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MapCores 2013-2014 Assessment Report

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MapCores 2013-2014 Assessment Report

I. ***Objective: Increase women's participation and persistence in the fields of mathematics, physics, and computer science.***

A. Number of first year students taking mathematics, computer science and physics courses

To examine the participation of first year women in entry-level STEM courses, the class lists for target classes offered in fall 2013 and spring 2014 were obtained: Math 119 (Calculus I), Math 120 (Calculus II), Physics 191 (Foundations of Physics I), Physics 200 (Foundations of Physics II), and CSCI 150 (Introduction: Science/Computing). These classes were selected because they are all classes recommended by their respective departments for first year students to take to stay on track for the major (see Table 1 for numbers in each class). Fewer MapCores students and non-MapCores first year female students than non-MapCores first year male students were enrolled in all the targeted math, physics, and computer science courses. There was not a consistent pattern in the number of MapCores vs. non-MapCores women enrolled in mathematics classes. Many more male than female first years completed CSCI 150 in the fall semester; the only female first year students to complete the introductory computer science course were the MapCores students. In both physics courses, a few more MapCores women completed the courses than non-MapCores women. These results suggest that male students are still much more likely to take the math and physics courses foundational to STEM majors than female students.

Table 1

Number of First Year Students Who Completed Classes Designed for Math, Physics, and Computer Science Majors

	MapCores Women	Control Women	Control Men
Fall 2013			
F13 Math 119 Calculus I	9	19	47
F13 Math 120 Calculus II	3	4	10
F13 Physics 191 Foundations of Physics I	5	3	23
F13 CSCI 150 Introduction: Science/Computing	4	0	22
Spring 2014			
S14 Math 120 Calculus II	6	11	28
S14 Physics 200 Foundations of Physics II	3	2	14
S14 CSCI 150 Introduction: Science/Computing	0	1	2

B. Withdrawals from Targeted Mathematics, Computer Science, and Physics Courses

The Registrar's Office only tracks if students withdraw from a class after the first three weeks of the semester. Thus, if a student were to enroll in a class and then drop the class right away, this information would not be recorded. Although it might be possible to ask instructors to track withdrawals from classes after the first day of class, it is possible that a student could drop a class to enroll in a different section of the same course or that they may drop the class due to scheduling issues or other issues not related to concern that the course would be too difficult. We have decided to focus on the data we could gather from the Registrar's Office. Table 2 lists the number of first years who withdrew from the targeted mathematics and physics classes, followed by the percent of the subgroup that withdrew. As can be seen in the table, the MapCores women were less likely to withdraw from any of the targeted classes than the control group first year male and female students. MapCores women did not withdraw from any of the targeted courses during their first year, which makes it more likely that they will remain on track to progress in the major on time.

Table 2

Number of First Year Students Who Withdrew From Targeted Mathematics, Physics, and Computer Science Classes

	MapCores Women Number withdrew (% of subgroup who withdrew)	Control Women Number withdrew (% of subgroup who withdrew)	Control Men Number withdrew (% of subgroup who withdrew)
Fall 2013			
Mathematics 119 Calculus I	0 (0%)	1 (5%)	2 (4%)
Mathematics 120 Calculus II	0 (0%)	0 (0%)	0 (0%)
Physics 191 Foundations of Physics I	0 (0%)	0 (0%)	1 (4%)
CSCI 150 Introduction: Science/Computing	0 (0%)	1 (100%)	1 (4%)
Spring 2014			
Mathematics 120 Calculus II	0 (0%)	0 (0%)	4 (20%)
Physics 200 Foundations of Physics II	0 (0%)	0 (0%)	0 (0%)
CSCI 150 Introduction: Science/Computing	0 (0%)	0 (0%)	3 (60%)

C. Graduation Rate

Now that two cohorts of MapCores women have graduated, we are able to examine the impact of the MapCores program on graduation rates. The results suggest that graduation rates have only increased slightly in 2014 as compared to 2008 (before the program was implemented; see Table 3). The impact of the MapCores program on graduation rates will likely increase as students enter into a program in which there are always more senior level MapCores mentors and role models; the first few graduating classes did not have this experience as they were the trailblazers for the program.

