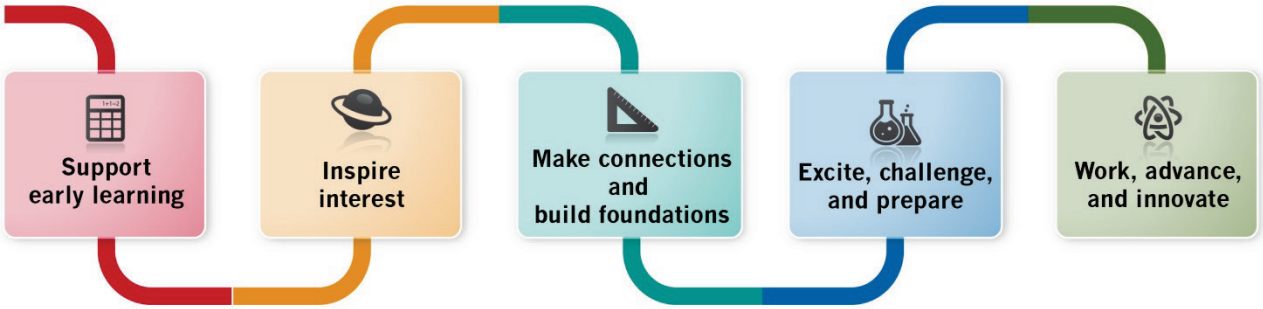
STEM IN MINNESOTA (Science, Technology, Engineering, Math)



Education and Workforce Disparities

Gender: A cradle to career perspective

Prepared by Dan Mueller, Wilder Research

JANUARY 2014

The number of women entering STEM careers has increased in recent years but overall a smaller proportion of Minnesota women than men pursue careers in STEM fields. Women continue to be greatly underrepresented in some traditionally male-dominant STEM occupations. The pattern of female-male differences along the STEM education and workforce continuum is fairly complex with differences in achievement varying by subject and grade level. Substantial female-male differences in college readiness and fields of study begin to emerge in high school that are later seen in college majors and career choices.

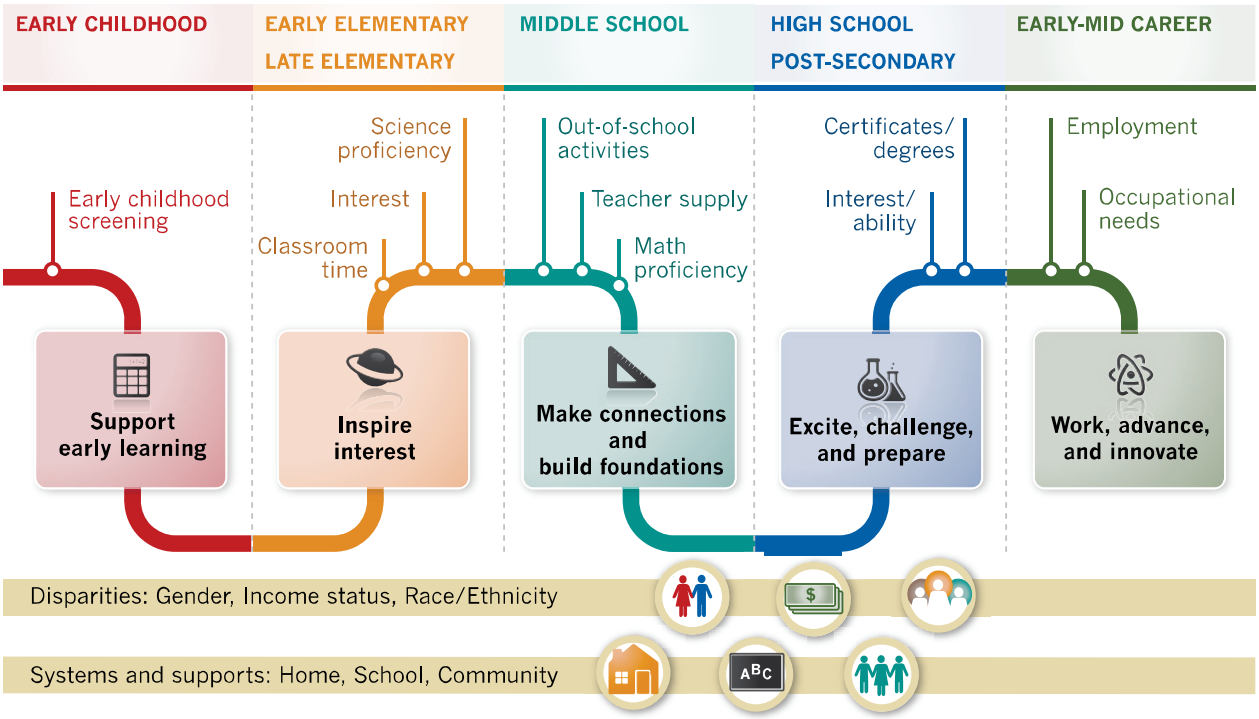
Underrepresentation of women compared to men in such fields as physics, engineering, and computer science is likely related to traditional gender roles in the U.S. and perceptions that women's abilities in these areas may be less than those of men. However, females' early success in STEM subjects in school in Minnesota and across the U.S. as well as women's success in STEM fields in other countries, suggest that these attitudes or perceptions sell women short. They appear to be limiting women's career choices with likely negative economic consequences for women individually and for the state as a whole. Minnesota could benefit from more women pursuing careers in STEM fields, especially in fields where women are currently considerably underrepresented. Addressing gender gaps requires understanding disparities and calling attention to successes that can counter perceptions that STEM generally, or specific STEM fields, are not for girls.

MINNESOTA COMPASS

Boston Scientific

Wilder Research
Information. Insight. Impact.

This paper was developed to augment STEM information on the Minnesota Compass website, which provides a common foundation of knowledge and resources that can be used to collectively address concerns and most effectively target resources. The website is organized around a cradle-to-career framework.



While STEM conversations generally take a holistic approach, at this point, data are often available by discipline (e.g., math, science). For this reason, data presented in this paper are often organized by discipline, but sections generally follow along the continuum.

