STEM SMART Workshop
Las Vegas - Sept 19, 2012

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Engineering Pathway Partnership Program

- EP3 -

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Overview

- Science Foundation Arizona
- Arizona STEM Network
- NSF Grant – Engineering Pathways
- STEM Pathways Best Practices align with NRC Report, *Successful K-12 STEM Education*
- SFAz STEM Pathway at Cochise Community College

Science Foundation Arizona

- 2006 – Unique 501(c)3 public/private nonprofit organization to help achieve a strong economy, a good education system, and the availability of high-quality, high-paying jobs in Arizona.

- 2008 – SFAz launched its STEM Initiative with a commitment from Freeport-McMoRan Copper and Gold Foundation to focus on STEM.

- $16M has since been invested in STEM programs[1] – including $1M for STEM Pathways at Cochise College and $1.3M for three rural colleges to develop their engineering and applied technology pathways.

1 Source of funds: Arizona 21st Century Fund, Arizona State Board of Education, National Science Foundation, American Recovery and Reinvestment Act Stimulus Fund

Arizona Cities and Schools Impacted

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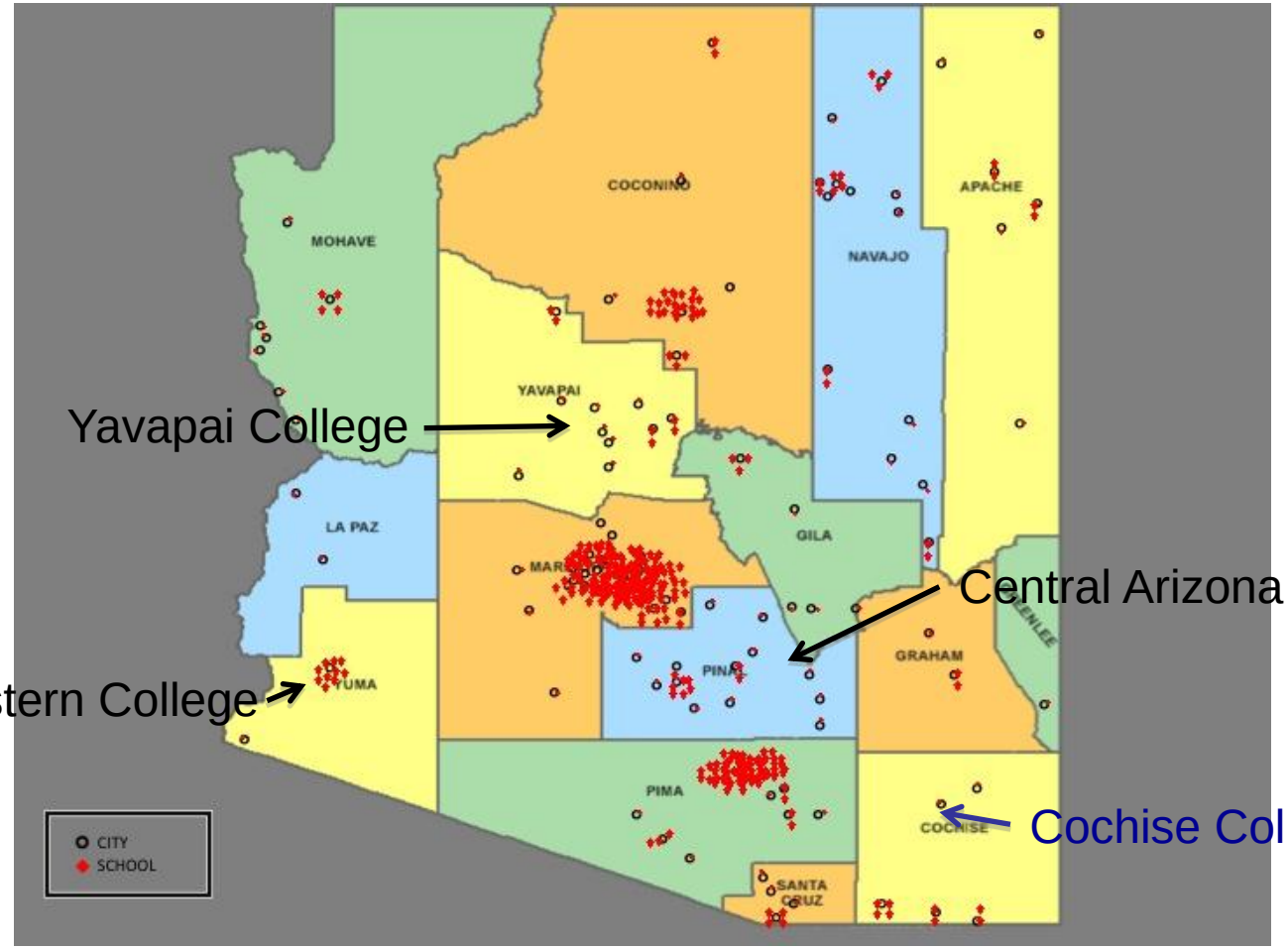

