them opportunities to demonstrate new competencies, and provided substantial motivational support for learning” (p. 102). Furthermore, these teachers “demonstrated that being unsure, learning from mistakes, and asking questions were natural and necessary parts of learning” (p. 102-103).

Schweinle, Turner, and Meyer (2006) studied the motivation and affect of a sample of students in upper elementary mathematics classes (N = 6). While the sample size was small, the findings suggested that additional study was warranted regarding the provision of frequent, elaborative, positive, and helpful feedback related to the motivation and affect of male and female students in mathematics. Although the studies by Turner et al. (2002) and Schweinle, Turner, and Meyer (2006) used correlational and qualitative methods, their findings indicate that motivational support and feedback from teachers may enhance the motivation and affect of students with respect to mathematics achievement and persistence.

Substantial literature also examines the number and type of courses taken and their respective relationship with mathematics and science achievement (Farmer et al., 1995; Spade, Columba, & Vanfossen, 1997; Gutierrez, 2000; Ma and Wilkins, 2002). For instance, Lee, Croninger, and Smith (1997) studied a sample of high school students (N = 3,056) from the 1990 High School Transcript Study that is part of NAEP. Their correlational study indicated that students exhibited high math achievement in schools where they take more mathematics courses, where their mathematics courses fall within a college preparatory program, and where the
mathematics curriculum consists of higher proportions of academic courses. Davenport et al. (1998) analyzed the same dataset and compared the Carnegie units between gender and racial groups for a sample of 10,498 students. They noted that females earned less Carnegie units than males; however, the difference was extremely small and not significant. Females, on the other hand, earned more Carnegie units in the standard sequence of mathematics courses than males, but earned less Carnegie units in the advanced sequence of mathematics courses. With respect to racial groups, Asians and Whites significantly earned more Carnegie units than Blacks and Hispanics in the standard and advanced sequences of courses, and Black and Hispanic students earned more Carnegie units in the functional, preformal, and remedial mathematics courses. Finally, Trusty (2002) examined a nationally representative sample of recent college students (N = 2,956 females and 2,747 males) from NELS: 1988, and reported that female students, taking trigonometry, pre-calculus, or calculus in high school, were more likely to choose science and mathematics majors in college. Furthermore, compared to male students, the relationship between courses taken and college major was stronger in mathematics and weaker in science for females.

Several types of instructional practices, such as cooperative learning (Chang & Mao, 1999; Vaughan, 2002), small group instruction (Yackel, Cobb, & Wood, 1991), inquiry-based instruction (Kahle, & Damnjanovic, 1994), hands-on and laboratory inquiry (Lee & Burkham, 1996; Greenfield & Feldman, 1997), and project-based instruction (Barron et al., 1998), appear to have a relationship with the mathematics and science participation and achievement of females and minorities (Clewell & Campbell, 2002). However, the evidence is not entirely clear. For instance, Von Secker and Lissitz (1999) studied the relationship of instructional strategies emphasizing laboratory inquiry, critical thinking, and teacher-centered instruction with science
achievement using a sample of 10th grade students (N = 7,642) from the High School Effectiveness Study (HSES) of 1990. They noted that all three instructional practices either enlarged science achievement differences by race and gender or had a weak influence on the reduction of the race and gender gaps. Furthermore, Pine et al. (2006) used an experimental design to compare the effects of science hands-on inquiry with textbook curricula on four performance assessments given to a sample of fifth grade students (N = 1000). They indicated that no curricular effects or significant differences in the performance of male and female students due to either the hands-on inquiry or textbook curricula. Randler and Hulde (2007) also used an experimental design to study the effects of hands-on and teacher-centered experiments in soil ecology on a sample of fifth and sixth grade students (N = 123). However, dissimilar to Pine et al. (2006), they found that students participating in the hands-on experiment scored significantly higher than students that participated in the teacher-centered experiment. Also, female students exhibited superior achievement when compared to male students without a treatment by gender interaction. This indicates that both female and male students benefited from the hands-on experiment.

Finally, the Institute of Education Science (2007) also reviewed evidence from several experimental, quasi-experimental, and correlational studies concerning the instructional practices that improve the mathematics and science interest of students as well as improving their science and mathematics achievement and choices. Evidence indicated that teachers can improve the mathematics and science outcomes of male and female students by contextualizing and personalizing activities (Parker & Lepper, 1992; Cordova & Lepper, 1996; Renninger, Ewen & Lasher, 2002), using multimedia and technology-assisted instruction (Turner & Lapan, 2005;
Linn et al., 2006; Bottge et al., 2007), and using project-based learning (Schneider, Krajcik, Marx, & Soloway, 2002) and cooperative learning (Barron, 2000; Turner & Lapan, 2005).

Course-taking and instructional practices are school features that maintain relevance from elementary to post-secondary schooling; however, financial aid typically has direct application at the post-secondary level unless we refer to financial aid in the context of vouchers to attend private elementary and secondary schools or the provision of direct and indirect cash transfers to low SES families. Avery and Huxby (2004) studied the relationship between financial aid and college enrollment with a sample of high achieving high school students (N = 510) from various racial backgrounds. They noted that students choose institutions that offer larger grants, larger loans, and increased opportunities for work study employment. Additionally, Bettinger (2004) examined the relationship of gift aid or Pell Grants with the persistence of students in college and reported that rates of persistence correlated with the size of the Pell Grant. Finally, Hu (2008) discovered that, in one state university system, the decline in student enrollment in science and mathematics majors for five consecutive years correlated with the commencement of merit-aid programs. He also suggested that students may believe that science and mathematics courses are difficult and negatively impact GPA. Thus, they believe that difficult courses reduce their likelihood of competing for future merit aid. The findings by Avery and Huxby (2004), Bettinger (2004), and Hu (2008) demonstrate the important relationship financial aid has with the opportunities and persistence of racial minorities at the post-secondary level and in mathematics and science majors. Moreover, these findings also confirm evidence from Fenske et al. (2000), Kim (2004), St. John, Paulsen, and Carter (2005), Trent, Lee, and Owens-Nicholson (2006), and Chen and DesJardins (2008).

Societal Forces
Societal forces manifest themselves within the school as characteristics and behaviors of the institution, administration, teachers, parents, and students. They represent the social, economic, and political conditions that are typically outside the control and influence of the school, and include the following: the socio-economic status of the student’s family, parental involvement and expectations, and discrimination. We will primarily address parent involvement and expectations in this section; however, we must call attention to the importance of familial socio-economic status and discrimination, and their relationship with the science and mathematics opportunities, achievement, choice, and persistence of female and minority students.

