ATE Student Success: Building a Diverse and Entrepreneurial Workforce

A Report from the Birds of a Feather Sessions

2010 ATE Principal Investigators Conference

Washington, D.C., October 27-29, 2010

AACC AMERICAN ASSOCIATION OF COMMUNITY COLLEGES

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The American Association of Community Colleges (AACC) is the primary advocacy organization for the nation's community colleges. The association represents 1,200 two-year, associate degree–granting institutions and more than 12 million students. AACC promotes community colleges through five strategic action areas: recognition and advocacy for community colleges; student access, learning, and success; community college leadership; economic and workforce development; and global and intercultural education.

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Executive Summary

The Birds of a Feather sessions took place on October 28, 2010, during the 17th national Advanced Technological Education (ATE) Principal Investigators Conference in Washington, D.C. The 400-plus session participants organized into groups representing 12 technical education discipline, and engaged in a scenario-based exercise to identify key challenges, promising strategies, and effective progress measures for developing workplace and entrepreneurial skills and for increasing workforce diversity in each of these areas. An initial synthesis of the Birds of a Feather discussions was presented at the conference plenary session on October 29.

Birds of a Feather session participants identified community colleges' key challenges to developing workplace and entrepreneurial skills as

- Defining necessary soft skills, teaching them to students, and assessing whether students have learned them.
- Addressing how instructors' lack of technical background, pedagogical preparation, or understanding of industry needs, and their practice of confining their instruction to discipline-specific "silos," creates a disconnect between instruction and actual workplace needs.
- Meeting the needs of underprepared students who lack basic academic skills, soft skills, and motivation, and who have a limited understanding of the work involved in science, technology, engineering, and mathematics (STEM) fields.
- Overcoming colleges' shortages of time, money, staff, facilities, and other resources.

Promising strategies that community colleges can use to address the key challenges to teaching workplace and entrepreneurial skills include

- Integrating real-world experiences, such as service learning and internships, and experiences that simulate workplaces, such as virtual enterprises, into teaching and learning.
- Building better partnerships with industry and business.
- Addressing structural and cultural issues through educational standards; incentives, evaluations, and professional development for faculty; and student success measures.
- Infusing interdisciplinary approaches into teaching and student projects.
- Improving the pathways among middle and high schools, community colleges, and employment in STEM fields.
- Providing faculty with resources for experiential teaching and learning.

Community colleges should measure how well a program teaches workplace and entrepreneurial skills by

- Surveying employers about on-the-job performance of STEM graduates.
- Surveying students and graduates about their satisfaction with the program.
- Monitoring evaluations of student work by peers, faculty, and potential employers.
- Evaluating student portfolios and learning outcomes.

Gauging the extent to which employers participate in a program by serving as instructors or advisory board members.

- Tracking student graduation and employment rates.
- Gathering longitudinal data about graduates' careers and continuing education.
- Tracking employer demand for the program and its graduates.

The key challenges to serving underrepresented populations and increasing workplace diversity are

- Cultural barriers, such as differences in communication styles, between students, faculty, administrators, and industry personnel.
- Students' lack of technical education role models.
- Students' lack of basic math skills, STEM career awareness, and college readiness.
- Economic factors that create competing priorities within a college for program access and equity.

To meet these key challenges to serving underrepresented populations, community colleges should

- Partner with business, industry, and K–12 school systems to enhance students' learning opportunities and college readiness.
- Provide students with services such as child care, flexible scheduling, tutoring, mentoring, financial support, computer rentals, 24/7 academic help, special programs that address the needs of underrepresented populations, and intrusive advising.
- Give students multiple ways to engage in technical education, including experiential learning, service learning, problem-based learning scenarios, and learning communities.
- Educate parents, guidance counselors, and education support staff about career opportunities in STEM fields and about two-year college pathways to those careers.

Community colleges should gauge their progress in serving underrepresented populations by using

- Employer reports about graduates' on-the-job performance.
- Student and graduate surveys conducted using both traditional survey methods and social media.
- Longitudinal data about enrollment, persistence, graduation, and employment.
- Community and industry support for the program.