Table 3

The percentage of mathematics, physics, and computer science graduates who are women in 2008 (pre-MapCores) vs. 2014

Department	2008 (total number of women in parentheses)	2014 (total number of women in parentheses)
Mathematics	26% (5)	29% (7)
Physics	17% (1)	17% (1)
Computer Science	14% (3)	29% (4)

Another way to measure persistence is to examine the percentage of mathematics, physics, and computer science majors who are women, which includes first year through senior students who have listed a major with the Registrar's Office in one of the targeted fields. Because the targeted majors are relatively small, it is helpful to examine the trends using all students who have declared a major in the targeted areas, which will wash out idiosyncrasies that may be present within a single graduating class. Examining Table 4, a greater percentage of women have declared majors in the targeted disciplines compared to the baseline. The analysis of the percentage of female majors across time demonstrates an upward trend, particularly for mathematics and computer science (see Table 5). The percentage of physics majors who are women, surged last year, but appears to have returned to a more constant level.

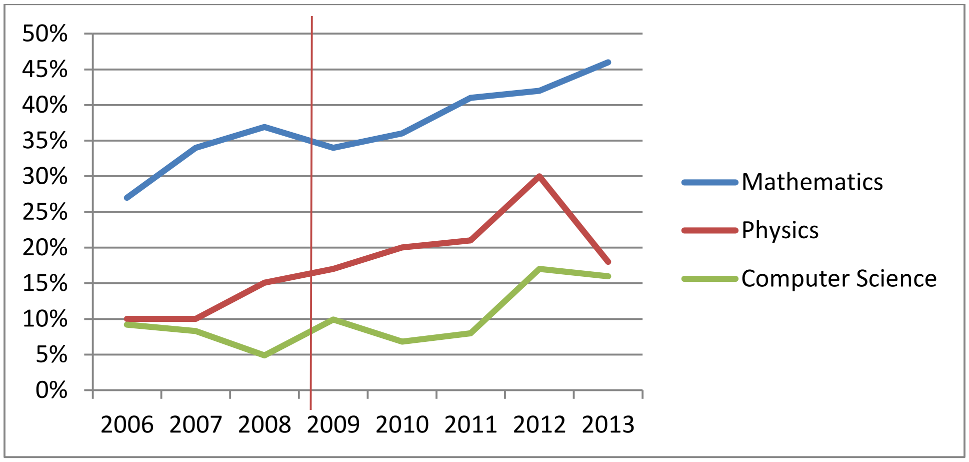
Table 4

The percentage of mathematics, physics, and computer science majors who are women from 2008 (pre-MapCores) to 2014 (five MapCores cohorts)

Department	2008 (total number of women in parentheses)	2014 (total number of women in parentheses)
Mathematics	37% (66)	46% (59)
Physics	15% (13)	18% (12)
Computer Science	5% (4)	16% (16)

Table 5

The percentage of mathematics, physics, and computer science majors who are women before MapCores (2006-2007, 2007-2008, and 2008-2009 school years) and after MapCores (2009-2010 and beyond)



D. Graduate Training in STEM Disciplines

The first year students planning to major in STEM disciplines were asked to indicate the highest degree they planned to obtain. A comparison of the responses of the MapCores students and non-MapCores first year students revealed differences between the groups. As can be seen in Table 6, the pattern of results suggests that MapCores students were less likely to indicate that they plan to pursue an MS or Ph.D./M.D./J.D. than the non-MapCores first year students. It should be noted that this year's cohort has many more computer science majors than in previous years of the MapCores program, and there are more employment opportunities for computer science majors with a BA compared to the opportunities for mathematics and physics majors with a BA. The results suggest that nearly half of the MapCores women who completed the survey plan to attend graduate school.

Table 6

First Year Students' Highest Degree Expectations by Program

Highest Expected Degree	MapCores Students *N* (%)	Control Students *N* (%)
BA	7 (54%)	2 (18%)
MS	3 (23%)	8 (73%)
Ph.D./M.D./J.D.	3 (23%)	1(9%)

For the first time, we are also able to report on the number of MapCores women currently enrolled in a graduate program in physics, computer science, or mathematics. Among the MapCores cohort that graduated in 2013, four students have started Ph.D. programs in the targeted disciplines: two in mathematics, one in computer science, and one in physics. These data support our objective of increasing women's participation in graduate training in the STEM disciplines.