According to Buchmann (2002), socio-economic status consists of parental education, parental occupation, and family income. Yet, socio-economic status may also include additional family background measures, such as family structure (sibship size, birth order, and the number of parents in the home), social and cultural capital (social relationships and socially valued cultural practices, cues, and signals) and home resources (books, computers, and access to the internet) (Buchmann, 2002; Sirin, 2005). Several studies examined the relationship of familial socio-economic status with various cognitive and schooling outcomes including mathematics and science achievement (Secada, 1992; Pong, 1997; Duncan, Yeung, Brooks-Gunn, & Smith, 1998; Cameron & Heckman, 2001; Ermisch & Francesconi, 2001; Yang, 2003; Noble, Norman, & Farah, 2005). These studies, as well as earlier findings (Coleman et al., 1966), suggest that familial socio-economic status explains a disproportionate amount of variation in various schooling outcomes. With respect to discrimination, several studies examined its relationship, in forms including biased teachers and physical and verbal harassment, with participation and achievement among racial minorities (Sanders, 1997; Roscigno, 1999; English, 2002;
It appears that discrimination exists and continues to influence the opportunities, achievement, choice, and persistence of minorities despite substantial efforts during the last 40 years to provide equal access to schooling opportunities for all students.

Parental involvement and expectations refer to the behaviors and practices of parents that may include parental confidence and aspirations, communication to children, participation in school activities, communication with teachers, and their education-related standards, requirements, and demands (Fan & Chen, 2001). A number of articles discussed the relationship of parental involvement and expectations with the educational outcomes of females (Bleeker & Jacobs, 2004; Bhanot & Jovanovic, 2005; Jacobs, 2005) and minorities (Smith & Hausafus, 1998; Jeynes, 2003). Jacobs, Chhin, and Bleeker (2006) analyzed a sample of students from 143 sixth grade classrooms using MSALT. They discovered that the parental gender-stereotyped occupational expectations for their children had a significant relationship with their children’s later occupational expectations. Most notably, both the fathers’ and mothers’ gender-stereotyped occupational expectations for their daughters at age 17 significantly related to their daughters’ actual gender-stereotyped occupations at age 28. Yan (1999) examined a sample of eighth grade students (N = 6,459) from the NELS: 1988 dataset, and reported that families of high achieving Black students had higher levels of parental involvement than families of low achieving Black students. Furthermore, families of high achieving Black students, despite having a comparative disadvantage due to income and family structure, demonstrated equal or higher levels of parental involvement when compared to families of high achieving White students.

Parental involvement and parental expectations, together with socio-economic status, represent parental privilege that passes from parent to child and has a very strong relationship with achievement (Jacobs & Harvey, 2005), choice (Dick & Rallis, 1991; David, Ball, Davies, &
Gender and Racial Attainment Disparities

Reay, 2003), and the acquisition of high status occupations (Andres & Grayson, 2003). However, Jeynes (2003) cautioned that, while parental involvement appears to be beneficial to minority students, the influence of parental involvement does not benefit all groups equally. That is, variables, such as the absence of cultural incentives and differences in family structures, moderate the relationship between parental involvement and educational outcomes for some minority groups more than others. For instance, Jeynes (2003) indicated that parental involvement has a greater influence on Black and Hispanic students over Asian students because “there are enough educational incentives present in other aspects of Asian American culture so that even without a large degree of parental involvement, students still do relatively well” (p. 215). Finally, Fan and Chen (2001) noted in their meta-analytic review of parental involvement and expectations that socio-economic status may act as a confounding variable in the context of the relationship between parental involvement and academic achievement. Therefore, it is necessary, according to Fan and Chen (2001), to partial out the influence of socio-economic status before forming claims concerning the importance of parental involvement and expectations.

Conclusion

The primary objective of our review is to discuss the current state of the gender and racial attainment disparity, and to identify the variables that relate to the opportunities, achievement, choice, and persistence of females and minorities in mathematics and science. From our review, we identified several critical variables and their relationship to females, minorities, and the fields of science and mathematics. There is some evidence to suggest that prior achievement, socio-economic status, and high quality teaching have a relationship with the educational outcomes across both gender and minority groups in science and mathematics at various levels of
schooling. Furthermore, we found evidence that the individual attributes of female and minority students (attitude, commitment, self-efficacy, interest, and self-concept), school features (teacher distribution and socialization, course-taking, instructional practices, and financial aid), and societal forces (parental involvement and expectations) have direct and indirect relationships with the attainment disparity.

Despite the relatively large number of variables listed above and the attractiveness of their implications as potential policy interventions, only a few represent policy interventions based on evidence from rigorous causal research. These policy interventions are school-based and relate to the instructional interaction between teachers and students. According to the literature, teachers should praise student effort, contextualize instruction, and use of technology-assisted instruction, hands-on inquiry, project-based learning, and cooperative learning as part of classroom mathematics and science instruction. The literature also indicates that these interventions have a positive effect on a student’s beliefs, learning goals, learning strategies, interest and motivation, achievement, and participation in mathematics and science courses. The remainder of the variables received mixed and insufficient support from the literature. For instance, we found a lack of clear evidence concerning the relationships of attitude, self-concept of ability, and self-efficacy with student educational outcomes. Additionally, we noted several inconsistencies across the literature with respect to the influence of some instructional practices and parental involvement and expectations on the opportunities, achievement, choice, and persistence of females and minorities in mathematics and science. It is apparent, not only from the review by Oakes (1990), but also from our review 18 years later, that significant gaps continue to exist in the literature. We recommend that policymakers, district leaders, and school leaders act cautiously when interpreting the potential impact of the variables.
Considering the strengths and weaknesses of the literature, we list several suggestions for further research.

First, the literature consists of a rich variety of research methodologies ranging from qualitative, correlational, and quasi-experimental and experimental designs. Unfortunately, the majority of the studies use qualitative and correlational designs. There is a paucity of causal studies that use experimental or quasi-experimental designs with well-matched, equivalent control and treatment groups. While other types of research designs may be helpful in developing promising interventions or providing preliminary findings, they have difficulty separating the effect of the treatment from the characteristics of the participants or rival explanations (National Research Council, 2002). Qualitative and correlational studies are subject to selection bias due to the failure to randomly assign participants to treatment and control groups (Schneider, Carnoy, Kilpatrick, Schmidt, & Shavelson, 2007). The Institute of Education Science (2003) noted that “this leads to erroneous conclusions about the effectiveness of the intervention” (p. 2). Acknowledging this limitation, we strongly encourage the use of more rigorous causal research in the form of randomized controlled experiments to inform policymakers and practitioners about the effectiveness of these interventions in districts, schools, and classrooms.