Introduction

The Birds of a Feather sessions took place during the 17th national Advanced Technological Education (ATE) Principal Investigators Conference, held in Washington, D.C., on October 27–29, 2010. Addressing the conference theme, "ATE Student Success: Building a Diverse and Entrepreneurial Workforce," more than 400 session participants identified key challenges that the ATE community faces in two areas, developing workplace and entrepreneurial skills and increasing workforce diversity by serving underrepresented populations. The participants also identified promising strategies for addressing those challenges, and measures for gauging progress.

Participants in the Birds of a Feather sessions formed 12 disciplinary groups, with each person joining the group that aligned most closely with the focus of his or her ATE project or center. Members of projects and centers involving multiple disciplines split up among the 12 groups to increase interdisciplinary conversations.

Each of the 12 disciplinary groups met in its own room. Within each room, participants worked in table groups where facilitators used a scenario-based exercise to guide discussions on a common set of questions. The group responses were shared with the whole room, which then developed a single set of recommendations for the discipline.

After the sessions, ATE conference staff synthesized the discipline reports for a brief plenary report.

The Exercise

Session facilitators presented each table group with the following scenario:
You are serving on a blue ribbon task force that must respond to two disturbing pieces of information gleaned from nationwide surveys of employers and from other research:

- Employers believe that most of today's postsecondary technical education students are not developing the foundational and technical skills needed for the 21st century workplace.
- Student demographics in technical education programs and the demographics of the technical workforce do not reflect the overall demographics of the U.S. population.

Respond to this information by doing one of the following:

- Design pedagogical systems that will ensure that graduates of technical education programs have the knowledge, skills, and experiences to succeed quickly when they join the technical workforce.
- Design solutions to attract people from traditionally underrepresented groups and underserved populations to technical education programs, to meet their training needs, and to prepare them to join the technical workforce.

Session Summaries

Agriculture, Environment, and Natural Resources

Participants in the agriculture, environment, and natural resources group noted that although educators generally agree that it is good for students to learn such "soft" skills as critical thinking and problem solving, the best ways to teach these skills are not clear. Although accreditation standards require that technical education program faculty have master's degrees, instructors often lack firsthand work experience in the fields they teach. Conversely, many people with work experience in technical fields do not have the academic credentials to teach in community colleges.

Developing Workplace and Entrepreneurial Skills

CHALLENGES

The key challenges to developing students' workplace and entrepreneurial skills in agriculture, environment, and natural resources programs are

- Lack of knowledge about how to teach soft skills.
- Shortages of instructors who have both industry experience and advanced degrees.
- Inconsistencies between technician skills and entrepreneurial skills, which are not necessarily identical for all disciplines.
- Limitations on how much can be taught in the four semesters of an associate degree program.
- Geographic constraints that determine which industries are located in a community college's service area and influence students' employment aspirations.

PROMISING STRATEGIES

Community colleges should develop articulation agreements with colleges and universities that grant bachelor's degrees to ensure that associate in applied science degrees are not terminal degrees. To teach workplace and entrepreneurial skills, educators should

- Use integrated curricula that combine technical instruction, core courses, inquiry-based science, and applied research with instruction in written and oral communication.
- Offer work-based learning experiences such as internships, practicums, and hands-on training with employer feedback.
- Develop career pathways that allow students to move from high school to community college, then to a four-year college or university.
- Nurture students' leadership and soft skills by providing opportunities for service learning and for participation in co-curricular activities such

as those offered by student organizations.

- Engage alumni in recruitment, retention, internship, and job-placement efforts.
- Involve industry managers and technicians on technical education program advisory panels, in certification workshops and other educational programs, and in curriculum development.

SUCCESS MEASURES

Graduation rates are inadequate measures of success, particularly for students who want to learn specific skills or who seek employment but aren't trying to earn a degree. The success of technical education programs should be measured by

- Metrics that include students' skill acquisition, job attainment, degrees, and certificates.
- Employer feedback about alumni performance on-the-job and career progress over extended periods of time.
- Certification exam passage rates and other performance-based assessments.
- Data on employer demand for particular programs and student enrollment in those programs.