The paper is divided into five sections with each section identifying female-male STEM-related differences and potential actions to reduce or eliminate gaps:

- Math and science proficiency in elementary and middle school
- STEM course-taking and achievement in high school, and college readiness
- STEM interest
- STEM postsecondary degree completion
- STEM workforce participation

The STEM acronym stands for science, technology, engineering, and mathematics, but represents much more: a range of disciplines, a way of thinking and knowing, and a set of creative, inventive, and technical skills. STEM includes the basic sciences and mathematics and applied sciences such as agriculture, natural resources, computer science, health care and engineering. Viewed more broadly, everyday science and engineering, from cooking to car repair, are also STEM.

– Minnesota STEM Network, 2013

Summary

Key findings for Minnesota students

Proficiency in elementary and middle school

- Girls' and boys' proficiency in math is similar in elementary and middle school.
- Boys have somewhat higher proficiency rates in science than girls, especially in eighth grade.

High school course-taking and achievement, and college readiness

- Girls and boys are about equally likely to take math and science general-credit advanced courses in high school.
- Girls are more likely to take math and science International Baccalaureate courses and boys are more likely to take STEM Advanced Placement courses, especially in computer science.
- Boys are more likely than girls to obtain a passing score on STEM Advanced Placement exams.
- Girls and boys proficiency is quite similar on state tests in math and science in high school, with boys having a slight edge.
- Boys are more likely to be college ready in math and science than girls based on ACT results.

STEM interest in K-12

- Fourth-grade girls and boys interest in science is about the same.
- A larger proportion of eighth-grade boys than girls reported participating in non-school science activities.
- The proportions of college-bound females and males expressing interest in STEM majors is nearly the same.

STEM postsecondary degree completion

- The transition from high school to college may be an important point for women in deciding whether or not to pursue a STEM major. National studies indicate men are more likely to pursue STEM majors than women.
- Among those completing postsecondary degrees or certificates, a higher proportion of men than women complete them in STEM fields, and the fields men and women complete them in differ greatly.
- Women are underrepresented in the proportion of STEM degrees/certificates they earn relative to their proportion of the college-age population, but less so than a decade ago.

STEM workforce participation

- The proportion of women workers in STEM occupations is lower than for men.
- The STEM occupations in which Minnesota men and women are employed differ greatly. Women are much more likely than men to work in health occupations.
- STEM occupations most likely to face worker shortages in Minnesota are male-dominated occupations.
- Women educated in STEM fields are less likely than men to be employed in STEM occupations, or stay in these occupations, based on national studies.

Suggested actions

- Improve K-12 science teaching by connecting it more effectively to the everyday lives of students, especially those underrepresented in science or STEM fields.
- Encourage more girls and their families to participate in informal science education programs.
- Provide more coordinated and aligned informal STEM education to build on students' initial interest in science or STEM.
- Improve the planning, monitoring, and support of students' progress toward college readiness.
- Study potential factors that may explain females' lower performance on STEM Advanced Placement and ACT exams compared to that of males.
- Increase awareness of STEM careers, especially among girls.
- Help entering college students interested in STEM majors form connections with faculty in their STEM fields of interest.
- Foster partnerships between businesses and undergraduate STEM programs to increase degree completion and transition to STEM occupations by providing students with internships, mentoring, or "hands on" training in STEM jobs.
- Encourage employers to follow best practices in hiring and retaining STEM workers.
- Increase the number of women in STEM production and trade occupations and computer occupations to help avert potential worker shortages in these areas.

Math and science proficiency in elementary and middle school

Key findings

Girls' and boys' proficiency in math is similar in elementary and middle school

Very small or no difference in math proficiency was found between Minnesota girls and boys in grades 3 through 8 in 2013. Minnesota public school students in these grades are tested in math each spring using the Minnesota Comprehensive Assessments, Series III (MCA-III). In grades 3 through 5, boys had a proficiency rate 1 percentage-point higher than girls (72% vs. 71% in grades 3 and 4, and 61% vs. 60% in grade 5). In grades 6 and 7, there was no difference in the percent proficient between girls and boys (57% of both groups were proficient in grade 6 and 56% were proficient in grade 7). In eighth grade, the math proficiency rate was 2 percentage points higher for girls than boys (60% vs. 58%) (Figure 1).

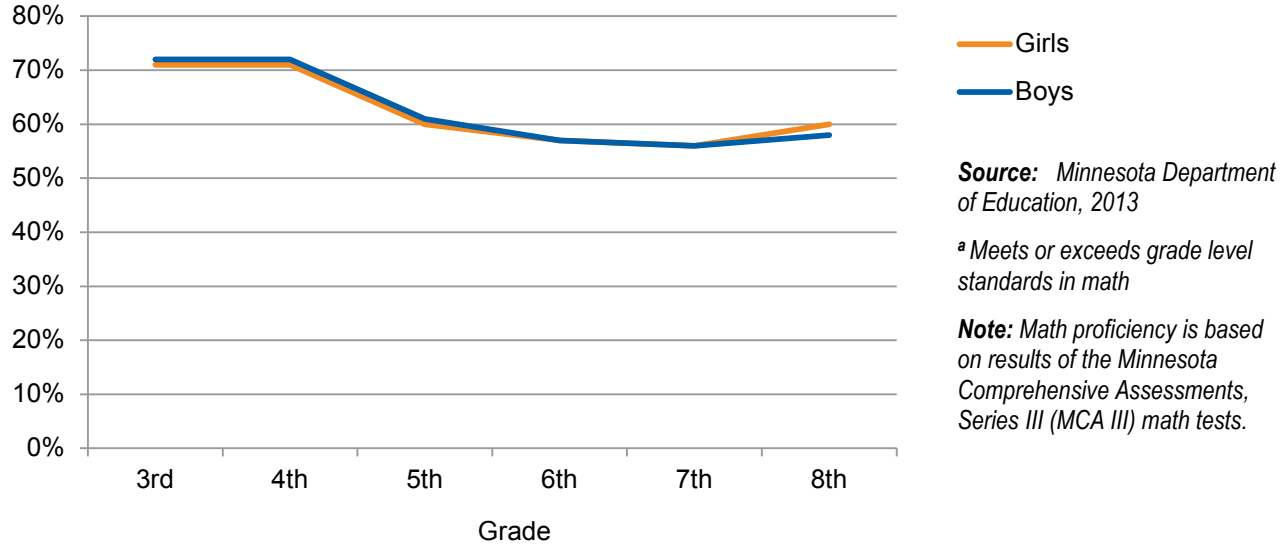
These results for 2013 indicate a slight improve for girls in relation to boys over the previous two years. In 2011 and 2012, the math proficiency rate for boys was 1-2 percentage points higher than for girls in each grade from third through seventh. In all three years (2011-2013), girls' eighth grade proficiency rate was 2 percentage points higher than the boys' rate (Minnesota Department of Education, 2013).