Second, there is also a paucity of studies that examine racial differences in terms of opportunities, achievement, choice, and persistence in science and mathematics. While small differences do exist between male and female students, the differences between Whites, Blacks, Hispanics, Asians, and other racial and ethnic groups are substantially larger and warrant an augmented share of the research. Therefore, we suggest that research place an increased emphasis on racial minorities. We support this assertion with recent evidence from Levin,
Belfield, Muennig, and Roouse (2007) that suggests that investing in the schooling of minorities, especially Black students, is an economic priority considering the high public returns.

Third, it is difficult to fully understand the influence of individual attributes, school features, and societal forces on the educational outcomes of minorities due to group aggregation. Group aggregation is particularly relevant for studies using large-scale, nationally representative datasets; however, it is applicable to any study. It is important to disaggregate or unpack racial and ethnic groups, such as Asians and Hispanics, in order to identify and understand the social, cultural, and behavioral phenomena that influence their educational outcomes. The aggregation of Asians and Hispanics is misleading when considering the variability within each racial and ethnic group (Gutierrez & Rogoff, 2003). For instance, group aggregation assumes that Hispanic and Asian students are homogeneous or that no dissimilarities exist between Cuban and Mexican American students, and between Japanese and Laotian American students. This represents a grave misconception that may lead to erroneous generalizations regarding each racial and ethnic group (see Ngo & Lee, 2007, concerning Southeast Asian American students as model minorities).

Fourth, our literature review is neither exhaustive nor comprehensive because the research concerning the improvement of opportunities, achievement, choices, and persistence of females and minorities in science and mathematics is multi-disciplinary, multi-level, and multi-methodological. Unfortunately, due to the extensive number of studies and reports from different disciplines, levels of schooling, and methodological backgrounds, we could not include all relevant and important topics, and many fell outside the scope of our literature review. For example, we encourage an evaluation of the quantity and effectiveness of interventions used in after-school programs for increasing female and minority achievement in mathematics and
science. We also encourage an examination of the role of formative assessment in schools for identifying the performance of underrepresented students in science and mathematics and improving instructional strategies simultaneously. Fifth and finally, we acknowledge that the relationships among females, minorities, and the fields of science and mathematics are extremely complex due to the intersection of social, behavioral, and cultural contexts. We believe that the elimination of gender and racial disparities in science and mathematics will require a multifaceted and multi-level approach that includes interventions at the individual, school, and societal levels, as well as the recognition and application of the complexity of the social, behavioral, and cultural contexts of females and minorities.

Considering the complexity of addressing female and minority attainment disparity, it is apparent that a single context cannot adequately address the disparities nor serve as the single antidote (Ladson-Billings, 1997). However, the emphasis on a single context is evident in the comparative overabundance of literature and theoretical models that lack the simultaneous inclusion of social, behavioral, and cultural contexts. For instance, Kahle, Parker, Rennie, and Riley (1993) and Eccles (2005) presented exceptional behavioral models of the relationship between gender, race, and educational outcomes in the fields of science and mathematics. Both studies, and their corresponding models, represent important contributions. Yet, each model lacks the social and cultural predictors of opportunities, achievement, choices, and persistence. Many studies favor the social and behavioral context while the cultural context of the student, teacher, and classroom are absent or ignored (Fuller & Clarke, 1994).

We do not view the omission of the cultural context as a conspiracy or hidden agenda. In all likelihood, it is a product of the dominance of disciplines, such as psychology, sociology, and economics over anthropology (Ladson-Billings, 2006). Nonetheless, we strongly encourage the
inclusion of the cultural context for several reasons beyond the apparent omission. This suggestion, however, may seem at odds with our previous call for an increase in research using randomized controlled experiments. The study of the cultural context requires a qualitative approach due to the nature of culture. Culture refers to the interpretation and application of meaning from artifacts or symbols. Levinson (2000) asserted that culture is the “use of symbols to understand and act upon the world” (p. 2). Levinson (2000) further stated that culture represents “the symbolic meanings expressed through language, dress, and other means, by which people in a society attempt to communicate with and understand themselves, each other, and the world around them” (p. 4). Ladson-Billings (1997) added that culture is “the deep structures of knowing, understanding, acting, and being in the world” (p. 700). Therefore, culture is merely the way an individual learns and applies knowledge.

The addition of the cultural context to rigorous causal research must involve the use of qualitative (and even correlational) research to conceptualize the phenomenon and make available the provisional results to design and implement randomized controlled experiments (Schneider, Carnoy, Kilpatrick, Schmidt, & Shavelson, 2007). The use of qualitative approaches, such as ethnographic and design studies, to studying the cultural context is also applicable when examining the processes and mechanisms of causality after determining the causal agent within a randomized controlled experiment (National Research Council, 2002). Therefore, qualitative approaches to studying the cultural context are critical as \textit{a priori} and \textit{post hoc} analyses. We view them as complimentary to randomized controlled experiments, and as significant components to the entire field that cannot be excluded or omitted.

Recent literature emphasizes the value of the cultural context and its importance to the science and mathematics instruction for students from bilingual and non-English language
households (Ballenger, 1997; Lee & Fradd, 1998; Lee, 2002; Lee, 2005), teacher preparation (Haberman, 1991; Ladson-Billings, 1995; Cochran-Smith, 1995), and teacher professional development (Lee, Hart, Cuevas, & Enders, 2004; Lee, Deaktor, Enders, & Lambert, 2008). These studies present examples of culture as an additional lens to view students and teachers. We need to apply this lens for an alternative view of other facets of schooling, including school counselors and administrators, and their relationships with the opportunities, achievement, choices, and persistence of females and minorities. Finally, it is imperative that school personnel, especially teachers, become cross-culturally and multiculturally competent either through pre-service or in-service training programs. Competent teachers, whether labeled as cross-cultural or multicultural, have the affective, behavioral, and cognitive characteristics to effectively provide instruction to and understand the learning needs of diverse students (McAllister & Irvine, 2000). This is particularly critical to science and mathematics teachers that interact with students from diverse culturally, linguistically, and socio-economic backgrounds.