Yavapai College

Central Arizona College

Arizona Western College

Cochise College

SFAz STEM Programs have Impacted 314,000 students and 8,000 teachers

Arizona STEM Network

- 2010 – SFAz STEM was asked to lead and develop the *Arizona STEM Network*
- Support from Helios Education Foundation, Governor, and private business
- Purpose - unify, leverage, and align resources in STEM toward better student outcomes

STEM Network Plan - Due Diligence

Local engagement of over 1500 Arizonans and national authorities drawn from…

- SFAz Board, STEM Advisory Council
- Expert STEM work groups, Funding organizations
- National forum of state leaders in STEM
- Exemplary STEM education and business leaders, teachers, and schools
- 36 Town Hall meetings in 15 counties and Navajo Nation

STEM Network Plan – Strategic Concentrations

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- Strengthen Teacher Effectiveness
- Meaningful Business Engagement
- Integrate STEM into Schools and Districts
- Predictive Analysis and Measure Outcomes

Integrate STEM into schools and districts

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Sustainability

Integrating CTE + traditional academics

Culinary arts and nutrition

EcoTech
Metro Tech High School

Business management + entrepreneurship

Community + Civic Engagement

Integrate STEM at Metro-Tech High School

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Goals:

1) Integrate the use of instructional "best practices," 2) Increase achievement and interest in math and science knowledge, skills, and related careers, and 3) Implement models of sustainability on the campus and in the community.

Demographics: 95% Hispanic

Achievement Indicators at MetroTech High School:

99% attendance rate, 0.4% dropout rate, 82% graduation rate 99% with no major disciplinary violations, 40% increase in higher level math, 60% in higher level science, embedded ACT Quality Core Curriculum in math, science, English and social studies, added new courses in Agribusiness and Construction Technology this school year

STEM School Matrix

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Identified best practices from STEM Schools to create a guide to help schools and districts integrate STEM

STEM SCHOOL Immersion Matrix

ARIZONA STEM NETWORK
LED BY SCIENCE FOUNDATION ARIZONA

MCESA
Maricopa County Education Service Agency

Category	Exploratory	Introductory	Partial Immersion	Full Immersion
	The Exploratory Level describes a traditional school experience with STEM-related EXTRA CURRICULAR opportunities offered to students in addition to the regular school day. These experiences may include, but are not limited to; after school clubs, summer programs, science fairs, robotics clubs, video production clubs, etc.	The Introductory Level describes a traditional school day with STEM-related experiences offered in addition to the current curriculum. These experiences may include, but are not limited to; integrated STEM units delivered once the state testing is complete, supplementary stand-alone learning units offered through industry or non-profit partnerships, etc.	The Partial Immersion Level describes a non-traditional school experience where STEM-related opportunities are integrated into the curriculum. These experiences may include, but are not limited to; teaching to a school-wide STEM theme, teaching year-long integrated Problem/Project-Based Learning Units, teaching dual-enrollment programs, teaching in a "school within a school" model, etc.	The Full Immersion Level describes a non-traditional school where STEM-related experiences determine the curriculum. Full Immersion schools look more like 21st Century workplace environments rather 20th century K12 school environments. Problem-based Learning drives the curriculum and instruction. Students constantly collaborate to solve authentic problems, propose solutions, and contribute ideas to the larger community.

SFAz STEM Pathways

- 2008 - SFAz awarded $1M grant to Cochise College to develop their STEM Pathway
  - K-12 Outreach
  - Engineering Technology curriculum
- 2011 - NSF awarded SFAz $900K grant to expand the STEM Pathway at Cochise College
  - Industry engagement
  - Professional Learning Council
- 2011 – ARRA awarded SFAz $1.5M grant to deliver Engineering Pathway components at 3 rural colleges
- 2012 – NSF proposal to develop rural college network to expand Pathway model components to all 8 rural colleges

Why STEM Pathways?