As an aside, 2013 MCA-III reading proficiency rates were consistently higher for girls than boys across elementary and secondary grades.

Minnesota's results on the NAEP also indicate little difference in math proficiency between girls and boys

Fourth- and eighth-grade math results from the National Assessment of Educational Progress (NAEP), often called the Nation's Report Card, were available for Minnesota in 2013. NAEP results are based on a representative sample of Minnesota fourth and eighth graders. In both fourth grade and eighth grades, there was no significant difference in NAEP math scores of girls and boys. Minnesota ranked first among the

1. Math proficiency by grade, Minnesota students, 2013, percent proficient [a]



Source: *Minnesota Department of Education, 2013*

[a] *Meets or exceeds grade level standards in math*

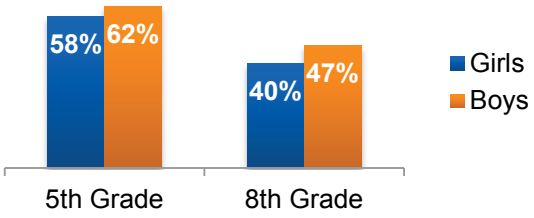
Note: *Math proficiency is based on results of the Minnesota Comprehensive Assessments, Series III (MCA III) math tests.*

states in NAEP fourth-grade math and fifth in eighth-grade math (U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics [U.S. DOE], 2013).

Boys have somewhat higher proficiency rates in science than girls, especially in eighth grade

Students' science skills in Minnesota are measured in elementary school in fifth grade and in middle school in eighth grade based on the Minnesota Comprehensive Assessments, Series III (MCA-III). Statewide results from spring 2013 showed a 4 percentage-point difference in science proficiency between boys and girls, with a proficiency rate of 62 percent for boys and 58 percent for girls. The gap was larger in eighth grade with 47 percent of the boys and 40 percent of the girls being proficient, a 7 percentage-point gap (Figure 2). The difference in proficiency rates in favor of boys was similar in 2012, a 3 percentage-point gap in fifth-grade science and an 8 percentage-point gap in eighth-grade science (Minnesota Department of Education, 2013).

2. Science proficiency in grades 5 and 8: Minnesota students, 2013, percent proficient [a]



Source: *Minnesota Department of Education, 2013*

[a] *Meets or exceeds grade-level standards in science based on the MCA-III science tests.*

Note: *The decrease in science proficiency from fifth to eighth grade may be due, at least in part, to how recently the material included in the test was covered. The fifth grade test included material covered in the fifth grade and the eighth grade test included material covered in grades 6-8.*

NAEP science results for girls and boys are consistent with the MCA results

NAEP science results for Minnesota fourth and eighth graders also showed higher proficiency rates for boys than girls, particularly in eighth grade. In the most recent year NAEP fourth-grade science data are available (2009), the proficiency rate for fourth-grade boys was 45 percent compared to 41 percent for girls. The difference of 4 percentage points is the same as that found for fifth-grade science using the MCA-III. The 4 percentage-point gap found on the NAEP was not statistically significant. Overall, Minnesota ranked ninth highest among the states in its NAEP fourth-grade science results (U.S. DOE, 2013).

NAEP 2011 eighth-grade science results for Minnesota showed a gap in proficiency between girls and boys similar to that found for eighth graders using the MCA-III. On the NAEP, 46 percent of the boys were proficient compared to 38 percent of the girls, an 8 percentage-point gap. This gap was statistically significant. Overall, Minnesota ranked eighth highest among the states in NAEP eighth-grade science results (U.S. DOE, 2013).

TIMSS math and science results for eighth-grade girls and boys are similar to those found on the MCA and NAEP

The Trends in International Mathematics and Science Study (TIMSS) in 2011 compared results for Minnesota eighth-grade girls and boys. Consistent with MAP and NAEP results, girls and boys had similar scores on the math assessment but boys tended to score higher than girls on the science assessment (U.S. DOE, n.d.a).

Actions to reduce gaps

Improve K-12 science teaching to better reach students underrepresented in science or STEM fields

As just described, girls' proficiency in science is significantly below that of boys in eighth grade. This difference could result from girls seeing science as less interesting or less relevant to their lives during adolescence. How science is taught, including how well it is connected to students' everyday lives, is likely to affect students' academic performance in the subject. Improving the teaching of science could be an important component in increasing the interest and performance of all students in science, including girls. Key to accomplishing this improvement is providing high-quality professional development opportunities for teachers to learn how to teach science more effectively to diverse student classrooms. Effective science teaching includes making it relevant to the context of students' lives and the things they care about. This includes using real-world examples to which students can relate, and providing frequent opportunities for students to engage in scientific inquiry and the processes of developing scientific knowledge (National Research Council, 2007 & 2011; MN P-20 Education Partnership, 2011; Schroeder, Scott, Tolson, Huang, & Lee, 2007). In addition, it might be helpful for middle school teachers to invite guest speakers from STEM professions, especially those from underrepresented groups in STEM (including women), to speak to their students.