Cross-cultural and multicultural competency training also has serious implications related to teacher socialization practices (i.e., expectations and beliefs, gender stereotyping, and communication and feedback) and their relationship with the science and mathematics interests and beliefs, achievement, and choices of females and minorities. Although theoretically and conceptually appealing, the evidence from qualitative and correlational research is mixed (Lee, Luykx, Buxton, & Shaver, 2007). Therefore, we suggest, as we did previously, that rigorous causal research and complimentary approaches targeting minorities should receive increased emphasis so as to evaluate promising policy interventions, such as cross-cultural and multicultural competency training. Without systematic evidence, we must be cautious concerning any policy intervention because we have no way of discerning whether the effect is due to the
policy intervention, the characteristics of the participants (i.e., students and teachers), or a rival explanation. Bearing in mind the severity of the gender and racial attainment disparity in mathematics and science, we cannot afford ineffective policy interventions at the expense of scarce public resources, our economy, and, most importantly, female and minority students.
References


Gender and Racial Attainment Disparities


Jones, M. G., Howe, A., & Rua, M. J. (2000). Gender differences in students’ experiences,


Rowan, B., Correnti, R., & Miller, R. J. (2002). What large-scale, survey research tells us about teacher effects on student achievement: Insights from the *Prospects* study of elementary schools. *Teachers College Record, 104*(8), 1525-1567.


## POSSIBLE OUTCOME MEASURES for INTENDED IMPACTS

<table>
<thead>
<tr>
<th>IMPACT 1: STEM Learning and Achievement (Testing only)</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and percent of students taking PSAT &amp; PLAN for 9th through 11th Grades</td>
<td>State/district</td>
<td>PSAT (Math Only) and PLAN (Math &amp; Science)</td>
</tr>
<tr>
<td>Number and percent of students passing PSAT &amp; PLAN for 9th through 11th Grades</td>
<td>State/district</td>
<td>PSAT (Math Only) and PLAN (Math &amp; Science) Define passing: What is the cutoff score?</td>
</tr>
<tr>
<td>Math SAT 10 scores (FCAT-NRT)</td>
<td>State/district</td>
<td>No Science SAT 10 (SAT 10 Is Ending in 2008)</td>
</tr>
<tr>
<td>Math and Science FCAT Scores</td>
<td>State/district</td>
<td>Math FCAT will be changed in 2011 to align with the new standards; Science FCAT in 2012.</td>
</tr>
<tr>
<td>Math and Science FCAT Scores and by Strand/Cluster</td>
<td>State/district</td>
<td>See above.</td>
</tr>
<tr>
<td>Number or percent of students passing end-of-course exams related to STEM</td>
<td>State/district</td>
<td>Math and Science</td>
</tr>
<tr>
<td>Number and percent of students taking Math and Science ACT &amp; SAT tests</td>
<td>State/district</td>
<td></td>
</tr>
<tr>
<td>Math CLAST scores</td>
<td>State/district</td>
<td></td>
</tr>
<tr>
<td>Number or percent of students participating in district/state STEM-related competitions</td>
<td>District</td>
<td>Science Fair, Mu Alpha Theta, First Robotics, SECME contests, Sunshine Math</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMPACT 2: STEM Choice</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of students declaring STEM-related majors in secondary school</td>
<td>State/district</td>
<td></td>
</tr>
<tr>
<td>Percent of students declaring STEM-related majors in college</td>
<td>State/colleges &amp; universities</td>
<td>As defined by the state</td>
</tr>
<tr>
<td>Percent of students declaring majors in STEM-support fields (e.g., Health) in college</td>
<td>State/colleges &amp; universities</td>
<td>Must better define the relation and association, e.g., IT, Forensics, Nursing. Support is defined as STEM related or support</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMPACT 3: STEM Persistence and Completion</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and percent of graduates (AS, BS, MS, and PhD) with degrees in STEM fields</td>
<td>State/colleges &amp; universities</td>
<td></td>
</tr>
<tr>
<td>Decrease in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and percent of attrition in STEM majors</td>
<td>State/colleges &amp; universities</td>
<td></td>
</tr>
<tr>
<td>Number or percent of attrition in STEM-support majors</td>
<td>State/colleges &amp; universities</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMPACT 4: Increase Female and Minorities in STEM</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportional percent of graduates in STEM fields in College</td>
<td>State/colleges &amp; universities</td>
<td>Example: If 20% of undergraduates are African American students and 10% are engineers, then 20% of the 10% should be African American</td>
</tr>
<tr>
<td>Proportional representation of high achieving students or students in top quartiles in math and science on FCAT</td>
<td>State/district</td>
<td>Comparable percentage among high achievers in middle/high school</td>
</tr>
<tr>
<td>Proportional percent of females and minorities working in STEM career</td>
<td>State</td>
<td>Would include academia, industry, and other related sectors of employment</td>
</tr>
</tbody>
</table>
## POSSIBLE OUTCOME MEASURES for OUTPUTS

### OUTPUT 1: Increase Student Access/Opportunity in STEM

<table>
<thead>
<tr>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in... among women and under-represented minorities</td>
<td></td>
</tr>
<tr>
<td>Number of high schools offering calculus, physics, AP math and science, chemistry, etc</td>
<td>State</td>
</tr>
<tr>
<td>Number of high schools offering science lab experiences</td>
<td>State</td>
</tr>
</tbody>
</table>

### OUTPUT 2: Increase Student Participation in STEM (i.e., math/sci course taking)

<table>
<thead>
<tr>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in... among women and under-represented minorities</td>
<td></td>
</tr>
<tr>
<td>Average number of math and science courses taken by students in secondary school</td>
<td>State/District</td>
</tr>
<tr>
<td>Number and percent of students taking advanced math courses annually in high school</td>
<td>State/District</td>
</tr>
<tr>
<td>Number and percent of students taking advanced science courses annually in high school</td>
<td>State/District</td>
</tr>
<tr>
<td>Number and percent of students taking higher level math courses in secondary school</td>
<td>State/District</td>
</tr>
<tr>
<td>Decrease in... by women and under-represented minorities</td>
<td></td>
</tr>
<tr>
<td>Number and percent of HS graduates needing math and science remediation in college</td>
<td>State/District</td>
</tr>
</tbody>
</table>

### OUTPUT 3: Increase Student Career Awareness in STEM

<table>
<thead>
<tr>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in... among women and under-represented minorities</td>
<td></td>
</tr>
<tr>
<td>Ratio of students per career/guidance counselor</td>
<td>District</td>
</tr>
<tr>
<td>Number of school STEM-related career activities offered per year, aimed to increase female/minority participation</td>
<td>School</td>
</tr>
<tr>
<td>Student knowledge of and interest in STEM careers</td>
<td>State</td>
</tr>
</tbody>
</table>