- Current standard pathway to post-secondary degree = attending and graduating from a 4-yr college after high school.
  - Only 30% complete this pathway[1]
- Desired system = broaden the range of high-quality pathways leading to degrees and meaningful credentials.
  - Enhance industry involvement on front end to inform and support program of study/pathway components
  - Integrate college and career readiness by better linking CTE and traditional instruction – "rigor and relevance"
  - Strengthen student support – such as career guidance and counseling, meaningful intern and/or cooperative education experiences

1. Pathways to Prosperity Project, Harvard Graduate School of Education, February 2011

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SFAz STEM Pathway Model

ENGAGE EXCITE PREPARE ACQUIRE PERFORM

Outreach & Career Exploration

- Elementary, middle and/or early high school STEM-focused summer activities
- Middle and early high school experiences exposing large number of students to STEM careers

Foundational Knowledge & Skills

- Integration of STEM-focused real world learning applications into Standards based curriculum
- Teacher in-service/curriculum design activities focused on student acquisition of STEM-based knowledge and skills

Certificates/Degree Programs

- Alignment of early college (high school) coursework to higher education certificate or degree program
- Industry-based certification(s) into programs
- Meaningful industry internships into programs
- Articulation of community college courses to university programs

Leading to Employment in a STEM Field

PATHWAY PILLARS
Critical to model development and implementation

Rigor & Relevance: *STEM-focused project-based learning - CTE Programs of Study - Early College Options - Paid &/or Credentialed Industry Internships - Industry Certification(s)*

Assessment: *Standards-Based - Work Readiness - Industry-Based - College Readiness*

Support Strategies: *"Intentional" interaction with Parents/Students - Academic/Career Planning- Student to Student Mentoring - Professional to Student Mentoring -Professional Development*

Technology: *Integration throughout Pathway - Online Curriculum & Training- Virtual Industry Interactions including Internships.*

This project is funded in part by the U.S. Department of Education and the Governor's Office of Economic Recovery.

SFAz STEM Pathways – Best Practices

- Community College Pathways offer components found in all 4 kinds of STEM-focused schools: Selective, Inclusive, CTE and Comprehensive

- K-12 Outreach programs link community college-based STEM Pathways with SFAz's K-12 STEM School Pilot program

- Offers "Effective STEM Instruction" that capitalizes on students' early interest and experiences, identifies and builds on what they know, provides them with experiences to engage them in the practices of science and sustain their interest

- Our next step: Create a guide of key success factors to help rural Arizona colleges develop their STEM Pathways

Best Practices from NRC Report

- Individual components taken together "*open up a pathway*" for students into STEM fields
- Offering programs from local community colleges encourages *students' return to live and work in their hometown/state*
- Community college as thrust of the Pathway builds *community involvement, student engagement, instructional leadership.*

Best Practices from NRC Report/contd.

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- Specialized *half-day STEM programs* that operate within a larger school (community college campus): reinforce students who are interested in science prior to high school are significantly more likely to stay in the field (RSA)

- Create an environment where students come by choice and get a strong sense that *they "belong"* (RSA)

- Offer a number of supports for students who may not be well prepared for a rigorous STEM curriculum (Modular Math, "Mother Hen")

- College maintains same *high expectations* of high school students as they do of their college students (RSA)

Best Practices from NRC Report/contd.

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- Encourage students to *conduct research, participate in internships, work with mentors*
- Engineering technology courses at the community college offer *project-based and work-based learning*
- Teachers frequently make *connections* across the curriculum and know their students individually (PLC)
- Students earn high school credits that articulate with the community college and prepare students to obtain industry or academic credentials

Best Practices from NRC Report/contd.

- Community College-centered pathway offers the five organizational supports crucial to school improvement and student achievement:
  - Administrative leadership
  - Teachers work together
  - Parents as partners
  - Safe and instructional climate
  - Student-centered
- Community College's draw on expertise from industry
- Replicable

SFAz STEM Pathways at Cochise College

Stimulating Minds.

Inspiring Careers.

