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MapCores 2012-2013 Assessment Report

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MapCores 2012-2013 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 2012 and spring 2013 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 both physics courses, a much greater number of MapCores women completed the courses than non-MapCores women. These results suggest that by spring semester the MapCores women were more similar to male first years than the non-MapCores female first years in terms of the frequency with which they took math and physics courses foundational to STEM majors.

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 2012			
F12 Math 119	9	9	58
Calculus I			
F12 Math 120	5	12	15
Calculus II			
F12 Physics 191	10	3	27
Foundations of Physics I			
F12 CSCI 150	2	2	18
Introduction:			

Science/Computing

Spring 2013

S12 Math 120	8	2	16
Calculus II			
S12 Physics 200	7	1	8
Foundations of Physics II			

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.

Table 2

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

	MapCores Women	Control Women	Control Men
	Number withdrew (% of subgroup who withdrew)	Number withdrew (% of subgroup who withdrew)	Number withdrew (% of subgroup who withdrew)
Fall 2012			
Mathematics 119	0 (0%)	2 (18%)	5 (8%)
Calculus I			
Mathematics 120	0 (0%)	0 (0%)	1 (6%)

Calculus II			
Physics 191	1 (9%)	0 (0%)	1 (4%)
Foundations of Physics I			
F12 CSCI 150	0 (0%)	0 (0%)	7 (28%)
Introduction: Science/Computing			
Spring 2013			
Mathematics 120	0 (0%)	2 (50%)	4 (20%)
Calculus II			
Physics 200	0 (0%)	1 (0%)	6 (0%)
Foundations of Physics II			

C. Graduation Rate

Now that the first cohort of MapCores women are graduating, we are able to examine the impact of the MapCores program on graduation rates. The results suggest that a greater percentage of math, physics, and computer science graduates are women in 2013 as compared to 2008 (before the program was implemented).

Table 3

The percentage of mathematics, physics, and computer science majors who are women from 2008 (pre-MapCores) to 2013 (four MapCores cohorts)

Department	2008 (total number of women in parentheses)	2013 (total number of women in parentheses)
Mathematics	37% (66)	42% (74)
Physics	15% (13)	30% (20)
Computer Science	5% (4)	17% (16)

The percentage of women majoring in mathematics, physics, and computer science now that the MapCores program is in place has increased from the baseline (see Table 4). The analysis of the

percentage of female majors across time demonstrates an upward trend, particularly for mathematics and physics.

Table 4

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 failed to reveal a difference between the groups, $\chi^2(2, N = 39) = 4.51, p = .11$, although given that one cell contained fewer than 5 responses, the chi-square results may not be accurate. As can be seen in Table 5, the pattern of results suggests that MapCores students were more likely to indicate that they plan to pursue a Ph.D./M.D./J.D. than the non-MapCores first year students. This is important to note because the non-MapCores comparison group was made up of 19 men and 5 women, suggesting that the MapCores women have higher educational goals than their predominantly male peers. Additionally, the results suggest that over 60% of the MapCores women who completed the survey plan to attend graduate school.

Table 5

First Year Students' Highest Degree Expectations by Program

Highest Expected Degree	MapCores Students	Control Students
	<i>N</i> (%)	<i>N</i> (%)
BA	5 (33%)	8 (33%)
MS	6 (40%)	15 (63%)
Ph.D./M.D./J.D.	4 (27%)	1(4%)

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 2012 (part 1) and the research experiences they are pursuing 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. Whitney Radil presented her Fairfield research at the Pi Mu Epsilon (PME) conference at St. Norbert in 2011, and at NCUWM in January 2012. She presented her San Diego research at Mathfest (Madison) fall 2012, and at St Norbert PME in fall 2012.
2. Marie Meyer presented her summer 2012 research at Mathfest (Madison) fall 2012, and at St Norbert PME in fall 2012 where she won a speaking award.
3. Amanda Luby presented her biostatistics research at St Norbert PME in fall 2012.
4. Every sophomore and junior MapCores student presented a poster at Scholarship and Creativity Day April 2013 (see Appendix B for complete listing of presentations).