Increasing Workforce Diversity

CHALLENGES

The many types of cultural differences and communication problems that can impede community college efforts to serve underrepresented populations include

- Language barriers between underrepresented populations and college personnel.
- Culture-based misperceptions of agriculture careers.
- Lack of basic STEM skills in underrepresented populations.
- Lack of cultural understanding among college faculty, administrators, staff members, and students.
- Lack of cultural understanding between college personnel and industry personnel.

PROMISING STRATEGIES

"Diversity" can mean different things in different student populations. For example, fewer young men than in the past are enrolling in agriculture technical education programs, which several group participants agreed may be their next diversity issue. (According to the National Center for Agriscience and Technology Education, in 2007, 42% of U.S. agriculture students were women.) To meet the needs of traditionally underserved populations, educators should

- Network 2+2+2 academic programs with community needs.
- Involve industry personnel by having them mentor in the classroom and provide students with opportunities for internships, service learning, field trips, and community-based experiential learning.
- Recognize and reward faculty members who go above and beyond to support the needs of their students.
- Recognize and reward students who engage in activities beyond the classroom to develop their technical and workplace skills.

SUCCESS MEASURES

The most important measures of program success are whether students obtain employment in their chosen disciplines and how satisfied their employers are with their performance. Students do not need to graduate to believe their education was a success. One measure of program success should be whether students gain the specific skills they need for employment. Progress in serving underrepresented populations should be gauged by

- Student employability and career advancement.
- Employer satisfaction.
- Students' attainment of their own expectations.
- Industry involvement as guest speakers and hosts for field trips and internships.
- Data on graduation rates, program retention rates, and other student success milestones.

Biotechnology

Developing Workplace and Entrepreneurial Skills

CHALLENGES

To develop students' workplace and entrepreneurial skills, biotechnology programs must

- Assess soft skills and teach troubleshooting, critical thinking, and teamwork while giving students opportunities to build self-confidence.
- Overcome faculty members' alienation from industry so they can teach soft skills together with technical skills.
- Address students' lack of knowledge about workplace expectations and how to transfer what they learn in college to the workplace.
- Boost students' calculating skills.
- Understand the needs and expectations of local industry.
- Work within their colleges' constraints and curricula.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills, biotechnology educators should use

- Virtual materials, such as web-based supplements, and virtual and remote-access labs.
- Internships that let students gain specialized knowledge or fill in the gaps left by classroom assignments and the limits of their instructors' knowledge.
- Tools that integrate soft skills and technical skills, including software for hybrid instruction, team teaching, experiential assignments, problem-based instruction, interdisciplinary projects, and cohort mentoring.
- College resources including advising services and college success courses.
- Simulations of workplace experiences, such as virtual enterprises and mock interviews.

SUCCESS MEASURES

To measure the success of biotechnology education programs, community colleges should

- Track job placement and graduates' career advancement.
- Obtain feedback about internships from employers (during and upon completion of internships) and from graduates.
- Use traditional methods, e-mail, and social networking media to survey students and graduates about how well the program prepared them for the workplace.
- Assess real-world projects that demonstrate students' knowledge and skills.
- Use student portfolios to show attainment of both technical and soft skills.

Increasing Workforce Diversity

CHALLENGES

Students from underrepresented populations often have difficulty focusing on education while meeting many other immediate and competing needs. Many minority students do not have a clear understanding of how education affects long-term earnings. It is important for underrepresented populations to know that education—particularly the completion of certificates and degrees—will lead to employment. The challenges of serving some underrepresented students in biotechnology education programs include their

- Lack of basic academic and social skills.
- Inadequate preparation for college.
- Need to juggle work, family, and college responsibilities.
- Limited knowledge of the biotechnology field and its job and career opportunities.
- Lack of role models in their communities.
- Need to deal with language barriers, disabilities, and environmental conditioning that can prevent community support of education efforts.

PROMISING STRATEGIES

To serve underrepresented populations, biotechnology education programs should

- Help students complete developmental and preparatory courses more quickly.
- Work with secondary school students, their families, and K–12 teachers to improve math and language skills.
- Provide mentoring from student peers, college employees, or industry personnel.
- Organize students into learning communities or other cohorts.
- Help students receive financial assistance and resources such as child care, equipment, access to technology, and administrative support.