Engineering Pathways Program

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BUILDING THE FUTURE

SFAz STEM Pathway Model

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SFAz STEM Pathways at Cochise College

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COCHISE COLLEGE

Science, Technology, Engineering, and Mathematics (STEM)

Math/Science Experience

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- Goal – increase interest in and enthusiasm for STEM
- One-day spring event on Sierra Vista campus (3rd year)
- 4th - 8th grade students (1250 students with 180 teachers and chaperones from 15 schools and home schools)
- 25 workshops
  - Plasma welding, computer game design, Patterson Observatory, Arthropods of Sonoran Desert, physics discovery, plant DNA extraction
- 30 ongoing activities
  - Math in the kitchen, robot design and testing, engineering and flight, rocks and minerals and mining, capturing the wind, iris scanning identification

Math/Science Experience: What We Are Learning

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- Over 1250 students were signed up in less than 3 hours.
- A majority of exhibitors continue year after year. (33,10)
- We don't know how to measure long-term impact.
- Seventy percent of student indicate they learned "quite a bit" or "a lot".
- Before and after responses to liking to study STEM "a little" or "really like" – 46% to 70%
- Sixty-two percent of teachers indicated the program provided improvements to their ability to teach STEM
- Teachers feel the program increases student's motivation or interest in STEM. (96.3%)
- Timing occurs after testing season.

STEM Exploration Academy

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Innovation at Work

- Goal – Increase hands-on STEM opportunities
- Four Fridays during the school year on Douglas or Sierra Vista campuses (3rd year)
- 9th and 10th grade students (40 to 50 participants)
- Three workshop days taught by Cochise College faculty
  - electromagnetism, solar technology, forensic entomology, robotics, DNA, satellite & security design, G-force & crash testing, architectural design
- Fourth day is an out-of-county field trip
  - Biosphere 2, U of Arizona Bio-Medical Institute, U of Arizona Engineering College

STEM Exploration Academy
What We Are Learning

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- Students have barbeques and tours. 96% indicated they felt welcome. 93% would come again.
- We try to gauge their interests and favorites. After the three workshops last year, the top field of study that they would seriously consider was engineering/programming. (39%)
- The field trips seem to be very valuable. Some students have never even been to Tucson.
- The workshops and particularly the field trips have also turned out to be a great way to get the students to interact with new people and make friends with students from other districts.

Summer Camps

- Nineteen camps in 2012, 12 in STEM (6th year).
  - robotics, small engine design, astronomy/space camp, forensics, video game design, science, technology
  - radio DJ, metal art, rock band camp, 3D sculpture, girls week out
- Most camps run 12:30 – 4:30 pm.
- Grade levels vary from 4th to 12th grades.
- Average camps has 20 participants and an average participant to adult ratio of about 8:1.
- Camps are planned to be financially self-supporting.

Summer Camps
What We Are Learning

- Need enough teachers & aides to keep things going well.
- Rate of participant engagement and learning progresses quickly.
- Participants are looking for real experiences and real connections to future career options.
- Many participants take multiple camps per year or over multiple years.
- Close to 100% of participants would recommend the camp to their friends.
- Difficult to do longitudinal data collection.

Classroom Speakers and University Visits

- A team of faculty from Arizona State University (ASU) comes to the college and visits numerous STEM-related classrooms to talk about engineering opportunities.
  - Computer science, biology, math, physics, chemistry, engineering
- Classroom speakers talked to 300 Cochise students during 2011-2012.
- Students travel as a group to ASU for campus visits with engineering representatives and visit the METS center.
- Twenty-six Cochise students visited ASU (2011-2012).

Classroom Speakers and University Visits
What We Are Learning

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- Seven Cochise students said they were going to ASU engineering in fall 2012.
- Number of Cochise students graduating in STEM programs increased by 40% over the three years ending 2010-2011.
- First year that ASU faculty visited high school classes, it did not seem to engage the students. This was different when high school students were on campus for an event.
- Timing of the visit to ASU shortly after the classroom visits by ASU increases participation.