Honors Theses

1. Allison Reinsvold presented her honors thesis entitled "Roll and Pitch Corrections for a Shipboard Anemometer"
2. Becca Simon presented her honors thesis entitled "A Spectral Alternative to K-means Clustering for Graph Data"
3. Laura Nierengarten presented her honors thesis entitled "Path-Finding Algorithms for Robots"
4. Michelle Hromatka presented her honors thesis entitled "A fuzz logic approach to collision avoidance in smart UAVs"
5. Whitney Radil presented her honors thesis entitled "The Growth in Normal Subgroups under Direct Products"
6. Marie Meyer presented her honors thesis entitled "Nim on Groups"
7. Jessica Solfest presented her honors thesis entitled "With One Breath - Analysis of Cardiorespiratory synchrony"

8. Katelin Weiers presented her honors thesis entitled “Applying Probability Theory to Alphabetical Ordering”

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 I, Calculus II, and Linear Algebra) 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 10 \$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 6). 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 6

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

MapCores	Non-MapCores	Non-MapCores
Students	Female Students	Male Students

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 7). 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, fall 2012 mathematics grade and estimated fall 2012 mathematics grade.

Table 7

Reliability of Measures

Scale	Coefficient Alpha
STEM Self-Efficacy	.96
Self-Concept	
Math	.92
Natural Science	.90
Academic	.76
Self-Theories of Intelligence	.90
Self-Theories of Math and Science	.96
Learning Goals	.94
Mentoring	.82
Social Support	.93
Loneliness	.92
Self-Esteem	.84

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 15 MapCores students to the 24 non-MapCores first year students (5 women and 19 men) majoring in STEM disciplines will be discussed (see Table 6 for means and effect size information). Given that there were only five non-MapCores first year women who completed the survey, it is impossible to make valid comparisons between the two groups of first year women. See Table 8 for specific means and effect sizes.

Mathematics and Science Self-Efficacy. The MapCores students reported higher 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 small. 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 self-concepts than the non-MapCores students, suggesting that MapCores students have strong interest and identification with academics in general. MapCores students had lower natural science self-concepts than the non-MapCores students. There was not a difference in math self-concept means. Both groups had higher mathematics self-concept scores than natural science self-concept scores.

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 the same on the learning goals measure as the non-MapCores students. Both groups of students tended to endorse learning goals. 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. The MapCores students reported higher levels of mentoring than the non-MapCores students, which suggests that the program is providing students with strong mentoring. Although not directly tested, it is likely that having the three faculty members attend

every FYS class has led to the MapCores students perceiving that they have multiple mentors and advocates on campus.

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. Surprisingly, the MapCores students had higher average loneliness scores than the non-MapCores students and lower self-esteem than the non-MapCores students. These findings are contrary to past years, which typically find that the MapCores students are less loneliness and higher self-esteem than the non-MapCores students. The current year's feelings of support suggest that the cohort model may help students 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 stay in the STEM disciplines. Compared to the MapCores students, non-MapCores students were more likely to report thoughts of dropping their STEM major. Non-MapCores students reported greater confidence than the MapCores students that their choice to attend CSB/SJU was a good one, however both groups were fairly confident. Taken together, these findings suggest that the MapCores students appear to be at lower risk than the non-MapCores students for disengaging from the targeted disciplines.

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 difference, however, is small (amounting to a 1.5 point average difference).

Academic Performance. One potential risk of having positive beliefs about one's abilities arises when these beliefs are out of touch with reality. When students are unable to accurately appraise their abilities, they may not adequately prepare for classes, believing that they understand things they do not really understand. This phenomenon of being "incompetent and unaware" can lead to a host of negative outcomes. The MapCores students have higher estimated math grades than the non-MapCores students. This suggests that it is not simply that the MapCores students believe they are strong students; their college performance suggests that their high self-efficacy is justified.