### OUTPUT 4: Increase Student Engagement in STEM (i.e., math/sci outreach, programs, afterschool)

<table>
<thead>
<tr>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in... among women and under-represented minorities</td>
<td></td>
</tr>
<tr>
<td>Number and percent of students involved in STEM extracurricular activities (e.g., Science Olympiad, Future Cities, state science fair, university programs</td>
<td>School</td>
</tr>
</tbody>
</table>

### OUTPUT 5: Increase Individual Student Attributes (i.e., resilience, work ethic, good study habits, interest, attitude toward math/sci)

<table>
<thead>
<tr>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in... among women and under-represented minorities</td>
<td></td>
</tr>
<tr>
<td>Percent of students with more positive attitude towards math/science courses/activities</td>
<td>State/District</td>
</tr>
<tr>
<td>Number and percent of students who failed Algebra I but passed on second try</td>
<td>State/District</td>
</tr>
</tbody>
</table>
## Possible Measures for Evaluating the Success of the Plan

### POSSIBLE OUTCOME MEASURES for OUTPUTS (continued)

<table>
<thead>
<tr>
<th>OUTPUT 6: Increase administrator and faculty math and science content and pedagogy</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increase in...among women and under-represented minorities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of administrators/teachers successfully completing X or more hours of math/science professional development training</td>
<td>State</td>
<td>X hours to be defined (possibly 80 or more hours in a year) (training)</td>
</tr>
<tr>
<td>Percent of students taught math/science courses by a teacher certified in field</td>
<td>State</td>
<td>Elementary, middle, high school (certificate)</td>
</tr>
<tr>
<td>Percent of students taught math/science by math/science specialists</td>
<td>State</td>
<td>Elementary, middle, high school (degrees in field)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTPUT 7: Increase cultural competence among administrators and faculty</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increase in...among women and under-represented minorities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of administrators and math/science teachers (middle, high, postsecondary) who are male/female</td>
<td>State/district/ colleges &amp; universities</td>
<td></td>
</tr>
<tr>
<td>Percent of administrators and math/science teachers by ethnicity</td>
<td>State/district/ colleges &amp; universities</td>
<td></td>
</tr>
<tr>
<td>Percent of districts with a cultural competency plan</td>
<td>State</td>
<td>Organizational values, commitment to provide culturally competent instruction, governance, planning, evaluation staff dev, organizational infrastructure, svcs/intervention</td>
</tr>
<tr>
<td>Percent of administrators/faculty completing X hours of cultural competency training over last three years</td>
<td>State</td>
<td></td>
</tr>
<tr>
<td>Percent of students who feel that their administrators/teachers/faculty are culturally competent</td>
<td>State/district</td>
<td>Use student survey</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTPUT 8: Increase academic and workforce alignment</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increase in...among women and under-represented minorities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and percent of university STEM-degree graduates in a STEM-related job within a year of graduation</td>
<td>State/colleges and universities</td>
<td>Public Universities/Community Colleges only</td>
</tr>
<tr>
<td>Percent of HS and adult education students not pursuing college who obtain industry certification in STEM field</td>
<td>State/District</td>
<td></td>
</tr>
<tr>
<td>Percent of community college students receiving a STEM-related or STEM-support bachelor's degree</td>
<td>State/community colleges</td>
<td>Community College BS Degrees</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTPUT 9: Increase adult, family, and peer support for students</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increase in...among women and under-represented minorities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and percent of activities for parents, such as family nights, that are STEM-related</td>
<td>School/District</td>
<td>minority and gender focus is priority; baseline data compared w/current - # and % increase</td>
</tr>
<tr>
<td>Number and percent of parents, adults, volunteers, and mentors with STEM experience</td>
<td>School/District</td>
<td>baseline data compared w/current - # and % increase</td>
</tr>
<tr>
<td>Number of STEM related afterschool programs</td>
<td>School/District</td>
<td>Includes traditional afterschool programs, YMCA, etc.</td>
</tr>
<tr>
<td>Number of parental workshops that provide parents for helping students with math/science</td>
<td>School/District</td>
<td></td>
</tr>
<tr>
<td>Number of dollars supporting STEM-related activities (PTO funds, grants, etc)</td>
<td>School/District</td>
<td></td>
</tr>
</tbody>
</table>
## POSSIBLE OUTCOME MEASURES for OUTPUTS (continued)

<table>
<thead>
<tr>
<th>OUTPUT 10: Function of STEM Pipeline (or pipeline facilitation from K-20)</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and percent of students selecting STEM-related careers in high school who are admitted to STEM majors in college</td>
<td>District/University</td>
<td>Measure leakage; decrease/increase in interest (baseline data compared w/current school and labor market - # and % increase)</td>
</tr>
<tr>
<td>Percent of undergraduate and graduate students pursuing STEM fields with financial assistance</td>
<td>University</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTPUT 11: Shift or establish resources to support STEM goals (i.e., state, district, and school levels)</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dollar amount of line-item legislative appropriations supporting special initiatives/programs designed to increase participation and achievement in STEM field</td>
<td>State</td>
<td>baseline data compared w/current - # and % increase</td>
</tr>
<tr>
<td>Dollar amount of external grants that support STEM education (K-20)</td>
<td>State/districts/colleges and universities</td>
<td>baseline data compared w/current - # and % increase</td>
</tr>
<tr>
<td>Dollar amount of industry contributions (cash and in-kind) to STEM education from K-2</td>
<td>State</td>
<td>baseline data compared w/current - # and % increase</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OUTPUT 12: Establish or Increase accountability practices for women and minorities in STEM (K-20)</th>
<th>Level of Reporting</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in...among women and under-represented minorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of districts requiring STEM course and achievement data equity reporting</td>
<td>State</td>
<td></td>
</tr>
<tr>
<td>Percent of colleges/universities requiring diversity impact statements from faculty in annual reports</td>
<td>State</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D

FCR-STEM Female and Minority Initiative
Work Group Members

Julie Alexander
Director of Educational Services and Articulation
Division of Community Colleges
Florida Department of Education

Angela Birkes
Research Specialist
Research and Evaluation Department
DeKalb County Schools (Georgia)

Susan Blessing
Director of Women in Mathematics, Science and Engineering (WIMSE) and Professor of Physics
Florida State University

Susan Borland
Education Manager
Challenger Learning Center of Tallahassee

Consuelo Boronat
Director, Title V
Florida International University

Beverly Bower
Associate Professor of Higher Education
Florida State University

Tommy Chambers
President
Aim2Win Solutions, LLC

Paula Cifuentes
Faculty Coordinator of Math & Science
Lake City Community College

Todd Clark
Deputy Director
Office of Mathematics and Science
Florida Department of Education

Leah Cook
Program Director
Girls Get IT

Mary Jane Dann
Principal
Douglas L. Jamerson, Jr. Elementary School

Jimmie Lee Davis, Jr.
Senior Software System Engineer
MITRE Corporation

Anne Donnelly
Director
South East Alliance for Graduate Education and the Professoriate
University of Florida

Christina Drake
Research Engineer
Lockheed Martin Missiles and Fire Control

Patrick Enderle
Research Assistant and Doctoral Student in Science Education
Florida State University

Adeola Fayemi
Director
Office of Equity & Access
Florida Department of Education

Yvonne Fonnett
Educator
Dr. Phillips High School
Orange County Public Schools

Penelope Haskins
President and CEO
Radiation Technologies, Inc.