STEM course-taking and achievement in high school, and college readiness

Key findings

Girls and boys are about equally likely to take math and science general-credit advanced courses in high school

U.S. Department of Education, Civil Rights Division data from 2010 indicated that the percentages of Minnesota high school girls and boys taking general-credit advanced STEM courses in high school is similar, although it differed slightly by course. Girls were slightly more likely (by 1-2 percentage points compared to boys) to take algebra 2, geometry, chemistry, and advanced mathematics courses. Boys were more likely to take physics (by 2 percentage points compared to girls). Girls and boys were equally likely to take biology and calculus (Change the Equation, n.d.).

Girls are more likely to take math and science IB courses and boys are more likely to take STEM AP courses, especially in computer science

International Baccalaureate (IB) Organization data from 2011 indicate that Minnesota girls are more likely than boys to take IB courses in math and science in high school (Change the Equation, n.d.). In IB math, 55 percent of the students taking the courses were girls, and in science, 54 percent of the students taking the courses were girls (Change the Equation, n.d.).

Turning to Advanced Placement (AP) courses, College Board data from 2011 indicate that boys are more likely to take AP courses than girls. The difference is especially lopsided for computer

science. For both AP math and science, 53 percent of the students taking the courses were boys, and for computer science, 87 percent of the students were boys (Change the Equation, n.d.).

Among students taking the exams for STEM Advanced Placement courses, boys are more likely than girls to obtain a passing score

A score of "3" or higher (scale of 1 to 5) on an AP exam is considered a passing score. In math, 67 percent of boys and 63 percent of girls taking the tests received a score of three or higher. In science, 61 percent of boys and 45 percent of girls taking the tests received scores of three or higher. For computer science, 70 percent of boys and 63 percent of girls taking the test received a score of three or higher (Change the Equation, n.d.).

Minnesota AP results regarding gender differences are consistent with a national study that found girls are less likely to take STEM AP exams and to score as well as boys on them. The study also found that girls and boys earn about the same number of high school math and science credits and girls obtain slightly higher grades in these classes (Hill, Corbett, & St. Rose, 2010).

High school girls' proficiency in math and science is just slightly below boys on the MCA

In high school, Minnesota students' math skills are assessed in eleventh grade, using the Minnesota Comprehensive Assessments, Series II (MCA-II). Results in 2013 indicated that 54 percent of boys were proficient compared to 51 percent of girls, a difference of 3 percentage points. This represented a reduction in the gap over the previous two years when it was 5 percentage points each year. Also, the proficiency rate for both girls and boys improved in 2013 compared to the previous two years (Minnesota Department of Education, 2013).

Students are administered MCA-III science test in high school after they complete their second semester of biology. In 2013, boys had a slightly higher proficiency rate than girls (54% vs. 52%), a gap of 2 percentage points. The gap in favor of boys was 3 percentage points in 2012 (Minnesota Department of Education, 2013).

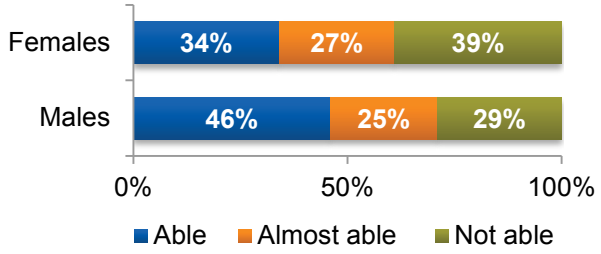
Boys are more likely to be college ready in math and science than girls based on ACT results

In Minnesota, most of the high school graduates who are college bound take the ACT exam, usually in their junior or senior year in high school. Seventy-four percent of Minnesota high school graduates in 2012 took the ACT. Students' results on the ACT are a measure of their preparation for college-level coursework. Overall, the percentage of Minnesota high school graduates in 2012 who met ACT college-readiness benchmarks in both the ACT math and science subject area tests ("able") was 39 percent, and 26 percent passed one of the two tests ("almost able"). College-readiness benchmarks reflect scores on ACT math and science tests that represent the level of achievement required for students to have an approximately 50 percent chance of obtaining a B or higher or a 75 percent chance of attaining a C or higher in corresponding credit-bearing first-year college courses in algebra and biology.

Results for Minnesota 2012 high school graduates show a gap in STEM college readiness between boys and girls: 46 percent of boys and 34 percent of girls were "able," a gap of 12 percentage points. If students in the "able" and "almost able" categories are combined, 71 percent of boys were able or almost able compared to 61 percent of girls (Figure 3). Average scores of boys were higher than those for girls on both the ACT math and science tests (ACT, Inc.). A higher percentage of Minnesota girls than boys met college-readiness benchmarks in ACT

English and reading tests (Ross, Kenna, Rathbun, et. al., 2012).

3. Minnesota 2012 high school graduates' ability in STEM



Source: *ACT, Inc.,2013*

Note: *"Able" students are those meeting both science and math benchmarks on the ACT assessment. "Almost able" are those meeting one of the two benchmarks. "Not able" are those meeting neither benchmark.*

Actions to reduce gaps

Improve the planning, monitoring, and support of students' progress toward college readiness

High school girls tend to be less ready to take college-level math and science courses based on ACT results. A tool that could be helpful in improving the STEM college readiness of girls and other students is the Educational Planning and Assessment System (EPAS) from ACT, Inc. The EPAS is a set of assessments designed to provide a longitudinal, systematic approach to educational and career planning, assessment, instructional support, and evaluation. These assessments were developed to benchmark college readiness for students nationally. Students are given the EXPLORE assessment in eighth grade, the PLAN assessment in tenth grade, and the ACT in eleventh or twelfth grade. The EXPLORE and PLAN, especially, could be used by schools to measure student progress toward college readiness, develop course plans, and intervene or provide extra support to students as appropriate. In addition to the EPAS, there are other tools of this kind available from other organizations.

Study potential factors that may explain females' lower performance on STEM AP and ACT exams compared to that of males

Girls in high school take as many STEM courses as boys and earn slightly higher grades on average in these courses. Hence, the lower performance of girls on STEM AP and ACT exams seems surprising. While there is speculation about possible causes, there is little solid evidence for what might account for this difference. Some think it may be related to gender stereotyping in our culture. That is, gender stereotyping (e.g., females aren't as good at math or science as males) may have psychological effects on female test-takers that are harmful to their test performance. The College Board is studying this issue of "stereotype threat" to determine if it is a significant factor in male-female differences in AP exam results.