Conclusion

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

Table 8

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

Measure	MapCores Students (<i>N</i> = 15)	Non-MapCores Students (<i>N</i> = 24; 5 women, 19 men)	Effect Size (<i>d</i>)
STEM Self-Efficacy	<i>M</i> = 73.57 <i>SD</i> = 16.27	<i>M</i> = 66.48 <i>SD</i> = 16.45	<i>d</i> = 0.43 (small difference)
Math Self-Concept	<i>M</i> = 73.67 <i>SD</i> = 10.96	<i>M</i> = 74.29 <i>SD</i> = 12.55	<i>d</i> = -0.05 (no difference)
Natural Science Self-Concept	<i>M</i> = 58.5 <i>SD</i> = 14.69	<i>M</i> = 62.34 <i>SD</i> = 12.61	<i>d</i> = -0.28 (small difference)
Academic Self-Concept	<i>M</i> = 73.5 <i>SD</i> = 10.65	<i>M</i> = 71.77 <i>SD</i> = 7.78	<i>d</i> = 0.19 (small difference)
Self-Theories of Intelligence (lower score = incremental)	<i>M</i> = 2.49 <i>SD</i> = 1.40	<i>M</i> = 2.50 <i>SD</i> = 1.09	<i>d</i> = 0.00 (no difference)
Learning Goals	<i>M</i> = 5.73 <i>SD</i> = 0.77	<i>M</i> = 5.61 <i>SD</i> = 0.88	<i>d</i> = 0.15 (no difference)
Mentoring	<i>M</i> = 11.2 <i>SD</i> = 3.61	<i>M</i> = 9.96 <i>SD</i> = 3.48	<i>d</i> = 0.35 (small difference)
Social Support	<i>M</i> = 86.69 <i>SD</i> = 9.00	<i>M</i> = 83.91 <i>SD</i> = 7.25	<i>d</i> = 0.35 (small difference)
Loneliness	<i>M</i> = 33.93 <i>SD</i> = 11.24	<i>M</i> = 31.43 <i>SD</i> = 7.18	<i>d</i> = -0.26 (small difference)
Self-Esteem	<i>M</i> = 54.93 <i>SD</i> = 9.64	<i>M</i> = 59.65 <i>SD</i> = 8.14	<i>d</i> = -0.54 (medium difference)

Thinking about Dropping STEM Major (higher = more thoughts of dropping)	$M = 2.00$ $SD = 0.85$	$M = 2.58$ $SD = 1.32$	$d = -0.5$ (medium difference)
Degree of confidence that choice to attend CSB/SJU was a good one	$M = 3.07$ $SD = 0.96$	$M = 3.58$ $SD = 0.50$	$d = -0.66$ (medium difference)
ACT Composite Score	$M = 27.86$ $SD = 3.29$	$M = 26.30$ $SD = 3.62$	$d = 0.44$ (small difference)
Fall 2012 Mathematics Midterm Grade Estimate (1 = A and 8 = F)	$M = 1.8$ (AB) $SD = 0.94$	$M = 4.13$ (BC) $SD = 1.46$	$d = 1.14$ (large difference)

Appendix A

1. Summary of Completed Research Experiences, summer 2012
 - a. REU at Auburn University studying unmanned aerial vehicles
 - b. REU at Fairfield University studying one-dimensional combinatorial dynamics
 - c. REU at The Ohio State University studying mathematics and biology
 - d. REU at San Diego State studying number theory
 - e. REU at the University of Maryland studying bioengineering
 - f. Aeronautics Academy at NASA Ames Research Center. The Aeronautics Academy is a premier internship in aeronautics because it seeks to develop future leaders in the field. As part of this program students travel to Washington D.C. and present their research at NASA Headquarters.
 - g. CSB/SJU Summer Research Fellows in the following disciplines: one in computer science, one in physics, two in mathematics, and one in chemistry.
 - h. Summer Institute in Biostatistics (IA) studying salmonella poisoning using Bayesian statistics
 - i. Programmer at an R&D computer science company in the Twin Cities
 - j. Internship in actuarial science at Thrivent Insurance
 - k. Internship at West Publishing
 - l. Summer leadership program with PwC, E&Y, Deloitte