SUCCESS MEASURES

Progress in serving underrepresented populations should be gauged by

- Enrollment rates.
- Retention rates in college.
- Graduation and transfer rates.
- Job placement data.
- Retention rates in biotechnology careers.
- Industry and community feedback on student portfolios, exit interviews, capstone projects, etc.

Chemical Processing and Refining Technologies

Developing Workplace and Entrepreneurial Skills

CHALLENGES

The key challenges to developing workplace and entrepreneurial skills in chemical processing and refining technologies programs are

- A dearth of soft skills within the core curriculum.
- Classroom time constraints.
- Differences between industry and academic expectations.
- Students' lack of awareness about potential career opportunities in chemical processing and refining technologies.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills, educators in chemical processing and refining technologies should

- Add practical exercises in economic and business analysis to hands-on group projects.
- Encourage industry partners to provide internships, scholarships, faculty education, and financial and material support to technical education programs.
- Incorporate into lessons basic economic principles that are pertinent to student majors.
- Develop curricula that use real-world examples to teach students common industry standards, give them realistic expectations, and develop their ability to interpret industry policies and regulations.
- Encourage peer evaluation and participation in instructional support.

SUCCESS MEASURES

The success of chemical processing and refining technologies programs should be measured with

- Surveys that assess program graduates' effect on facility safety, assess on-the-job training, measure promotion and turnover rates, and measure employee satisfaction.
- Graduating and non-graduating students' evaluations of their own success.
- Assessments of students' basic skills before and after employment placement.
- Student assessments of industry culture that indicate their awareness of risk.

Increasing Workforce Diversity

CHALLENGES

Key challenges to serving underrepresented populations in chemical processing programs include

- Misperceptions that result from a lack of role models, from cultural barriers, from low family expectations, from having only vague information about how attending college will affect their lives, and from concerns about work environments.
- Insufficient academic preparation, math and science phobias, and students' reluctance to be considered nerds.

- Institutional barriers including lack of understanding by faculty about the population they are trying to reach; insufficient institutional incentives to meet the needs of underserved populations; and a lack of effective student recruitment practices.
- Student financial needs being exacerbated by lack of scholarships and by job demands and other personal challenges.
- Workplace perceptions, cultures, and traditions that have not always welcomed members of underrepresented populations.

PROMISING STRATEGIES

Influencing attitudes by providing accurate information is an important way to counter the key challenges to increasing workforce diversity. Teachers and career counselors, as well as students and their families, benefit from community outreach efforts that inform them about chemical processing workplaces. To meet the needs of traditionally underserved populations in chemical processing and refining technologies programs, educators should

- Provide alternative course scheduling, financial support, 24/7 call-in centers, and on-demand academic support.
- Offer mentoring, internships, and motivational programs for program students; job-shadowing opportunities for high school and college students; and faculty externships.
- Market STEM programs and careers to specific audiences, particularly high school and college faculty and counselors.
- Sponsor "homecoming" programs to showcase successful program graduates.

SUCCESS MEASURES

Progress in serving underrepresented populations in chemical processing programs should be gauged by

- Recruitment and enrollment rates.
- Retention and completion rates.
- Job placement and performance.
- Workplace diversity data.
- Community perceptions.

Energy Production and Energy Efficiency

Students need help to overcome deficiencies that can hinder their career aspirations. In addition to addressing technical aptitude and soft skills, community college programs in this field must make students aware early on of the physical demands of certain energy technician careers. Energy technicians may be required to work at heights of 200 to 300 feet, in confined spaces, in remote locations, or outdoors during inclement weather. Attention to detail, accurate record keeping, and self-discipline are essential for personal and public safety.

CHALLENGES

Key challenges to developing workplace and entrepreneurial skills in energy program students include the need for

- Analytical thinking and problem solving abilities.
- Leadership skills, management skills, and professionalism.
- Education in soft skills, for both students and faculty members.
- Physical skills and physical fitness.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills in energy programs, educators should

- Offer capstone courses.
- Connect their technician education programs with the work of K–12 teachers and guidance counselors.
- Adopt interdisciplinary approaches that connect academic content and soft skills across the curriculum.
- Use team-based lab activities to foster leadership and time-management skills.
- Provide training on state-of-the-art equipment.
- Develop cooperative and internship opportunities with industry to give students real-world experience.
- Connect student club activities with professional organizations.