C. Awareness of Issues Facing Women in the Relevant Disciplines

The current first year students' final essay on the reasons why there are not more women in math and science will not be written until the final exam period, which is after the assessment report deadline.

II. Objective: Include women as junior members of the scientific community.

The MapCores women have been encouraged to seek out research experiences that will help them feel like junior members of the scientific community. Appendix A contains a listing of the research experiences of the MapCores students in the summer of 2013 (part 1) and the research experiences they are pursing for the upcoming summer (part 2). The list suggests that students are seeking out a variety of opportunities that will allow them to get hands-on experience in their discipline. These experiences should make them more competitive when they apply to graduate school and should make women feel like valued members of the scientific community.

Part of being a member of the scientific community is conducting independent research and presenting at conferences. In the past few years the MapCores students have been active undergraduate researchers. Below is a listing of the student research presentations in the past year.

Student Research Presentations

1. Sarah Lange presented her work on graph theory at the NCWUM conference; presented a poster at the MN Capitol; presented at Pi Mu Epsilon; and has been invited to give a talk at UMN-Duluth.
2. Three MapCores students participated in a presentation entitled "What can physics students do over the summer", sharing their summer research projects.
3. All students who participated in the CSB/SJU summer research program presented their findings at the end of the summer conference.
4. Every sophomore and junior MapCores student presented a poster at Scholarship and Creativity Day April 2014 (see Appendix B for complete listing of presentations).

Independent Research Projects

1. Amanda Luby presented her honors thesis entitled "Modeling Tolerance in Dynamic Social Networks"
2. Pa Woua Vang presented her honors thesis entitled "Exploring Alternative Clustering for PIY Source Code Detection"
3. Alex Brancale presented her honors thesis entitled "Measuring Ultrashort Laser Pulses using Frequency-Resolved Optical Gating in Conjunction with Genetic and Interative Algorithms"

5. Kate Talbot presented her honors thesis entitled "Using Electromyography to Move an Arduino Powered Arm"

6. Robyn Hall presented her honors thesis entitled “Investigation of Oxalate Decarboxylase by Electron Paramagnetic Resonance”
7. Kelsey Weiers presented her research project entitled “Computer Models and the Climate Change Controversy”
8. Alyssa Anderson presented her research project entitled “Achieving Reproducibility in Parallel Floating Point Dot Products”
9. Emily Furst & Melania Meyer presented their research project entitled “Scalable Parallel Sparse Matrix Computations for Manycore Architectures:Achieving Numerical Reproducibility in the Parallelized Floating Point Dot Product”

The active participation of MapCores students in STEM research is strong evidence that the women are contributing and valued members of the scientific community.

III. Objective: Strengthen women’s academic confidence and interest in the targeted disciplines.

A. Increased scores on measures of STEM self-efficacy, social support, self-esteem, math and science self-concept, incremental theories of intelligence, and intrinsic goals

Survey Information

The survey (see attached pdf file of the survey) was distributed via an online survey in at the end of the fall semester to ensure that students had enough experience with college life to accurately respond to the questions. Mathematics students were targeted because the STEM disciplines all require mathematics courses in the major. Specifically, students taking mathematics courses designed for first year mathematics majors (Calculus II) were contacted via e-mail by Dr. Kris Nairn. Dr. Nairn asked students to complete an online survey that took between 15-20 minutes to complete. Upon completion of the survey, students could submit their name and e-mail address to be entered into a drawing for one of 5 $5 bookstore gift cards. Dr. Bacon secured IRB approval for this survey so that results can be submitted for publication in peer reviewed journals.