Engineering Night

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- We held the first engineering night in fall 2011.
- Program included:
  - K-12 Outreach opportunities
  - Running Start Academy
  - Engineering programs
  - Transfer opportunities
  - Financial considerations
  - Mechatronics program
  - Motivating Engineering Transfer Students (METS) program
  - New AAS in Engineering

Engineering Night
What We Are Learning

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Innovation at Work

- We are trying some new things for this year:
  - Industry tables before and after the meeting
  - Presentations by people that have been involved in internships, both students and an industry representative
  - Opportunities in engineering presentations by industry reps
  - Door prizes – IEEE memberships, STEM summer camps
  - Broader marketing including some feature articles in newspapers before the event

SFAz STEM Pathways at Cochise College

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COCHISE COLLEGE

Science, Technology, Engineering, and Mathematics (STEM)

Summer Math Academy

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- The academy is designed to serve middle school students struggling with math
- Usually students are between 8th and 9th grade, but have tried both a year younger and a year older.
- Students take mathematics for college credit and take one or more other college courses in writing and computers.
- School district usually pays the tuition for the students.

Summer Math Academy
What We Are Learning

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- 630 registered students over 9 years, 90% completion, 94% of completers with a grade of C or better in the developmental math course
- Power of place – students seem to be motivated by the college environment
- Parent satisfaction survey – 10 of 11 were satisfied or very satisfied with their child's experience and 11 of 11 would recommend the Math Academy to another parent.
- Student satisfaction survey – 19 of 21 had a positive or very positive experience and 18 of 21 would recommend the Math Academy to a friend.

ITV Consortium Math Outreach

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- Many of the school districts in Cochise County have installed ITV systems in the last 3-4 years.
- Goal – help students progress in math by offering college math courses via ITV to high school students

ITV Consortium Math Outreach
What We Are Learning

- Only one district offered any math courses this way, precalculus in the fall and calculus I in the spring.
- Highest enrollment in any given course was eleven.
- Eventually the enrollments were insufficient to offer courses.

Modular Developmental Math

- Cochise participated in a grant program from the National Center for Academic Transformation to convert our developmental math courses to a computer-based modular design.
- We now have all developmental math taught in three courses, each representing five modules.
- All students who test into developmental math start with module one and test forward at their own pace. This promotes the mastery learning concept.
- We increased section sizes and have an instructor and several tutors to work with the students in each section.

Modular Developmental Math
What We Are Learning

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- First semester of college-wide implementation saw percentage of students with a grade of C or better rose from 55% to 60%.
- During this time the percentage of students who were retained in the courses rose from 76% to 81%.
- Some students can complete three courses worth of developmental math in one semester. This is another set of data that we have not yet collected for analysis.
- It is anticipated that the next area to be addressed will be the fine tuning of the approaches used by instructors and tutors as they work with students in this environment.

Running Start Academy

- Early college model, student spends morning at high school, afternoon at Cochise
- Junior students eligible to apply, must meet math placement score, be interviewed, parents are interviewed (about 30 of 70 students enter the program)
- Program has learning community coordinator who provides active support to students.
- Students agree to use tutoring as needed and go through a summer bridge program to ease transition.
- Most classes can be used for high school credit and are used for the Associate of Science degree at Cochise.

Running Start Academy

- Course sequence
  - Junior fall – Academic Success Seminar, Pre-calculus (8 cr)
  - Junior spring – General Physics I, Calculus I (9 cr)
  - Senior fall – Physics with Calc I, Principles of Engineering, Calculus II (11 cr)
  - Senior spring – Physics with Calc II, Programming for Engineering and Science, Math/Science elective (3-4 cr)
  - Total credits – 38-39

Running Start Academy
What We Are Learning

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- This fall we dropped College Algebra and Trigonometry and went to Pre-calculus. This provides students with Calculus I before the first Physics with Calculus course.
- This change slightly increased math scores for entrance. Math modules were used to help students during the summer to increase their scores. 8 of 10 students completing the modules were able to get into the program.
- Over 90% of students report that they were academically prepared.
- Twenty-nine percent of students held a job.

Running Start Academy
What We Are Learning

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- Seventy-seven percent of recent completers felt the RSA positively affected their education or career goals.
- Eighty-four percent intend to complete a 4-year degree or higher. Twenty-nine percent plan to continue their education at Cochise.
- A large majority of completers would like the opportunity for internships as a part of the program.
- About half of the students complete the entire program.
- Almost all participants continue with post-secondary education regardless of completion.
- Half of these are in STEM areas.