SUCCESS MEASURES

Before measuring student success, energy technology program educators should determine what skills the energy industry requires technicians to have and should explicitly inform students about core outcomes. Program success should then be measured by

- Using industry competency standards.
- Tracking graduates' employment placement rates.
- Gauging advisory committee involvement.
- Surveying employers about graduates' on-the-job performance.
- Gathering qualitative data about how well the interests and needs of students and industry communities align.

Increasing Workforce Diversity

CHALLENGES

Recruiting underrepresented populations to energy technician careers should begin long before students reach college age. Students in elementary and middle school should be encouraged to consider careers in STEM fields and to take appropriate high school courses. They should be given the materials and pedagogy needed to understand math and prevent math phobia. Community colleges should reach out to and recruit young students and their families, teachers, and school guidance staffs. The challenges of serving underrepresented populations include

- Cultural expectations based on gender, race, or disability that prevent students from considering energy careers or that make it difficult for them to persist.
- Physical requirements for some careers.
- Lack of college readiness.
- Student and family misconceptions about STEM programs, business, industry, and energy careers.
- Faculty members' limited use

of effective STEM curricula and teaching strategies.

- Lack of pre-service and in-service professional development for college faculty.

PROMISING STRATEGIES

To meet the needs of underserved populations, energy technology programs should

- Structure career pathways with help from well-informed guidance counselors.
- Use target messaging to attract diverse populations.
- Use modern teaching methods such as virtual environments and lab tools, authentic problems, and experiential learning opportunities.
- Offer strong support systems for students.
- Provide resources, including financial resources, to support faculty education and innovation.
- Involve industry in student internships and other educational programs for students and faculty.

SUCCESS MEASURES

Progress in serving underrepresented populations should be gauged by

- The numbers of students who earn nationally recognized certification.
- Student feedback about how well programs meet their personal and professional goals.
- Assessments of student learning outcomes.
- Employer satisfaction with program students and graduates.
- Comparisons of enrollment and graduate numbers with local populations.

Engineering Technology

To improve learning outcomes and increase students' interest in STEM disciplines and careers, engineering technology experiences should be added to more courses, in more ways. Science and mathematics courses should provide hands-on experiences to engage and hold students' interest. To encourage more students to consider and enroll in STEM courses, educators must address science, technology, and engineering in developmental education courses. Nationwide, many students are required to complete courses in reading, English, and mathematics—but not engineering—before they can take college-level courses. Students should be introduced to engineering early in their college careers, when they typically take a range of courses designed to turn them into "well-educated citizens."

Developing Workplace and Entrepreneurial Skills

CHALLENGES

Key challenges to developing workplace and entrepreneurial skills in engineering technology include

- Systemic problems in K–12 education that leave students underprepared for college-level work.
- Students' lack of critical thinking and communications skills.
- Colleges' lack of resources.
- College administrators' limited support for technical programs.
- Colleges' difficulty in keeping curriculum content up to date and providing enough student slots in technical programs.
- Students' lack of computer literacy.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills in engineering technology programs, community colleges should

- Provide students with opportunities for internships, mentorships, cooperative education, and other relevant experiential learning.
- Collaborate with STEM stakeholders in K–12 schools, other community colleges, universities, and industry.
- Offer capstone courses that encourage problem solving, critical thinking, and teamwork.
- Ask industry members to share equipment and resources and to serve on program advisory boards.
- Offer hybrid courses that deliver theory online and hands-on learning in campus labs.
- Pool assets with neighboring schools and colleges.

SUCCESS MEASURES

To determine whether engineering technology programs meet the needs of students and employers, educators should

- Monitor student performance in capstone courses.
- Gather data on student enrollment, retention, graduation, and employment rates.
- Conduct longitudinal studies of student careers, possibly by using social media.
- Survey employers about how well students perform on the job and how they affect the engineering technology community.
- Collect data about student performance on industry certification tests.