2. Summary of Anticipated Research Experiences, summer 2013
 - a. Seven REU's in physics or engineering
 - b. Two REU's in mathematics
 - c. One REU at Carleton College for women in mathematics
 - d. One pre-REU at Texas A&M in mathematics
 - e. Three working with Mike Heroux in parallel computing and large systems of linear equations

- f. CSB/SJU Summer Research Fellows: one in mathematics, one in computer science, and one in chemistry
- g. Internships: bioengineering, Price Waterhouse Coopers, accounting, Federated Insurance

Appendix B

MapCores students who presented at Celebrating Scholarship and Creativity Day: April 24, 2013

<i>Peter Engel</i> <i>Science Center,</i> <i>SJU</i> PEngl PENGL 212 8:00 - 8:40 AM	Mass Extinction by Gamma Ray Burst Erynn J Schroeder <i>Astronomy, MapCores, Mathematics, Physics</i> - Gamma-Ray Bursts are astronomical events, such as a dense star collapsing in on itself, that emit high-energy light waves. These waves can damage the Earth's ozone layer and cause mass extinction if pointed toward the Earth. The probability of this occurring is low, though these bursts can be seen throughout the galaxy every day. GRB's can lead to an ice age because of the depletion of the Earth's ozone layer. In this project, we calculated the probability of GRB's causing mass extinction on the Earth. This probability depends on the distance to the GRB and the direction they point. The dangerous rays only come out a small cone-shaped beam from each side of the star. We found that events that could be dangerous occur approximately once every 170 million years.
<i>Peter Engel</i> <i>Science Center,</i> <i>SJU</i> PEngl PENGL 212 8:00 - 8:40 AM	Arduino Piano Kathleen K Talbot <i>Computer Science, Physics</i> - Arduino microprocessors are used for open-source electronics prototyping. The Arduino board can receive inputs from a variety of sensors, such as touch, buttons, and sound, as well as output to its surrounding environment using lights, motors, or even a speaker. For our project we built an Arduino piano. It receives touch input from a user (in the form of a piano), and in return, outputs the note corresponding to the key. Our project is based on examples of programs for touch sensors and sound outputs.
<i>Quadrangle,</i> <i>SJU</i> Quad Alumni Lounge 8:00 - 8:50 AM <i>Peter Engel</i> <i>Science Center,</i> <i>SJU</i> PEngl 212 9:00 - 10:00 AM	Gauss-Legendre Quadrature Amanda S Luby <i>Computer Science</i> - Gauss-Legendre quadrature is a very accurate form of numerical integration which uses a system of points and weights to estimate integrals of functions without singularities. For this project, we created a program that performed Gauss-Legendre quadrature using known Legendre polynomial weights and zeros to estimate the integral of any non-singular function over any interval. We then attempted to recreate the Gauss-Legendre procedure using a simple weight function (x^2). Although we were unable to find the weights of these polynomials past the 3rd degree (and so were unable to test our process) we were able to find the polynomials and their zeros, up to the fourth degree.
<i>Peter Engel</i>	Double Pendulum

Science Center,
SJU
PEngl PENGL
212
8:00 - 8:40 AM

Emily A Furst
Computer Science, MapCores, Mathematics, Physics
- A poster examining the chaos in a double pendulum using both physical observations and mathematical modeling. With a physical double pendulum, we filmed and observed the behavior of the pendulum with different large initial angles. Then, using given equations, we modeled the behavior of a double pendulum using Mathematica. Using these equations and Mathematica, we were able to plot behavior for large and small initial angles. We examined these plots to find any normal behaviors that might be present. Then, we looked at our videos of the physical pendulum to determine how similar the mathematical model was to the physical pendulum. From these observations, we were able to determine that the behavior of a double pendulum is predominately chaotic. Finally, using the physical double pendulum, we experimented with large initial velocity as opposed to no initial velocity as in my other tests. From this, we concluded that large initial velocities also produced highly chaotic behavior.