Monica Hayes
Regional Director
National Math and Science Initiative

Jacqueline Hightower
Coordinator of Academic Affairs and Advisor to the Environmental Sciences Student Organization (ESSO)
Florida A&M University

1 * Also served on the Advisory Board
APPENDIX D

FCR-STEM Female and Minority Initiative
Work Group Members

**Shouping Hu***
Associate Professor of Higher Education
Department of Educational Leadership and Policy Studies
Florida State University

**Gladis Kersaint**
Associate Professor of Mathematics Education
University of South Florida

**Charlene Kincaid**
Coordinator of Mathematics (K-12)
Santa Rosa County School Board.

**Kathy Leroy**
Chief Officer of Math & Science
Duval County Public Schools

**Karen Martinoff**
President and CEO
Hayes e-Government Resources, Inc.

**Lisa McClelland**
Doctoral Student in Higher Education
Florida State University and Former Director of the McNair Program
Florida A&M University

**Mike McKee**
Director
GO-GK-12
University of Central Florida

**Kimberly Moore**
Chief Executive Officer
WORKFORCE plus

**Louise Muscarella-Daxon**
Test/Chair
Miami-Edison Senior High School
Miami-Dade County Public Schools

**Jeffery Murfree**
Director of Prek-12 STEM Educator Professional Development
Teacher Resource Network/The Teacher Channel

**Nirmala Ramlakhan**
Education Project Manager
Workforce Central Florida

**Ava Rosales**
Instructional Supervisor, Curriculum and Instruction (Science)
Miami-Dade County Public Schools (M-DCPS)

**Walter Secada**
Professor, Curriculum & Instruction, University of Miami

**Jacqueline Smith**
Director, Minority Engineering & Computing Science Center for Academic Advancement
University of Central Florida

**Berrin Tansel**
Associate Director, Center for Diversity in Engineering and Computing and Associate Professor, Civil and Environmental Engineering,
Florida International University

**Sylvia Wilson Thomas**
Assistant Dean
College of Engineering
University of South Florida

**Sharisse Turnbull**
Graduate Assistant in Instructional Systems Design
Florida State University
APPENDIX D

FCR-STEM Female and Minority Initiative
Work Group Members

Biographies

**Julie Alexander** is the Director of Educational Services and Articulation for the Florida Department of Education's Division of Community Colleges. Her primary responsibilities include admissions-related issues, articulation, dual enrollment, residency, bill analysis and policy recommendation and interpretation. Ms. Alexander has previously served as Bureau Chief of Special Projects in the Division of Workforce Education; Policy Analyst in Planning and Institutional Research at the Florida Board of Governors; Assistant Administrator of the Statewide Course Numbering System, and as an art teacher in Texas and Botswana, Africa. Ms. Alexander holds a Master's degree in Education in Instructional Technology from the University of West Florida and a Bachelor's degree in Fine Arts in Art Education from University of North Texas.

**Angela Birkes** is a Research Specialist for the Research and Evaluation Department of Georgia’s DeKalb County School System, where she serves on the Research Review Committee and makes recommendations on research proposals. She formerly was a Senior Research Associate for the P-16 Data and Analysis Systems Division where she was the project manager for the Middle School Achievement and Interest in Mathematics and Science (MS-AIMS) initiative and a member of the Data and Analysis Systems team supporting the P-16 Data Mart project. Dr. Birkes also has served as the Associate Director of the Southern Regional Education Board’s Adult Learning Campaign established to encourage adults to consider postsecondary education. She also has provided consulting/project management services for SECME Inc. and the Georgia Space Grant Consortium at the Georgia Institute of Technology’s College of Engineering, where she has been research faculty. Dr. Birkes earned her mechanical engineering degree at Howard University and both master’s and doctoral degrees in civil engineering from the Georgia Institute of Technology.

**Susan Borland** is the Education Manager of the Challenger Learning Center of Tallahassee, where she engages students, especially females and minorities, in STEM subjects through space science and simulation. She has developed STEM-oriented curricula and provided STEM programming for Title I and 21st Century grant-funded schools in Leon County. Ms. Borland has a wide range of experience providing in-service training to teachers through Challenger Pre-Mission workshops, Aerospace education workshops, NASA CONNECT and Careers in Engineering, among others. Ms. Borland received the 2007 Kid’s Incorporated Children’s Champion award primarily for her work with underserved populations. She is certified to teach health, middle school science, biology, and earth science.

**Tommy L. Chambers** is the President of Aim2Win Solutions, LLC, a small professional services company that provides management and technology consulting, professional and personal development services, and professional speaking services. He is also Program Director of the Student Information System at Jobs for the Future in Boston, Massachusetts. Before starting Aim2Win Solutions, Mr. Chambers served as the Director of the Early College High School Initiative at SECME, Inc. at the Georgia Institute of Technology. He has extensive software engineering, technology, and technical management experience, including lead software engineer and flight controller at NASA’s Jet Propulsion Laboratory, software engineer and software engineering manager at Skytel/MCI, computer programmer at the U.S. Geological Survey, and President of Intelogix Corporation, a software company in Acworth Georgia.
APPENDIX D

FCR-STEM Female and Minority Initiative
Work Group Members

Mary Jane Dann is Principal of Douglas L. Jamerson, Jr. Elementary School, a diverse inner city public school in St. Petersburg, Florida which has earned the Magnet Schools of America “Magnet School of Excellence” award for the last two years. The focus on engineering and mathematics in an elementary school gives students real world opportunities to think and analyze critically and quantitatively. Students engage in high-level learning experiences in engineering using the Jamerson Design Process, where students define problems and then research, design, construct, test, analyze, and communicate solutions. The staff, with University of South Florida Engineering direction, has created its own integrated engineering curriculum that is standards based and focuses on basic engineering concepts as well as provides awareness of nontraditional STEM career professions.