Increasing Workforce Diversity

CHALLENGES

Many students from typically underrepresented populations have parenting responsibilities, and the availability of child care determines whether they can enroll in engineering technology programs. Other challenges of serving underrepresented populations include

- Stereotypes and myths that create barriers to program participation.
- A dearth of inspiring role models from within students' own communities.
- Lack of family knowledge about the engineering technology industry and the career opportunities it offers.

- Students' personal, academic, financial, and career needs that conflict with program demands.
- Student deficiencies in math and science.

PROMISING STRATEGIES

Students benefit when colleges provide them with social support mechanisms that let them connect with each other in positive ways. At various colleges, students connect with each other through clubs, Friday afternoon labs, and academic team competitions. To meet the needs of students from underrepresented populations, engineering technology programs should

- Target financial resources to promote student success.
- Provide secondary school students with activities and services that make STEM instruction relevant to their lives, including summer camps, cohort groups, learning communities, articulation and bridge agreements, internships, mentoring, and general education courses in science, technology, engineering, and math.
- Offer professional development and diversity awareness programming to college faculty and advisors.
- Use invasive advising to check students' grades and attendance each week, to encourage them, and to guide them toward needed services.
- Engage recruitment partners for underserved populations.
- Use information gained from tracking student success and progress to improve programs.

SUCCESS MEASURES

Engineering technology programs should gauge their success at serving underrepresented populations by

- Recruitment and enrollment rates.
- Retention and graduation rates.
- Rates of student employment in STEM fields.
- Rates of student matriculation from two-year to four-year programs.
- Student responses to career satisfaction surveys.
- Diversity of student population within the program as a whole and in classrooms.
- Community perceptions about the desirability of programs.

Geospatial Technology

Identifying their target audiences may be more challenging for geospatial educators than for others because courses that use geographic information systems (GIS) technologies often include a mix of two-year technician students, working professionals, and students seeking bachelor's degrees. Some students who aspire to technical careers intend to be GIS technicians; for others, GIS technology is part of another discipline and career path. The growing importance of GIS to many fields leads to the question of whether geospatial technology skills should be taught as part of core STEM courses.

Developing Workplace and Entrepreneurial Skills

CHALLENGES

Key challenges to developing workplace and entrepreneurial skills in geospatial technology include

- Insufficient student preparation in math and information technology.
- Students' lack of geospatial literacy.
- Students' lack of problem solving skills in general, and understanding of how to use GIS to solve problems in specific.
- Students' limited awareness of the geospatial industry and the jobs it offers.
- Students' lack of knowledge about how their own skills could apply to jobs in geospatial technology.
- Community colleges' limited funds for programs, equipment, and faculty.
- Community colleges' uncertainty about how geospatial education fits within the academic structure.

PROMISING STRATEGIES

Teaching problem solving is inherent to all strategies for developing students' workplace and entrepreneurial skills. To meet the key challenges in this area, geospatial technology educators should

- Use project-based learning that involves activities or case studies.
- Offer internships at various levels.
- Mobilize social networks to engage students with cultural-based awareness and solutions.
- Use resources such as the ATE GeoTech Center.
- Develop course modules that target a specific concept, such as math skills, spatial literacy, or computer skills.

SUCCESS MEASURES

Because some students take just one or two GIS courses, while some complete a degree or certificate program, the success of geospatial technology programs should be measured in many ways, including

- Surveying students about their satisfaction with the program.

- Tracking student attainment of degrees and certificates.
- Following student career progress.
- Monitoring student performance in internships, capstone courses, and skill tests.
- Obtaining feedback about program content from external advisors.

Increasing Workforce Diversity

CHALLENGES

What constitutes an underserved population varies depending on location: in some places, ethnic minorities are underserved; in others, the underserved are low-income members of the ethnic majority. First-generation college students are almost always members of underserved populations. The key challenges to recruiting students from underrepresented populations and preparing them for geospatial technology programs are

- Students' lack of awareness of GIS.
- Students' lack of technical, spatial, and soft skills.
- Faculty members' uncertainty about which underserved populations to serve.
- Faculty members' ability to link academic content to the real world.