Comparisons

Because we are assessing the first year MapCores students’ attitudes and beliefs, it makes the most sense to compare their responses to the responses of other first year students who also are planning to major in a STEM discipline. Thus, the comparison group included in this assessment was limited to first year students who indicated that they either were listed as a STEM major according to the Registrar’s Office or they were definitely majoring in one of the targeted STEM disciplines. Unfortunately, a very small number of non-MapCores female STEM major students completed the survey (see Table 7). Because of the small sample size, null hypothesis significance testing comparing the MapCores and non-MapCores first year women would be inappropriate because it would be heavily influenced by the small sample size and unequal group sizes. To mitigate the impact of small sample size, we have decided to focus on effect size rather than null hypothesis significance testing.

Table 7

Number of First Year Students Who Completed the Survey by Gender and Program

MapCores Students	Non-MapCores Female Students	Non-MapCores Male Students
13	2	9

Effect size is a measure of the magnitude of the difference between two groups; the larger the effect size, the greater the difference. Effect sizes are commonly computed when researchers compare the results of multiple studies in a meta-analysis. One of the strengths of estimating effect size is that it is not influenced by sample size. Another strength is that it allows researchers to talk about the strength of the effect. Cohen determined that a small effect size has a *d* of .2, a medium effect size has a *d* of .5, and a large effect size has a *d* of .8. Any *d* value between 0 to .2 demonstrates the lack of difference between the two comparison groups. The larger the effect size, the smaller the sample size needed to find a statistically significant difference between the groups. Thus, if researchers rely on null hypothesis significance testing and fail to gather a large enough sample, they may incorrectly conclude that there is not a significant difference between the groups despite the small or medium effect size. To provide the most information, all comparisons were made between female MapCores and non-MapCores first year students and also between MapCores students and all non-MapCores first year students.

Students completed surveys designed to measure the following constructs: STEM self-efficacy, Self-Concept (Math, Natural Science, and Academic), Self-Theories of Intelligence, Learning Goals, Mentoring, Social Support, Loneliness, and Self-Esteem. Reliability analyses suggest that the measures all had adequate reliability (coefficient alpha around or above .80; see Table 8). Additionally, students were asked to indicate how frequently they thought about dropping their STEM major, and their degree of confidence that the choice to attend CSB/SJU was a good one. Students also reported their ACT composite score and estimated spring 2014 mathematics grade.

Table 8

Reliability of Measures

Scale	Coefficient Alpha
STEM Self-Efficacy	.89
Math Self-Concept	.87
Natural Science Self-Concept	.89
Academic Self-Concept	.83
Self-Theories of Intelligence	.87
Learning Goals	.87
Mentoring	.83
Social Support	.94
Loneliness	.94
Self-Esteem	.88

Measures

Well-established, published measures were used whenever available. We created the Natural Science Self-Concept scale by rewording the Mathematics Self-Concept items to focus on natural science rather than mathematics. Based on Cross and Vick (2001), the STEM Self-Efficacy scale was created by the researcher by having students estimate their confidence that they could receive a grade of C or higher in specific STEM courses that are considered difficult in the major (Discrete Computational Structures, Linear Algebra, Foundations and Structures of Mathematics, and Modern Physics) and their confidence that they could successfully complete a major and a minor in computer science, mathematics, numerical computation, physics, and pre-engineering on a 7-point Likert-type scale ranging from 1 (*not very confident at all*) to 7 (*very confident*). Based on the high internal consistency of the items, the responses to the 13 items were summed together to create a total score.

Results

The results comparing the 13 MapCores students to the 11 non-MapCores first year students (2 women and 9 men) majoring in STEM disciplines will be discussed (see Table 9 for means and effect size information). Given that there were only two non-MapCores first year women who completed the survey, it is impossible to make valid comparisons between the two groups of first year women.

Mathematics and Science Self-Efficacy. The MapCores students reported lower confidence in their ability to take challenging STEM courses and major and minor in STEM disciplines than the non-MapCores students. The difference between the groups is moderate. Higher self-efficacy scores are typically associated with higher performance and persistence.

Interest/Identification with Mathematics and the Natural Sciences. The self-concept items asked students to talk about how much they like math, the natural sciences, and academics in general and what their performance is typically like in those areas. The MapCores students had higher academic and mathematics self-concepts than the non-MapCores students, suggesting that MapCores students have strong interest and identification with math and academics in general. There was not a difference in natural science self-concept means.