STEM interest

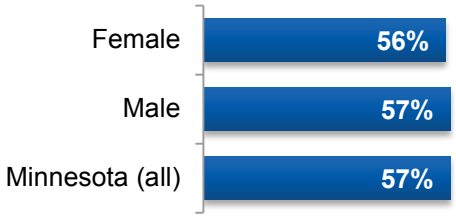
Key findings

Fourth-grade girls and boys interest in science is about the same

As part of fourth-grade science assessments, the National Assessment of Educational Progress (NAEP) includes a question about interest in science. Fourth graders are asked how much they like studying science: very little, some, quite a bit, or very much. The most recent results available (2009) indicated that nearly identical proportions of Minnesota fourth-grade girls and boys had high interest in science (combines the "quite a bit" and "very much" responses). Fifty-six percent of the girls had a high interest in

science compared to 57 percent of the boys (Figure 4) (U.S. DOE, 2013).

4. Percent of 4th graders with high interest in science by gender, Minnesota, 2009



Source: *U.S. Department of Education, 2013*

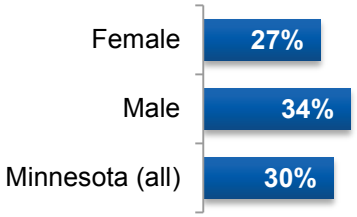
Note: *Fourth-graders were asked how much they like studying science: very little, some, quite a bit, or very much. Combines response categories of "very much" and "quite a bit" of interest.*

A recent national survey of 14-17 year-old girls found that about three-quarters of those surveyed had at least some interest in STEM. Those interested in STEM liked to learn how things work, solve problems, and do hands-on science projects (Modi, Schoenberg, & Salmond, 2012).

A larger proportion of eighth-grade boys than girls reported participating in non-school science activities

As part of eighth-grade NAEP science assessments in 2011, students were asked how much they disagree or agree that they do science-related activities that are not for schoolwork: strongly disagree, disagree, agree, or strongly agree. This question probably measures both interest in science and opportunity to participate in out-of-school science programs or activities. Combining those who responded "strongly agree" or "agree," the percentage of Minnesota eighth-grade boys who said they did non-school science activities was 34 percent compared to 27 percent for eighth-grade girls, a gap of 7 percentage points (Figure 5) (U.S. DOE, 2013).

5. Percent of 8th graders doing science activities not for school by gender, Minnesota, 2011



Source: *U.S. Department of Education, 2013*

Note: *Eighth-graders were asked how much they disagree or agree that they do science-related activities that are not for schoolwork: strongly disagree, disagree, agree, or strongly agree. Combines response categories of "agree" and "strongly agree."*

The proportions of college-bound females and males expressing interest in STEM majors is nearly the same

High school graduates in 2012 who took the ACT exams while in high school were asked their choice of a major in college. Those students who indicated that they were "very sure" of their choice of a STEM college major were classified as "interested" in STEM by ACT, Inc. Results indicated that 10 percent of female Minnesota high school graduates were interested in STEM based on this definition compared to 9 percent of their male counterparts.

We examined the proportion of Minnesota high school graduates in 2012 who were "able" (met the college-readiness benchmarks on both the ACT math and science exams) that were also "interested" in STEM (very sure about pursuing a STEM major in college). Among students who were able in STEM, an equal percentage of girls and boys were interested in majoring in a STEM field (11%). Among all high school girls assessed, 3.6 percent were both able and interested in STEM compared to 5.0 percent of the boys (ACT, Inc.). The higher percentage for boys is due to more boys than girls being able in STEM based on the

ACT exam results. These ACT results along with occupational projections in STEM areas suggest that it is desirable to increase Minnesota girls' and boys' interest and ability in STEM from a workforce needs perspective.

Actions to increase interest in STEM

Encourage more girls and their families to participate in informal science education programs

As indicated, fewer eighth-grade girls participate in non-school science activities than eighth-grade boys. Informal science or STEM education programs can be important in stimulating interest in science/STEM and offering opportunities for children to engage in "hands-on" scientific investigation. Participation in these programs may be especially important for girls to help counter messages they may have internalized that they do not belong or cannot excel in STEM fields. Through these types of programs girls may have opportunities to meet or hear from female scientists or engineers who could serve as an inspiration or role models for them in planning their education and careers (President's Council of Advisors on Science and Technology, 2010).

Provide more coordinated and aligned informal STEM education to build on students' initial interest in science or STEM

Reaching more students with high-quality informal STEM education opportunities can boost interest in STEM. However, another challenge is sustaining the interest of students after an initial, stimulating STEM experience through an informal STEM education program, school classroom lessons, or both. One approach to this challenge is creating greater coordination among informal education providers such that students have the opportunity to participate in a series of informal STEM education activities over a number of years, offered by several providers that build on each other's program activities and strongly align with and complement what the students are learning in the school classroom. Such a model, focused especially on students underrepresented in STEM, is being developed and evaluated over the next two years through a partnership of the Minneapolis Public Schools with seven informal STEM education organizations and the Minnesota Department of Education. Wilder Research is serving as the evaluator for the project.

STEM postsecondary degree completion

Key findings

The transition from high school to college may be an important point for women in deciding whether or not to pursue a STEM major. National studies indicate men are more likely to pursue STEM majors than women.

National research suggests that the transition from high school to college may be a critical point when many young women with an interest in STEM decide not to pursue a major in a STEM field (Hill, Corbett, & St. Rose, 2010). Men are more likely than women to pursue STEM majors when they reach college, especially in the fields of mathematics, engineering, and computer sciences, according to a longitudinal, nationally representative survey of postsecondary students conducted from 1995 to 2001. Among postsecondary students pursuing a major in STEM, persistence rates for men and women are similar, however (Chen & Weko, 2009).