Peter Engel
Science Center,
SJU
PEngl PENGL
212
8:00 - 8:40 AM

Double Pendulum Behavior
Kelsey M Rollag
Computer Science, MapCores, Mathematics, Physics
- This project examines the behavior of a double pendulum. We conducted the project using a variety of initial conditions for the pendulum. The resultant behavior depended on the different initial angles of each piece of the double pendulum. We observed this behavior physically and then compared the motion and angular velocities of the pendulum to mathematical models. Using modelling equations in a mathematical software We could graphically display the motion of the double pendulum. This represented the expected behavior. Final analysis compared the observed behavior to the theoretical expectations. We found that the mathematical model agreed with the physical observations. Thus although the motion of a double pendulum is very chaotic it can be accurately predicted using proper mathematical models.

Peter Engel
Science Center,
SJU
PEngl PENGL
212
8:00 - 8:40 AM

Mass Extinction - Comets
Kathryn R Jacobson
Astronomy, MapCores, Mathematics, Physics
- Comets are celestial objects consisting of a dense nucleus of ice and dust that release gas or dust tails as they travel near the sun. Comets travel orbits throughout space. The orbits that comets take sometimes end with them colliding with planets and their moons. If an impact is large enough, a collision between Earth and a comet could cause a mass extinction. Comets can differ in size from microscopic pebbles to enormous bodies measuring 1 million miles in diameter. In order for a comet to cause such a catastrophic event on Earth, the comet would need to be 6 km or larger in diameter. This project was designed to calculate the probability of a comet colliding with Earth,

causing mass extinction within the next 100 years.

Peter Engel
Science Center,
SJU
PEngl PENGL
212
8:00 - 8:40 AM

Probability of Mass Extinction by Asteroid

Kaela H Kopp

Computer Science, MapCores, Mathematics, Physics

- Asteroids are classified in groups by many variables including size, material, and distance from Earth. Near Earth Asteroids are asteroids that are within 10-14 million miles from the sun. Out of these, only asteroids with a diameter of at least 150 meters at a distance of 4.6 million miles from Earth are considered to be Potentially Hazardous Objects (PHO). In this project we examined the probability of mass destruction/global damage from an asteroid strike. With a current number of PHO and an estimated rate of global damaging asteroid strikes in the past, we calculated the probability of future mass extinctions from an asteroid. This probability could vary due to the possibility of asteroids being thrown out of an asteroid belt into a PHO orbit, as well as a previously calculated PHO being thrown out of its current orbit, eliminating its chance of striking Earth.

Peter Engel
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The Probability of Mass Extinction Caused by Supernovas

Sophia M Korman

Computer Science, MapCores, Mathematics, Physics

- Supernovas are stellar explosions that have the capability to wipe out a species by the significant amount of radiation they emit. They can irradiate life directly and also have devastating effects on the atmosphere, such as burning off the ozone layer. Although it is an unconventional theory, supernovas have been proposed as a cause of mass extinctions in Earth's history. In order to determine the likelihood of such a catastrophic event, my partner and I calculated how close an event of a given size would have to be to cause mass extinction. Our analysis involved determining the probabilities of several conditions ranging from the size of various stars to the lifespan of each type to their distance from Earth. We discovered that there is very little to no possibility that a supernova will cause mass extinction during any given year.

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Gamma-Ray Burst Detection

Elizabeth M Hansen

Computer Science, MapCores, Mathematics, Physics

- Gamma-ray bursts, most commonly caused by supernovas or merging neutron stars, are brief periods of high-energy radiation that appear randomly in the sky. Known as the brightest electromagnetic events to occur in the universe, gamma-ray bursts can last anywhere from under a second to a few hours. Current gamma-ray burst detectors are able to detect the length of these gamma-ray bursts, but not where they occur. This project looks at one possible way of detecting the location of gamma-ray bursts by use of triangulation. By using spacecrafts that detect the start and end time of

gamma ray bursts, approximations are made of where the gamma-ray bursts occurred. Each pair of spacecrafts can create a circle in the sky where the gamma-ray burst potentially happened. By looking at the overlap of the circles and possible uncertainties, the area in which the gamma-ray burst occurred can be determined down to a single angle. We applied this method to sample data in order to determine approximate gamma-ray burst locations.