Self-Theories of Intelligence. People have different beliefs about the nature of intelligence. People who hold an entity self-theory (Dweck, 2000) believe that intelligence is fixed and that people are either smart or they're not. People who hold an incremental self-theory believe that intelligence can be changed through effort. Students who hold entity self-theories tend to avoid challenging tasks and stick with what is safe and easy because they believe that if they fail at a task it is a sign that they are not smart and if they succeed at a task (however easy), they are smart. Students who hold incremental self-theories tend to seek out challenges and are not satisfied to continue working at tasks they know they can easily complete. When entity theorists encounter a setback, they tend to disengage and give up, whereas incremental theorists redouble their efforts and seek out help to improve their performance. People's self-theories are influenced by the feedback they receive from parents and teachers. Teachers who praise students' intelligence (e.g., saying "you're a natural! Or

You got a perfect score; look at how smart you are!") can cause students to develop an entity self-theory. Teachers who praise students for working hard and seeking out challenges can lead to students developing an incremental self-theory. The MapCores FYS team has read research on self-theories and has attempted to avoid feedback that would promote an entity self-theory among students. The results from the survey suggest that the MapCores students were no more likely to hold incremental self-theories than the non-MapCores students.

Learning Goals. Students have a variety of goals when they take classes, including getting high grades, outperforming their peers, and demonstrating their abilities. One goal that is linked to better academic outcomes (and to incremental self-theories) is learning goals. When students hold learning goals, they value being challenged and learning new skills (intrinsic motivation) rather than receiving external rewards such as grades or status. The MapCores students scored higher on the learning goals measure than the non-MapCores students. A focus on learning goals among the MapCores students suggests that they will benefit from the extra educational opportunities that they will encounter during their sophomore problem solving class and that they will be more likely to take academic risks that may be difficult but ultimately rewarding.

Mentoring. Past research suggests that providing women in STEM disciplines with strong mentoring can increase women's persistence. Unlike in past years, this year the MapCores students reported similar levels of mentoring as the non-MapCores students.

Social Support, Loneliness, and Self-Esteem. Past research suggests that women who feel isolated and who lack support are more likely to leave STEM disciplines than women who feel strong social support and a sense of community in their chosen discipline. Additionally, having high self-esteem has been associated with positive academic outcomes. The MapCores women reported higher levels of perceived social support than the non-MapCores students, although this difference was small. The MapCores women reported less loneliness than the non-MapCores students. The current year's feelings of support and lower levels of loneliness suggest that the cohort model may help students feel supported an thus will be more likely to persist in the STEM disciplines.

Leaving. Past research suggests that students who are likely to leave STEM disciplines are likely to think about dropping the major much more than students who ultimately stay in the major. Students who leave STEM disciplines are also less committed to the institution than those who say in the STEM disciplines. There were no differences between the groups regarding thinking about dropping the STEM major or degree of confidence that attending CSB/SJU was a good choice.

ACT Composite Scores. There is some evidence that the MapCores students entered CSB/SJU with slightly higher academic aptitude than the non-MapCores students based on their self-reported ACT composite scores. This year, however, the non-MapCores students had slightly higher ACT scores. This small difference may be due in part to one MapCores outlier ACT score, which was substantially lower than the rest of the scores (the student learned English as a second language, which may have reduced the validity of her ACT score).

Academic Performance. The MapCores students reported higher midterm grades than the non-MapCores students in their calculus II course, which suggests that the MapCores students are thriving in this important course.

Conclusion

The results of the survey suggest that the students in the MapCores program have strong academic confidence and feel that they are being supported.