PROMISING STRATEGIES

To succeed in educating students from underserved populations, geospatial technology programs must have both recruitment and retention strategies and help K–12 teachers and college faculty learn about geospatial technologies. To meet the needs of underserved populations, educators should

- Use targeted marketing.
- Articulate GIS uses and applications.
- Identify role models.
- Integrate GIS into general education and in core STEM courses across campus.
- Use distance education and hybrid courses to increase student access to GIS courses.
- Link GIS to problem solving and other strategies that increase student confidence.
- Provide computer literacy and support services.

SUCCESS MEASURES

Progress in serving underrepresented populations in geospatial technology programs should be gauged by

- Establishing baseline measurements for various population groups, and keeping up-to-date metrics of completion.
- Using self-evaluation measures that consider students' goals, attitudes, cultural relevance, and family support.
- Defining retention and completion according to students' own goals.
- Measuring post-graduation or post-enrollment employment success.
- Measuring the expanded use of GIS technologies by other programs on campus and by K–12 educators who have attended professional development or enrolled in GIS courses.

Information and Communication Technologies

The information and communication technologies (ICT) education programs should be more like the real world and information technology (IT) workplaces, where students will be expected to communicate, solve problems, find resources, take charge of their own growth, and ask for help.

Developing Workplace and Entrepreneurial Skills

CHALLENGES

Key challenges to developing workplace and entrepreneurial skills in ICT programs in community colleges are

- Shortages of funds and other resources.
- Pervasive culture and faculty resistance to change.
- Lack of integration of soft skills into ICT programs, and systems that recognize that one size does not fit all students and all fields.
- Institutional silos that inhibit cross-disciplinary instructions.
- Poor dissemination of faculty members' good work and practices.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills in ICT programs, educators should

- Connect structural and cultural changes to educational standards by linking them to accreditation processes and faculty compensation.
- Integrate real-world experiences and real-world-like experiences into teaching and learning with apprenticeships, internships, scenario learning, service learning, capstone courses, cross-disciplinary capstone courses, job shadowing, mentoring, and classroom visits by industry personnel.
- Map and disseminate information about community resources so that faculty can connect with businesses.
- Obtain grants for faculty to disseminate promising practices.
- Give faculty members professional development opportunities that are real-world based and include project shadowing or project-based courses.

SUCCESS MEASURES

Classroom evaluations should be based on the successful completion of projects and assignments, just as workplace evaluations are. Program success should be measured by using

- Portfolios of student work.
- Employer feedback about how students perform and grow on the job.
- Longitudinal data on student careers.
- Peer evaluations, particularly with project-based learning.

Increasing Workforce Diversity

CHALLENGES

Cultural misunderstandings and stereotypes disconnect underserved populations from

ICT programs. Students and their families may not know how to enroll in college, may have pre-conceived ideas that they will not fit into a "college culture," or stigmatize certain careers. Underserved populations often lack realistic ideas about what it takes to succeed in college. For instance, students may not know that working full time and taking a full class load usually leads to failure in both areas. Key challenges to serving underrepresented populations in ICT programs are

- Student and family misperceptions and misunderstandings about college.
- Student and family unfamiliarity with IT and the benefits of an IT education.
- Financial impediments, including cost of attendance, wages lost from not working full time, lack of knowledge about financial resources, and cultural requirements to support or contribute to the household.
- Lack of basic skills and limited English language ability.
- Insufficient motivation to commit to a course of study.

PROMISING STRATEGIES

ICT educators must contact underrepresented populations "early, often, and anytime," and should

- Provide students from underrepresented populations with information and guidance, and give them experiences such as field trips, job shadowing, and interactive programs.
- Provide instructors and advisors with professional development in understanding and communicating with students and families from underrepresented populations, including ways of reaching them with career ambassadors, peers, native speakers, and mentors.
- Take outreach programs into high schools and middle schools, to parent–teacher organizations, and to other community groups.
- Provide cultural awareness programs for faculty, staff, and students.
- Promote curriculum changes that integrate basic skills course work with non-basic skills coursework, use learning communities, require group study or tutoring, and offer non-sequential or modular work.
- Develop partnerships with businesses and other sources to provide students with scholarships and assistance with living and college expenses.