Jimmie Lee Davis, Jr. is a Senior Software System Engineer for the MITRE Corporation and serves on the Space Florida Board of Directors. Established to create new technology for the Department of Defense, MITRE currently manages research and development centers for the Department of Defense, the Federal Aviation Administration and the Internal Revenue Service. Dr. Davis has an impressive record of leadership in the minority technology and science community. He has worked with organizations that reach out to young people, including the Harriet G. Jenkins Predoctoral Fellowship Program Review Committee and the J.C. & Frankie Watts Foundation Inaugural Full Impact Leadership Academy. As an undergraduate at Morehouse College, he founded a successful outreach program with the National Society of Black Engineers. Dr. Davis holds doctorate and master’s degrees in Electrical Engineering from the University of Massachusetts Lowell.

Anne Donnelly is the Director of the South East Alliance for Graduate Education and the Professoriate at the University of Florida, one of a national network of National Science Foundation (NSF) Projects designed to increase the diversity of the nation's faculty in science, engineering, and mathematics. She has served in this capacity for the past 10 years, during which time 22 science, engineering, and mathematics (SEM) departments have graduated 23 Ph. D. recipients and 7 Master's degree recipients. Dr. Donnelly also serves as the Associate Director of Education for the Particle Engineering Research Center, a graduated NSF ERC, that offered research experiences to over 700 undergraduate students over 10 years. This program consistently outperformed national averages for inclusion of women and minorities.

Christina Drake is a Research Engineer for Lockheed Martin Missiles and Fire Control where she is a member of the Sensor Technology and Materials group. Dr. Drake holds a Ph.D. in Materials Science and Engineering from the University of Central Florida and a B.S., cum laude, in Materials Science and Engineering from the University of Florida where she worked as a mentor, tutor, and camp counselor with the Step-UP program. Based at the UF College of Engineering, the Step-UP program aims to increase minority and female retention in the engineering disciplines, through middle and high school summer camps, and mentoring and tutoring for freshman and sophomore engineering students. At UCF, she was a National Science Foundation GK-12 Fellow helping low-performing public schools transform science instruction for students who have traditionally underperformed in that subject area. Her continuing teaching interests involve working with minority and female students in the sciences.
APPENDIX D

FCR-STEM Female and Minority Initiative
Work Group Members

Patrick Enderle is a Research Assistant and Doctoral Student in Science Education at Florida State University, where he is involved in a five-year NSF project aimed at understanding the effectiveness of different professional development approaches related to inquiry teaching practices. His other research interests include reforming undergraduate science education and evolution and Nature of Science education. Mr. Enderle is originally from North Carolina, where he earned a Bachelor’s and Master’s degree in Molecular Biology from East Carolina University. His teaching experience includes high school, community college, and large undergraduate courses in different aspects of biology. In Florida, Patrick has assisted in developing the new Sunshine State Standards in science and has offered professional development experiences related to evolution education.

Jacqueline Hightower is a Coordinator of Academic Affairs and Advisor to the Environmental Sciences Student Organization (ESSO) in the Academic Affairs – Office of Accreditation Reaffirmation at Florida A&M University (FAMU), where she is a student advocate and champion of environmental sustainability. After working for ten years as a Technology Analyst in the corporate sector, she was awarded a one year sabbatical to teach Information Systems courses at FAMU. Upon completing her graduate degree, she joined the Environmental Sciences Institute (ESI), where she secured grant funds and in-kind donations to support ESSO initiatives including a science poster competition for local elementary schools. Ms. Hightower was selected FAMU’s “Advisor of the Year” after one year in her current position. Over the last 14 months she co-chaired the planning committee that brought Focus the Nation Teach-In on Global Warming Solutions for America to FAMU.

Monica Hayes, is the former Regional Director with the National Math and Science Initiative. She is also the former Director of the K-20 Office of Equity, Global and International Education in the Florida Department of Education, where she managed Florida’s $7.125 million dollar partnership contract with the College Board, and the former statewide Director for Florida’s College Reach-Out Program (CROP), a legislatively funded program ($3.92M) designed to reach at risk minority and underrepresented students. Ms. Hayes is an accomplished public speaker on a range of topics related to education, closing the achievement gap, and cultural competency. She believes that the primary mission of educational institutions should include modeling cultural competency, closing the achievement gap for minority and underrepresented students, and setting high expectations that enable all students to become well-rounded and fully functioning members of our communities.

Shouping Hu is an Associate Professor of Higher Education in the Department of Educational Leadership and Policy Studies at Florida State University. He received an M.A. degree in economics and a Ph.D. in higher education from Indiana University. Dr. Hu’s primary research interest is to identify factors influence student postsecondary decisions, including the choice of and persistence in the STEM fields.

Charlene Kincaid is the Coordinator of Mathematics (K-12) for the Santa Rosa County School Board. Over the years, Ms. Kincaid has received numerous recognitions and awards as a mathematics educator. She earned the Presidential Award for Excellence in Mathematics and Science Education (secondary mathematics) as a state and national awardee. She was named a Tandy Technology Scholar Teacher by RadioShack, an Associate Master Teacher for the State of Florida, and an Honors Master Teacher for NEWMAST (NASA and NCTM sponsored
Mathematics and Science Teacher Education Workshops). She has served on the Florida Department of Education’s Standards Writing Team for both the 1996 and 2007 mathematics standards; the Region I Planning Team for the Statewide Systemic Initiative in Mathematics; the Office of Mathematics and Science Advisory Committee; and the Florida Comprehensive Assessment Test Content Advisory Committee. Ms. Kincaid was a co-teacher, facilitator, and curriculum developer of the Flight Adventure Deck project, a hands-on mathematics and science program for middle school students designed by a partnership of Santa Rosa and Escambia County Schools and the National Naval Aviation Museum.

Karen Martinoff is President and CEO of Hayes e-Government Resources, Inc. headquartered in Tallahassee, Florida. As an entrepreneur, she has built Hayes from a small company into one of the leading woman-owned minority technology businesses in Florida. Hayes e-Government Resources, Inc has provided information technology services and solutions to State of Florida government agencies, local governments, school districts and commercial businesses. Currently, Hayes is the prime contractor for the Florida Department of Education’s Florida Information Resource Network (FIRN2) serving over two million users in K-12 schools throughout the state of Florida. As prime contractor, Hayes engineered the combined resources and industry expertise of major communication providers AT&T, Embarq and Verizon to serve Florida’s education community.