The reasons why men are more likely to pursue a STEM major in college than women are not entirely

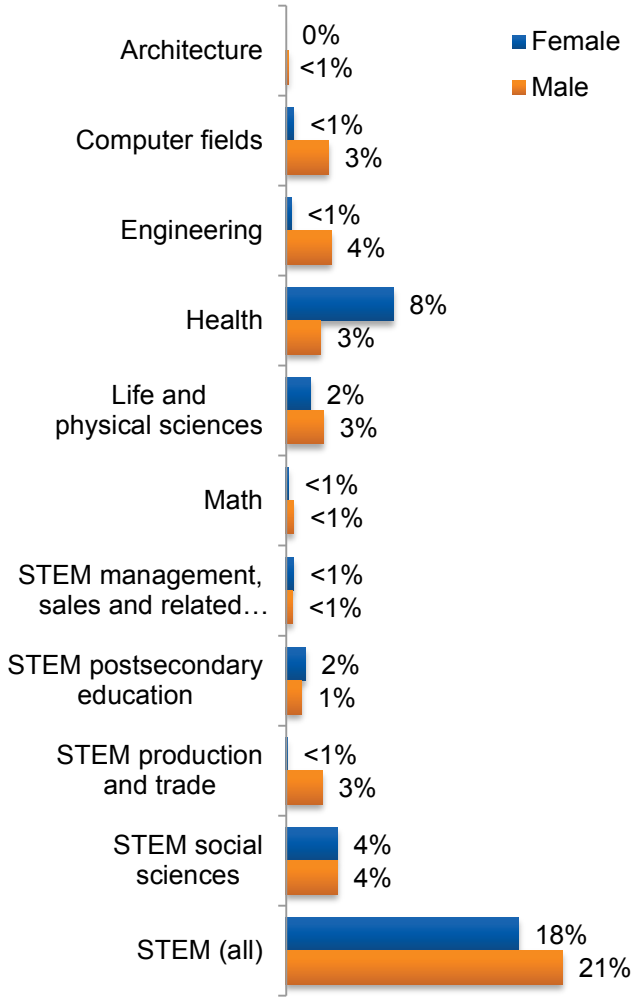
clear and may be a combination of academic and non-academic reasons. Results of STEM ACT and AP exams suggest that women may be less prepared for college coursework in STEM than men. Yet other national data indicate that females earn as many high school credits in STEM as males and receive slightly better grades in these courses than males (Hill, Corbett, & St. Rose, 2010). Traditional gender roles and expectations may also influences women's decisions about whether to major in a STEM field (Modi, Schoenberg, & Salmond, 2012; President's Council of Advisors on Science and Technology, 2010). Women's perceptions that STEM fields may not fulfill their career goals to make a difference in the world and help people may be another factor (Modi, Schoenberg, & Salmond, 2012).

Among those completing postsecondary degrees or certificates, a higher proportion of men than women complete them in STEM fields, and the fields men and women complete them in differ greatly

For degrees awarded from Minnesota postsecondary institutions from July 1, 2011 to June 30, 2012, 18 percent of degrees/certificates awarded to women were in STEM fields compared to 21 percent for men.

Among those receiving degrees/certificates in STEM from Minnesota postsecondary institutions, women were much more likely to receive them in health fields compared to men, and somewhat more likely to receive them in postsecondary education. Men were more likely to receive STEM degrees/certificates in architecture, computer fields, engineering, life and physical sciences, math, and STEM production and trades. Men and women were almost equally likely to receive degrees/certificates in STEM social sciences and management, sales, and related (Figure 6) (U.S. DOE, n.d.b).

6. Proportion of postsecondary degrees and certificates awarded in STEM fields by gender, Minnesota, 2012



***Source**: U.S. Department of Education, n.d. b*

Women are underrepresented in the proportion of STEM degrees/certificates they earn relative to their proportion of the college-age population, but less so than a decade ago

Minnesota women earn a smaller percentage of degrees/certificates in STEM fields relative to their percentage of the college-age population. In 2009, women earned 35 percent of STEM degrees/certificates and represented 47 percent of the college-age population, a gap of 12 percentage points. The

gap has decreased since 2001 when it was 18 percentage points (Change the Equation, n.d.).

Actions to reduce gaps

Increase awareness of STEM careers, especially among girls

Programs that enable high school students to gain exposure to and explore STEM occupations and careers can stimulate greater interest in STEM and open-up new career possibilities to them that they may not have considered. This may be especially important for girls given that traditional gender roles may tend to limit their choices of STEM fields. Also, it may be important for girls to better understand that STEM occupations, besides in health care fields, for example, can fulfill their career aspirations – i.e., they can help people and make a difference in the world in many different STEM occupations, while making a good salary.

Opportunities for STEM career exposure and exploration could include, for example, career centers, summer job opportunities, or STEM programs for high school students offered by local colleges and universities. Programs offered by colleges and universities often focus on students underrepresented in STEM, including female students (Mueller & Gozali-Lee, 2013; Schneider, Judy, & Marzuca, 2012; Yelamarthi & Mawasha, 2008; Lam, Srivatsan, Doverspike, Vesalo, & Mawasha, 2005).

Help entering college students interested in STEM majors form connections with faculty in their STEM fields of interest

For first-year college students, especially underrepresented students such as girls interested in majoring in a STEM field, developing a connection to a faculty member in their field of interest may be critical to their following through with the major. Relationships with faculty members, especially female faculty members for female students pursuing majors in male-dominated STEM fields, may be especially important. Often these faculty members can serve as role models or mentors for students.

STEM workforce participation

Key findings

The proportion of women workers in STEM occupations is lower than for men

Overall in Minnesota in 2011, the percentage of women workers employed in STEM occupations was 17 percent compared to 23 percent for men, a gap of 6 percentage points. A higher percentage of male than female workers were employed in STEM occupations in all age groups. The highest proportion of female workers in STEM occupations was in the 25-44 age group (20%) (Ruggles, Alexander, Genadek, et al., 2010).