Math/Engineering Professional Learning Council

- Goal – improve the number of students that select mathematics and engineering as a career option and improve the success rate of students pursuing these options
- Council made up of middle school, high school, community college and university faculty.
- Intent is to select priority components of STEM pathway, collect data on performance of those components, suggest improvement approaches, pilot those approaches and fully implement successful approaches.

Math/Engineering Professional Learning Council
What We Are Learning

- Current top priority – kindergarten to university transitions
- Second priority – teaching models
- The council has had very good discussions.
- One severe challenge is the massive amount of change occurring in Arizona with regard to new requirements for high school graduation in mathematics and the adoption of new standards at the same time.

SFAz STEM Pathways at Cochise College

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COCHISE COLLEGE

Science, Technology, Engineering, and Mathematics (STEM)

Industry Advisory Council

- This council was formed to support the success of students interested in pursuing STEM careers.
- Composition of council is primarily representatives from the military and military-related contractors and some utility representatives.
- Activities to date include:
  - a summary of specific job numbers employed by these companies
  - establishment of internship processes
  - support for engineering night
  - Initiation of subgroups to do detailed curriculum reviews

Industry Advisory Council
What We Are Learning

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- Main benefit to this point of this council is the informing of Cochise about industry and vice versa.
- This is a lot of work. We have hired an industry outreach coordinator to help support this effort.
- It takes continuous effort to maintain relationships with existing members, expand membership, and replace people who are retiring or leaving the area.

Curriculum Opportunities

- Goal – to provide students with traditional coursework related to programs like engineering while incorporating other applied courses to provide hands-on experiences and connect with potential students who aren't motivated by pure academics
- Cochise has a mechatronics certificate based on a Siemens certification program. This is a four-course, 16-credit certificate that prepares the student for the Siemens testing.
- Each year several Running Start Academy student also take these courses in addition to the RSA courses.

Curriculum Opportunities
What We Are Learning

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- It is not certain that mechatronics is a widely used terminology. Perhaps engineering technology is a better title.
- Enrollment is still not economical. The mechatronics courses may need to become part of a two-year program for them to be seen as more valuable by students.
- Universities that we are working with are very reluctant to consider these courses as potential transfer courses for all but a few BAS degrees.

Transfer Articulation

- Engineering transfer students can be disadvantaged by completing entire A.S. programs in pre-engineering. Not every course may be useful in the university program.
- In addition, front-loading general education courses can result in the transfer student having nothing but high-rigor engineering course left to take at the university.
- Cochise developed an AAS degree in engineering to provide more flexibility in course selection and to reduce the number of general education courses required.

Transfer Articulation
What We Are Learning

- General Education (20 credits) Composition, English Composition, Precalculus, Economics, Liberal arts, Technology literacy
- Core Curriculum (31 credits) Principles of Engineering, Programming for Engineering and Science, Calculus I, Calculus II, Calculus III, Differential Equations, Physics with Calculus I, Physics with Calculus II
- Department Approved Electives (to complete 65 credits) General Biology I, General Biology II, General Chemistry I, General Chemistry II, C Programming, Digital Logic, Linear Algebra

Transfer Student Support

- The METS grant has shown the benefit of supporting the engineering transfer student after they transfer.
- ASU provides a METS center with a director who provides significant mentoring support to transfer engineering students.
- The center itself provide refrigerator, microwave, free copies, study space and tutoring for these students.
- Students also take a course that emphasizes habits for student success and the professor that teaches the course ensures that students apply the principles.

Transfer Student Support
What We Are Learning

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- After 3 years of the grant, they have reached 30 students who qualify for scholarship support, up from 11.
- 420 students currently use the METS center and only 68% are transfer students. This is up 100 students in a year.
- ASU is developing a website with FAQs to help provide more support to students.

Industry Internships

- Summer 2012 is the beginning of STEM student internships at Cochise.
- Ten students received internship opportunities at a contractor that works with one of the military units at Ft. Huachuca.
- The students are paid for a 320 hours internship.
- At this point the funding for the internships is coming from a grant.
- Each student has a supervisor/sponsor within the company who makes sure that they are doing real work and getting a good picture of part of the industry.