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Comparison of Solar and Wind Energy Availability Patterns to Energy Consumption Patterns

Jenna M Vogel

Computer Science, MapCores, Mathematics, Physics

- This project compares the availability of wind and solar energy to times of the year in which energy is most needed. We used national data on wind and solar energy production and consumption from the U.S. Energy Information Administration due to the limited availability of consistent local data. Through our research, we found that wind and solar energy availability had a largely inverse relationship to energy consumption. Wind generation peaked at times of the year when energy needs were lower and dropped at times of the year when energy consumption was at its highest. Solar energy generation demonstrated fluctuations of alignment with energy consumption throughout the year. While solar energy generation peaked in the summer months when energy consumption was high, solar energy generation was at its lowest during the winter months when energy consumption was also high.

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Gamma-Ray Bursts

Melania R Meyer

Computer Science, MapCores, Mathematics, Physics

- Gamma-Ray Bursts are explosions of high-energy light waves that come from stars that have run out of fuel and collapse. This causes energy to be shot out of the opposite poles of the star, resulting in the Gamma-Ray Bursts. During this project, we showed how detectors are used to determine the location of the Gamma-Ray Burst. This location is found by using the time the Gamma-Ray Burst arrives at different spacecraft. Since the Gamma-Ray Burst signal arrives at different times at these locations, we are able to use triangulation form a circle in the sky of possible directions the Gamma-Ray Burst could have originated. In our calculations, we used angles in the sky and the distance from the center of the earth to find the circle in the sky. When given three spherical coordinates, we were able to find where our circles on the sky intersected and therefore we had a good estimation of where the Gamma-Ray Burst had originated.

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Eco-Simulation

Clare M Johnston

Computer Science, MapCores, Mathematics, Physics

- Population dynamics can be modeled using mathematical equations, and then these results can be displayed graphically. Using the computer-programming interface Python, we created a program based on these population dynamics equations to model potential population cycles of cabbage, rabbits, and foxes. Within the simplified ecosystem, foxes eat rabbits, and rabbits eat cabbage. Given the inputs of initial populations, birthrates, and death rates, we attempted to model different possible scenarios that could be found in a natural environment by varying the initial numbers. We explored boom and bust cycles, equilibrium situations, and also tried to find other interesting results.

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Super Volcanoes

Alyssa M Whitesell

Computer Science, MapCores, Mathematics, Physics

- There exists many possibilities for the end of the human race as we know it. One of these possibilities is the ever present threat of a super volcano. Only seven are known to exist in the world, but their potential danger is much greater. This project calculated the possibility of mass extinction due to a super volcano. It looks at the ever growing chance of a super volcanic explosion, and also that if Yellowstone was to erupt how much of the United States would be affected. The result is the calculated probability that an eruption will occur during the next calendar year. The probability we came up with was extremely close to the probability that the rest of the world came up with. The probability was quite small approximately 0.00014% for Yellowstone, the main super volcano we looked at.

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Lego Robots

Hamrawit G Tebeka

Computer Science, MapCores, Mathematics, Physics

- Our project was on how to manipulate Lego robots and make them follow a specific path using various features of the robot such as the light-sensor. The type of paths varied from simple shapes like squares and triangles to more complicated zig-zag paths. The software that allowed me to do this is installed on the robots. By connecting a robot to a computer with the software, we were able to change ways in which the robot can perform the given task. When to travel straight, for how long, when to turn right or left, to what extent it should make the turn (in degrees, revolutions, seconds, etc.) and specification of the intensity of light that the robot should respond to are more specific examples of what I had to work on. Since it is difficult to know the exact numbers right away, we used a trial and error method to observe

where my robot wasn't doing what we wanted it to do. We faced technical problems with our robot due to weak batteries but I was able to replace it with another robot and continue with the project. After plugging in different numbers and observing my robot we were able to make it follow the paths that it was supposed to follow.