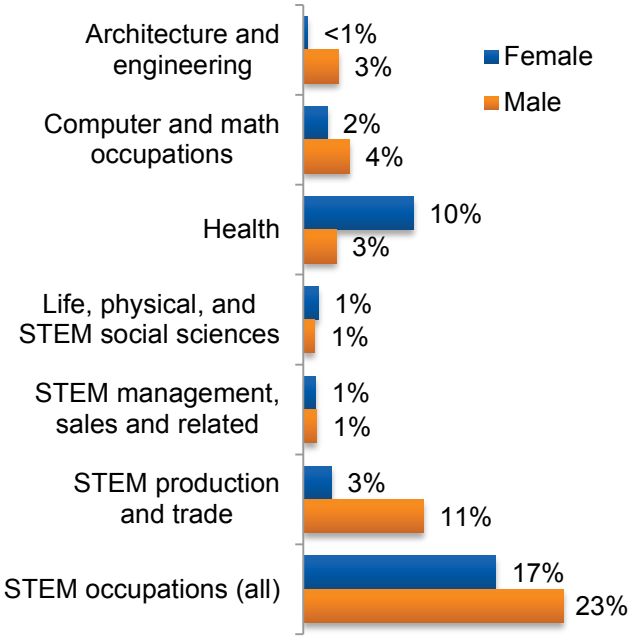
The STEM occupations in which Minnesota men and women are employed differ greatly. Women are much more likely than men to work in health occupations.

As with STEM majors in college, the STEM occupations in which men and women are employed differ considerably (Figure 7). The one STEM area where female workers were more highly represented than male workers was in the health occupations. Ten percent of female workers were in health occupations compared to 3 percent of male workers. Male workers were much more likely to be employed in the following occupational categories compared to female workers: architecture and engineering, computers and math occupations,

and STEM production and trades. Female and male workers were about equally like to be employed in the following two occupational categories: STEM management, sales, and related; and life, physical, and STEM social science (Ruggles, Alexander, Genadek, et al., 2010).

These differences in Minnesota in the types of STEM occupations in which men and women are employed are similar to the differences found nationally (National Science Board, 2012; Landivar, 2013).

7. Proportion of total workers employed in STEM occupational groupings by gender



Source: *Ruggles, S., Alexander, J.T., Genadek,et al. (2010)*

Note: Some occupational groupings in this chart are combined due to data availability: architecture occupations and engineering occupations; computer occupations and math occupations; and life and physical science occupations and STEM social science occupations. Data is not available for STEM-specific postsecondary teaching disciplines from this data source, and therefore does not appear in this chart.

STEM occupations most likely to face worker shortages in Minnesota are male-dominated occupations

Projected Minnesota employment needs in STEM occupational groupings were examined in relation to postsecondary degrees and certificates awarded in STEM fields by Minnesota institutions. This analysis suggests that STEM occupations in production and trades and computer occupations are most likely to face worker shortages in the current decade. These occupational areas are currently male dominated (Minnesota Department of Employment and Economic Development, n.d.; U.S. DOE, n.d.b; Ruggles, Alexander, Genadek, et al., 2010).

Women educated in STEM fields are less likely than men to be employed in STEM occupations, or stay in these occupations, based on national studies

Nationally, women who graduate with science and engineering degrees are less likely to be employed in STEM occupations than their male counterparts (Landivar, 2013). Similarly, retention rates of women in STEM careers tend to be lower than for men. That is, female scientists, engineers, and technologists in business and high-tech industries are more likely to leave these fields than their male counterparts, and females in other fields as well. Mid-career seems to be a critical period when women decide to leave their jobs for a variety of reasons including a non-supportive work environment, a problematic work schedule, or unclear criteria for advancement. Larger numbers of men than women are at the upper levels of STEM professions. There is a gender gap in pay in STEM fields as in other fields. However, women in STEM occupations tend to have higher earnings than women in other fields (Hill, Corbett, & St. Rose, 2010).

Actions to reduce workforce gaps

Foster partnerships between businesses and undergraduate STEM programs to increase degree completion and transition to STEM occupations by providing students with internships, mentoring, or "hands on" training in STEM jobs

Partnerships between businesses and undergraduate STEM education programs can help increase student retention and completion of STEM majors, particularly for students' underrepresented in the STEM workforce such as women. Such partnerships can provide mentoring and hands-on training for STEM college students through cooperative education, learn and earn, and internship programs which are proven ways by which businesses can both recruit future workers and help students complete their college studies. These programs can help develop students who more quickly integrate into the workplace and have higher job satisfaction. They also may provide opportunities for female students to meet and potentially form mentoring relationships with women working in male-dominated STEM occupations (President's Council of Advisors on Science and Technology, 2012; Committee on STEM Education, National Science and Technology Council, 2013; National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2011; Association of Public and Land-Grant Universities, 2012).

Encourage employers to follow best practices in hiring and retaining STEM workers

More employers following best practices in the recruiting, hiring, retaining, and advancement of STEM workers would likely increase the numbers of female workers who enter and stay in the STEM workforce. Examples of such practices include: recruiting widely, using gender neutral language in the recruitment process and removing gender identifiers in screening resumes, having family-friendly policies and benefits, training of all employees to prevent discrimination or harassment and providing resources for employees who experience discrimination or harassment, establishing and maintaining a culture of non-gender focus, ensuring pay equity, having transparency in criteria and opportunities for advancement, offering professional development opportunities, and offering professional coaching or mentoring programs (Association for Women in Science, n.d.; Michigan Council of Women in Technology Foundation, 2005).

Increase the number of women in STEM production and trade occupations and computer occupations to help avert potential worker shortages in these areas

Worker shortages in Minnesota seem likely to occur in the male-dominated STEM fields of production and trades and computers during the current decade. Hence, there may be good opportunities for more female workers to pursue careers in these fields. Greater efforts to expose females to occupations in these fields and encourage them to consider these occupations in their education and career planning may be warranted.

References

ACT, Inc. (2013).