Table 9

First Year Students Mean Scores and Effect Sizes by Program (Includes Men in Non-MapCores Group)

Measure	MapCores Students (*N* = 13)	Non-MapCores Students (*N* = 11; 2 women, 9 men)	Effect Size (*d*)
STEM Self-Efficacy	*M* = 66.77 *SD* = 15.33	*M* = 75.73 *SD* = 12.03	*d* = -0.67 (medium difference)
Math Self-Concept	*M* = 71.85 *SD* = 9.71	*M* = 60.45 *SD* = 13.43	*d* = 1.03 (large difference)
Natural Science Self-Concept	*M* = 59.83 *SD* = 16.99	*M* = 60.80 *SD* = 11.45	*d* = -0.07 (no difference)
Academic Self-Concept	*M* = 69.83 *SD* = 10.22	*M* = 63.10 *SD* = 10.38	*d* = 0.68 (medium difference)
Self-Theories of Intelligence (lower score = incremental)	*M* = 2.26 *SD* = 1.15	*M* = 2.24 *SD* = 1.03	*d* = 0.01 (no difference)
Learning Goals	*M* = 5.67 *SD* = 0.70	*M* = 5.29 *SD* = 0.92	*d* = 0.49 (medium difference)
Mentoring	*M* = 9.38 *SD* = 3.64	*M* = 9.18 *SD* = 3.66	*d* = 0.06 (no difference)
Social Support	*M* =79.77 *SD* = 11.54	*M* = 76.8 *SD* = 7.33	*d* = 0.31 (small difference)
Loneliness	*M* = 33.62 *SD* = 11.54	*M* = 38.8 *SD* = 10.76	*d* = -0.48 (medium difference)
Self-Esteem	*M* = 54.15 *SD* = 8.22	*M* = 55.55 *SD* = 11.56	*d* = -0.15 (no difference)
Thinking about Dropping STEM Major (higher = more thoughts of dropping)	*M* = 2.30 *SD* = 0.82	*M* = 2.18 *SD* = 1.25	*d* = 0.11 (no difference)
Degree of confidence that choice to attend CSB/SJU was a good one	*M* = 3.31 *SD* = 0.75	*M* = 3.36 *SD* = 0.92	*d* =- 0.07 (no difference)
ACT Composite Score	*M* = 26.67 *SD* = 4.23	*M* = 27.86 *SD* = 4.49	*d* = -0.28 (small difference)
Fall 2012 Mathematics Midterm Grade Estimate (1 = A and 8 = F)	*M* = 2.55 (AB) *SD* = 1.21	*M* = 2.91 (B) *SD* = 1.70	*d* = .26 (small difference)

Appendix A

1. Summary of Completed Research Experiences, summer 2013
    a. Seven REU's in physics or engineering
    b. Two REU's in mathematics
    c. Three working with Mike Heroux in parallel computing and large systems of linear equations
    d. CSB/SJU Summer Research Fellows: one in mathematics, one in computer science, and one in chemistry
    e. Internships: bioengineering, Price Waterhouse Coopers, accounting, Federated Insurance

2. Summary of Anticipated Research Experiences, summer 2014
    a. Three REU's in physics or engineering
    b. One working with Mike Heroux in parallel computing and large systems of linear equations
    c. CSB/SJU Summer Research Fellows: two in mathematics, two in computer science, and one in physics
    d. Internships: Research and Regulatory Affairs Intern at the Air Conditioning, Heating and Refrigeration Institute (AHRI); Statistical analysis for CSB/SJU Institutional Research.

Appendix B

MapCores students who presented at Celebrating Scholarship and Creativity Day, April 24, 2014

Follow The White Brick Road	Sydney L Hughes
A Distributed Multi-Agent Vacuum World	Emily A Furst & Hamrawit G Tebeka
Euler Problems	Esther M Banaian
Mass Extinction by Comet	Jordan Marshall
Mass Extinction by Asteroid	Amanda R Jendro
Gamma-Ray Burst Triangulation	Sarah J Lindenfelser
Double Pendulum	Stephanie K Bierman
Properties of Exoplanets	Kaela H Kopp
Graph Theory: Colored-Independence & Bridges	Sarah K Lange
Lego Robots	Charlotte R Waterhouse
Nim on Graphs	Sophia M Korman & Elizabeth M Hansen
Kapitza's Pendulum	Kathryn R Jacobson & Kelsey M Rollag
Supervolcanos	Cathleen M Gross
Gamma-Ray Bursts	Alida W Hovey
Large Scale Destruction by Tsunamis	Ariel F Lusty
Water Rocket	Erynn Schroeder