Lisa McClelland is a doctoral student in higher education at Florida State University, where her research interests include disparities in the representation of minorities and females in STEM fields. Ms. McClelland has worked in higher education for over sixteen years. During the last ten, she served as Director and Assistant Professor of the Ronald E. McNair Postbaccalaureate Achievement program at Florida A&M University. The McNair program is designed to increase the attainment of Ph.D. degrees by students from underrepresented segments of society by involving low-income, first-generation undergraduate students in research and other scholarly activities.

Kimberly Moore has spent nearly a decade in the workforce development arena. She currently serves as the Chief Executive Officer of WORKFORCE plus, becoming the youngest person, the first African-American and the first woman to hold this top position. WORKFORCE plus provides leadership and support for a workforce development system throughout Gadsden, Leon and Wakulla Counties. In her position as Chief Executive Officer, Ms. Moore is responsible for a $6 million budget, a staff of eleven and 55 employees under contract.

Jeffery Murfree is the director of Prek-12 STEM Educator Professional Development for the Teacher Resource Network/The Teacher Channel. Jeff has 18+ years of experience working in the prek-12 STEM education community and has strong relationships with this community and its national partners. Jeff has provided professional development in STEM to teachers, students and school and school system administrators throughout the country. He is a former poultry scientist and high school science teacher. His ten years working for SECME, highlights his career working with under-served populations and women, preparing them for entrance into STEM education and careers.
APPENDIX D

FCR-STEM Female and Minority Initiative
Work Group Members

**Ava D. Innerarity Rosales** is an Instructional Supervisor for Miami-Dade County Public Schools (M-DCPS) Curriculum and Instruction (Science) and an adjunct professor for Miami Dade College. She is currently a doctoral candidate at Curtin University of Technology, Perth, Australia researching the effects of pre-college programs on the attitudes and achievement of minority students in mathematics and science. For the past 20 years, Ms. Rosales has worked with M-DCPS as a science teacher and instructional leader. During her tenure with the district, she has been the district liaison for the Museum of Science Girls Raising Interest in Science and Engineering (RISE) program and coordinated SECME (formerly the Southeastern Consortium for Minorities in Engineering) district-wide, while collaboratively securing over $1 million to support pre-college STEM programs for M-DCPS minority students, teachers, and parents.

**Berrin Tansel** is the Associate Director of Center for Diversity in Engineering and Computing at Florida International University and an associate professor of Civil and Environmental Engineering. Dr. Tansel was named the 2007 Engineer of the Year by the American Society of Civil Engineers Miami-Dade Branch. She is an elected Fellow of the American Society of Civil Engineers (ASCE), an elected Diplomate of American Academy of Water Resources Engineers, and a Board Certified Environmental Engineer by the American Academy of Environmental Engineers. Before joining FIU, Dr. Tansel worked at the Massachusetts Water Resources Authority on the Boston Harbor clean up project and the Center for Environmental Management at Tufts University. She has been a consultant for PEER Consultants, Soap and Detergent Association, SCS Engineers, City of Pompano Beach, and ERM-South.

**Sylvia Wilson Thomas** is Assistant Dean in the College of Engineering at the University of South Florida, where she strengthens relationships and programs with industry, government and academia to increase the quantity, quality and diversity of students, faculty and staff. She has been a strong advocate for women in engineering as an instructor and mentor of engineering students, speaker for the Girl Scouts and parent-teacher organizations, and member of the Osceola High School Engineering Academy Advisory Board. Dr. Thomas also serves on the Florida Education Fund Board of Directors and works with the Society of Women Engineers (SWE), National Society of Black Engineers (NSBE), Society of Hispanic Professional Engineers (SHPE), the IEEE Women Affinity group, Junior Engineering Technical Society (JETS), National Engineer’s Week, First Robotics, and other student organizations.

**Sharisse Turnbull** is a graduate assistant at FCR-STEM, where she has provided research support for projects related to Florida’s new math and science standards and a professional development initiative designed to help teachers improve their instruction in the science and mathematics content areas. Sharisse was introduced to opportunities in the STEM field as a high school student. While completing her bachelor's degree in Industrial Engineering, she worked at NAVSEA as a co-op student and Human Factors Engineering Trainee. Currently, she is completing a Master's degree in Instructional Systems Design at Florida State University. Her long-term interests are improving student learning and instruction in mathematics on a broad scale and expanding STEM opportunities for females and minorities.
APPENDIX D

FCR-STEM Female and Minority Initiative
Work Group Members

Female & Minority Initiative Staff
Florida Center for Research in Science, Technology, Engineering and Mathematics
Florida State University

Laura Hassler Lang is the Director of the Learning Systems Institute and Associate Professor of Educational Leadership and Policy Studies at Florida State University. She is a co-principal investigator for the new state-funded Florida Center for Research in Science, Technology, Engineering and Mathematics (FCR-STEM), a co-principal investigator for Florida PROMiSE, a new math and science partnership created to support teachers and principals in the adoption of Florida’s new mathematics and science standards, and a former middle school principal and special education teacher in Florida. Dr. Lang’s research focuses on improving learning and performance in K-12 schools, with an emphasis on instructional leadership, professional development, data-driven decision making and interventions related to reading, science and mathematics.

Faye Jones is the project manager for the Female and Minority Initiative at FCR-STEM. She is a doctoral candidate in the Department of Educational Leadership and Policy Studies and the higher education program at Florida State University, where her research has focused on higher education administration, departmental productivity, leadership and gender/race differences in choice and persistence in postsecondary education. Faye has over 10 years of professional experience in higher education management in finance, budgeting, human resources, auditing, evaluation, and performance monitoring of individual faculty and academic departments.

W. Joshua Rew is a graduate assistant for the Female and Minority Initiative at the FCR-STEM. He is a doctoral student in the Socio-cultural and International Development Education Studies program at Florida State University, where he is studying the effects of school leadership on student achievement and organizational performance in developing countries and the relationship between education inequality and socio-economic status in Vietnam, South Africa, and the United States.

Christine Johnson is Assistant Director for Administration at FCR-STEM. She has over 25 years of experience in public policy, research, evaluation, and program administration related to education and human services. For the past eight years, she has managed policy, research and technical assistance projects related to K-12 education and welfare reform at the FSU Learning Systems Institute, including the $1.5 million Multi-University Reading, Mathematics and Science Initiative (MURMSI).

Danielle Sherdan is the Assistant Director for Technical Assistance at FCR-STEM, where she has been working with the Florida Department of Education and Florida's school districts on the implementation of Florida's new mathematics and science standards and designing professional development for principals and teachers. Dr. Sherdan holds a doctorate in Biological Science from Florida State University, with a specialization in plant physiology and molecular biology and has taught elementary and middle school science as a National Science Foundation Graduate K-12 Fellow.