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Tsunami Mass Extinction

Sarah K Lange
Computer Science, MapCores, Mathematics, Physics

- Many different causes have been proposed in what sources mass extinction events. Tsunamis as result of earthquakes are among these. Tsunamis are a series of waves caused by the displacement of a large body of water. In this project, we calculated the probability that earthquake generated tsunamis would cause mass extinction. Our calculations were based on a power-law relationship in which the magnitude increases as the intensity of the stimulus increases and the Poisson distribution in which the occurrence of an event is relative and constant with time. We found that as time, the number of occurrences each year, and the rate parameter increased, so did the probability of mass extinction due to earthquake generated tsunamis.

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The Effect of Weather Conditions on the Efficiency of Photovoltaic Cells

Kathryn A Barclay
Computer Science, MapCores, Mathematics, Physics

- Siliken, the manufacturer of the solar panels we have in the St. John's Solar Farm, claims no more than a 3% efficiency decrease in the first year and a decrease of 0.7% in the next 25 years. Our project aimed to study the decrease in efficiency of the St. John's panels over the last three years. We examined how certain conditions such irradiance, temperature, and humidity affected the efficiency. We built a regression function to model how all three interact with efficiency. Our results showed a negligible change in efficiency from year to year, however, we were able to demonstrate that St. John's solar panels follow expected trends with temperature, irradiance, and humidity versus efficiency.

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PEngl 212
9:00 - 10:00 AM

Ecosystem Simulation

Lucy K Colosimo
Computer Science

- Computer modeling is a useful tool for solving problems that can be reduced to mathematical equations. In this project, we took a situation, translated it into equations and then modeled that equation using the computer coding program python. The situation we modeled was the relationship between three species in an ecosystem. The three species we chose were foxes, rabbits, and cabbage. The foxes eat rabbits, and the rabbits eat cabbage. Thus, the computer model must show that when there are more foxes, the rabbit population decreases which then in turn causes the cabbage

population to increase. We also incorporated birth rates into our computer program. Every day there is a set rate of foxes, rabbits and cabbages that die naturally, are born and the number of the lesser organism they must eat to survive. We attempted to find the right balance of numbers to get a model that was near equilibrium. That means each organism fluctuates in a sinusoidal wave, but does not get too big or die out.

Peter Engel
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9:00 - 10:00 AM

Color Constancy Simulation

Kelsey A Weiers
Computer Science

- Color constancy is defined as the ability of the brain to correctly assign a constant color to an object under various projections of light. For example, grass always looks green to the human eye whether it is dawn, dusk, or midday despite the changing tint of the projected light from the sun. In our project, we attempt to simulate the ability of the brain to distinguish color under various colors of light. We wrote and used a program in MATLAB that utilizes the process of averaging to determine the original color of the image. Our program takes in a colored image under three different light projections (blue, red, and yellow) and predicts what the same image looks like under white light conditions.

Peter Engel
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11:00 - 11:30
AM

Roll and Pitch Corrections for a Shipboard Anemometer

Allison C Reinsvold
MapCores, Physics

- Physics Thesis Presentation Abstract: An anemometer is an instrument which measures wind speed and direction. Ideally, an anemometer would measure solely the true wind, but in practice anemometers measure wind induced by the motion of the instrument in addition to the true wind. For anemometers mounted on ships, the pitch and roll of the ship is an important source of induced wind, but this effect has never been specifically investigated. In this project, I first explored the magnitude of the roll effect to determine whether or not it is worth correcting. Second, I investigated this effect for a particular anemometer: namely, a Flush Air Data System (FADS) anemometer designed by researchers at the Fluid Mechanics Lab at NASA Ames Research Center. The wind speeds measured while the anemometer was experiencing sinusoidal motion were analyzed to evaluate the robustness of the system. The experiment was insufficient to judge the FADS anemometer's performance, but the theoretical work demonstrated that the effect of pitch and roll is well worth examining further.