Association for Women in Science. (n.d.). *Industry best practices*. Retrieved from: http://awis.org/associations/9417/files/Industry_Best_Practices.pdf

Association of Public and Land-Grant Universities. (2012). *The quest for excellence: Supporting the academic success of minority males in science, technology, engineering, and mathematics (STEM) disciplines*. Retrieved from http://www.aplu.org/sslpage.aspx?pid=2274

Change the Equation. (n.d.). *Vital Signs*. Retrieved from http://vitalsigns.changetheequation.org/

Chen, X., & Weko, T. (2009). *Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education* (No. NCES 2009-161). Alexandria, VA: U.S. Department of Education, National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubs2009/2009161.pdf

Committee on STEM Education, National Science and Technology Council. (2013). *Federal Science, Technology, Engineering, and Mathematics (STEM) Education 5-Year Strategic Plan: A Report from the Committee on STEM Education.* Washington, D.C. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics*. Retrieved from AAUW website: http://www.aauw.org/files/2013/02/Why-So-Few-Women-in-Science-Technology-Engineering-and-Mathematics.pdf

Lam, P.C., Srivatsan, T., Doverspike, D., Vesalo, J., & Mawasha, P.R. (2005). A ten year assessment of the pre-engineering program for under-represented, low income and/or first generation college students at The University of Akron. *Journal of STEM Education: Innovations & Research*, *6*(3/4), 14-20.

Landivar, L. C. (2013). *Disparities in STEM employment by sex, race, and Hispanic origin*. Retrieved from United States Census Bureau website: http://www.census.gov/prod/2013pubs/acs-24.pdf

Michigan Council of Women in Technology Foundation. (2005). *Best practices for the advancement and retention of women in technology*. Retrieved from: http://www.mcwtf.org/files/mcwt/51/file/MCWTF%20Professional%20Women%20Docs/MCWT.Best.Practices.1.summary.pdf

Minnesota Compass. (n.d.). Retrieved from: www.mncompass.org

Minnesota Department of Education. (2013). Retrieved from: http://w20.education.state.mn.us/MDEAnalytics/Data.jsp

Minnesota Department of Employment and Economic Development. (n.d.). *Employment Outlook*. Retrieved from: http://www.positivelyminnesota.com/Data_Publications/Data/index.aspx

Minnesota STEM Network, An Initiative of SciMathMN. (2013). *Strategies for advancing STEM in Northeast Minnesota*. Presented by the Leadership Team for the Northeast Minnesota Region. November. www.scimathmn.org

MN P-20 Education Partnership. (2011). *STEM Achievement Gap Strategic Planning Workgroup final report*. Retrieved from http://mnp20.org/working_groups/documents/December152011WorkingGroupReport-STEMAchievementGapFinal3Report.pdf

Modi, K., Schoenberg, J., & Salmond, K. (2012). *Generation STEM: What girls say about science, technology, engineering, and math.* New York, NY: Girl Scout Research Institute. Retrieved from: http://www.girlscouts.org/research/publications/stem/generation_stem_what_girls_say.asp

Mueller, D. & Gozali-Lee, E. (2013). *College and career readiness: A review and analysis conducted for Generation Next*. Saint Paul, MN: Wilder Research.

National Academy of Sciences, National Academy of Engineering, & Institute of Medicine. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. Retrieved from The National Academies Press website: http://www.nap.edu/catalog.php?record_id=12984

National Research Council. (2011). *Successful K–12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics*. Retrieved from The National Academies Press website: http://www.nap.edu/catalog.php?record_id=13158

National Research Council. (2007). *Taking Science to School: Learning and Teaching Science in Grades K-8*. Retrieved from The National Academies Press website: http://nap.edu/download.php?record_id=11625

National Science Board. (2012). *Science and engineering indicators 2012* (No. NSB 12-01). Arlington, VA: National Science Foundation. Retrieved from http://www.nsf.gov/statistics/seind12/pdf/seind12.pdf

President's Council of Advisors on Science and Technology. (2010). *Report to the President, Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future*. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

President's Council of Advisors on Science and Technology. (2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*. Retrieved from http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-engage-to-excel-final_2-25-12.pdf

Ross, T., Kena, G., Rathbun, A., KewalRamani, A., Zhang, J., Kristapovich, P., & Manning, E. (2012). *Higher education: Gaps in access and persistence study* (No. NCES 2012-046). Retrieved from National Center for Education Statistics website: http://nces.ed.gov/pubs2012/2012046.pdf

Ruggles, S., Alexander, J.T., Genadek, K., Goeken, R., Schroeder M.B., & Sobek, M. (2010). Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]. Minneapolis: University of Minnesota. http://usa.ipums.org/usa/

Schneider, B., Judy, J., & Marzuca, C. (2012). Boosting STEM interest in high school. *Phi Delta Kappan*, *94*(1), 62-65.

Schroeder, C., Scott, T., Tolson, H., Huang, T., Lee, Y. (2007). Meta-analysis of national research regarding science teaching. *Journal of Research in Science Teaching*, *44*(10), 1436–1460. http://cmse.tamu.edu/pdf/FinalInitialreport-TexasScienceInitiative.pdf

U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, (n.d.a). *Trends in International Mathematics and Science Study (TIMSS)*. Retrieved from http://nces.ed.gov/timss/

U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics. (n.d.b). *Integrated Postsecondary Education Data System*. Retrieved from http://nces.ed.gov/ipeds/

U.S. Department of Education, Institute of Educational Sciences, National Center for Education Statistics. (2013). *National Assessment of Educational Progress (NAEP)*. Retrieved from http://nces.ed.gov/

Yelamarthi, K., & Mawasha, P.R. (2008). A pre-engineering program for under-represented, low-income and/or first generation college students to pursue higher education. *Journal of STEM Education: Innovations & Research*, *9*(3/4), 5-15.

Wilder Research
Information. Insight. Impact.

451 Lexington Parkway North
Saint Paul, Minnesota 55104
651-280-2700
www.wilderresearch.org

AMHERST H. WILDER FOUNDATION
ESTABLISHED 1906
Here for good.

For more information

This paper is part of a series developed to augment STEM information on the Minnesota Compass website. Learn more about STEM in Minnesota at www.mncompass.org.

For more information about this report, contact Dan Mueller at Wilder Research, 651-280-2711.

Author: Dan Mueller

JANUARY 2014