Industry Internships
What We Are Learning

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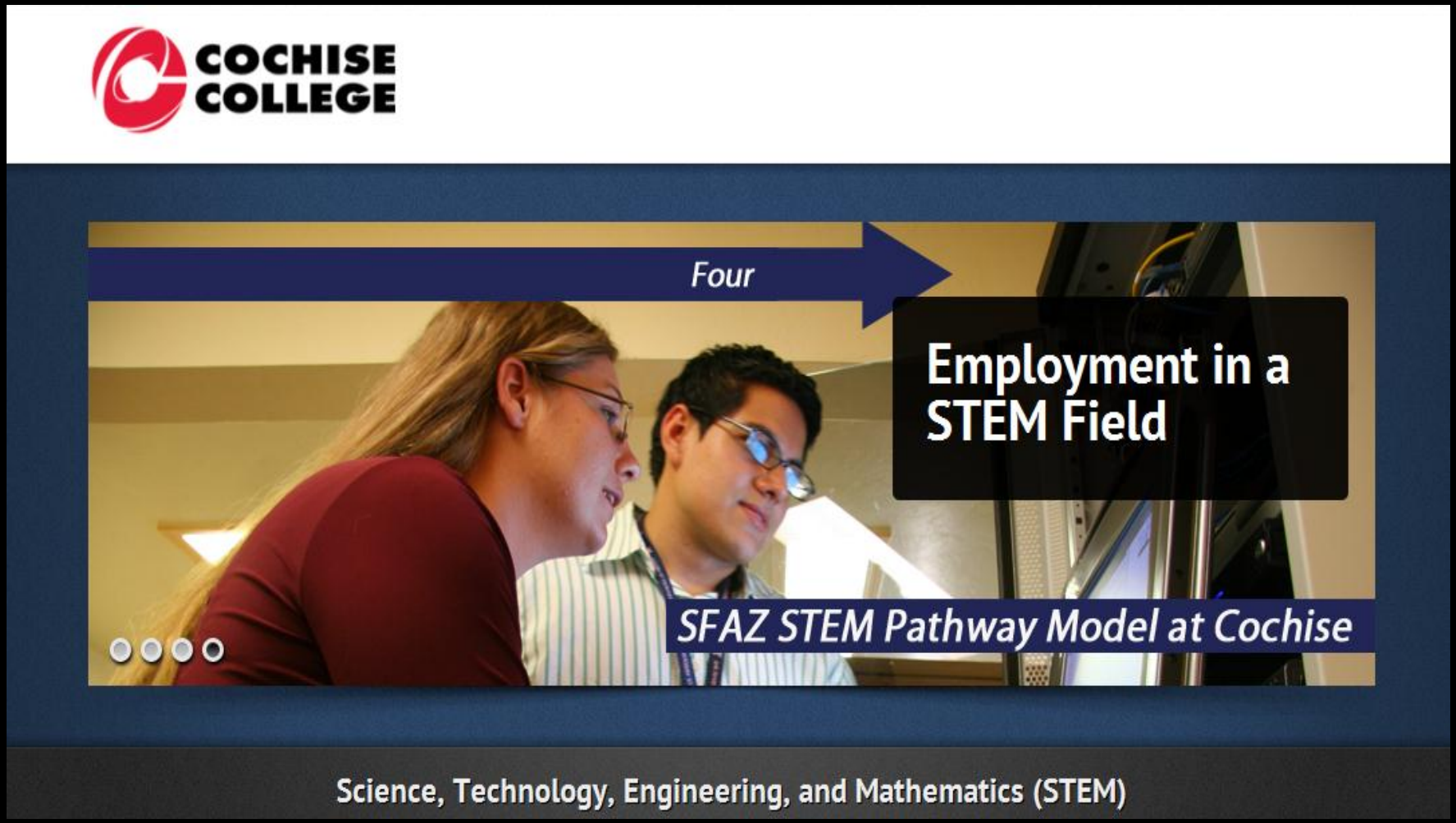
- It took a lot of the summer to get the program ramped up. Part of this was due to the need to hire the industry outreach coordinator.
- Another major hurdle that was always brought up was the need for security clearances. This part of the process has been successfully addressed by the current partner.
- Early feedback is that students would like a longer internship period.
- Additional industry partners are being recruited.
- Faculty internships are also being planned.

SFAz STEM Pathways at Cochise College



For More Information

- SFAz website - www.sfaz.org/
- STEM at Cochise website – www.cochise.edu/stem
- If you would like more details about Cochise programs, please leave me your card with requests and I will add information to the STEM at Cochise website.