SUCCESS MEASURES

Both quantitative and qualitative measures of success are important. Information about licensure passage rates is too difficult to obtain, particularly with data disaggregated by race, ethnicity, age, and gender. Progress on serving underrepresented populations should be gauged by the numbers of students from these populations who

- Enroll and persist in ICT programs.
- Change from undeclared majors to ICT-related majors.
- Earn ICT degrees and certificates.
- Obtain ICT employment.

Information Assurance, Secure Logistics, and Forensics Technologies

Younger and older students look at technology differently and communicate differently. The prevalence of cell phone texting and Internet-based social media means that many younger students struggle with face-to-face communication. They are less willing to read full chapters than previous generations were, and prefer shorter reading assignments. Older students may be reluctant to use new technologies. Assigning students to make videos was one suggestion for boosting students' communications skills and raising their awareness about how to present themselves in the workplace.

Developing Workplace and Entrepreneurial Skills

CHALLENGES

Key challenges to developing workplace and entrepreneurial skills in information assurance (IA), secure logistics, and forensics technologies programs are

- Instructor discomfort with teaching both hard skills and soft skills, especially in online courses.
- Convincing students that both hard and soft skills are necessary for success.
- The difficulty of providing faculty with professional development because of personnel intransigence, resource limitations, and time constraints.
- The difficulty of measuring successful student outcomes, particularly in hard to assess soft skills.
- Getting college administrators to set aside the resources and time needed to change pedagogy and support professional development.
- Financing equipment, faculty development, faculty release time, and other costs involved in keeping curriculum up-to-date.
- The need for marketing that engages students, as well as their parents and career counselors, from K–12 and beyond.
- Providing job placement for program completers.
- Understanding the language and skills challenges of diverse populations.
- Building seamless articulation between two-year and four-year colleges.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills, educators should

- Incorporate 21st century skills into teacher education programs.
- Use scenarios and problem-based learning methods in their teaching.
- Set student expectations with learning contracts and success courses.

- Expose K–12 students to IA careers with technology camps, early college high schools, and articulation agreements that provide clear pathways from secondary school to career.
- Partner with industry and government to develop curriculum, offer student internships and faculty externships, provide service learning opportunities, and bring industry people into classrooms.
- Use virtual and hybrid modalities for computer labs and instruction.
- Recruit students and convince employers to hire graduates of community college IA programs by using marketing that publicizes student success stories.

SUCCESS MEASURES

The success of IA education programs should be measured by

- Obtaining validation from industry personnel who observe classrooms and interview students.
- Gathering data on student graduation and employment, and alumni activity.
- Calculating the return on investment of graduates.
- Assessing student skills with structured, systemic, and systematic approaches from K–12 to employment.
- Using industry certifications, tests, and interviews.
- Evaluating student performance in capstone courses and in capstone activities within courses.
- Obtaining feedback from employers about the performance of graduates and interns.
- Establishing a standard exit exam or certification exam.
- Posting electronic portfolios of student work online.

Increasing Workforce Diversity

CHALLENGES

Key challenges to serving underrepresented populations in IA education programs include the need to

- Find skilled mentors.
- Accommodate low-income students' inability to complete assignments or attend class because they have to work or cannot afford child care.
- Counteract cultural norms and mass media messages that create different expectations for men and women.
- Address students' lack of basic academic and social skills.
- Deal with unrealistic student expectations, both positive and negative.
- Format courses for nontraditional students.
- Retain students with math phobia.
- Adapt programs for displaced workers and veterans.
- Encourage students to get involved in the overall college experience.

PROMISING STRATEGIES

To meet the needs of underrepresented populations, IA educators should

- Develop outreach and mentoring programs through partnerships with high schools, four-year colleges, and businesses.
- Direct students to internships, job fairs, and job shadowing and other opportunities to interact with people in IA careers.

- Provide engaging online courses with measurable outcomes.
- Offer supportive resources including laptops, child care, and transportation.
- Make course materials available online so students can access them from any place, any time.
- Host support groups for underserved populations.

SUCCESS MEASURES

An IA program's success at serving underrepresented populations should be gauged by whether

- Equal numbers of men and women enroll.
- Employers hire more diverse populations.
- Parental attitudes support college enrollment.
- The self images of students from underrepresented populations improve.
- Students from underrepresented populations persist semester-to-semester, complete programs, and obtain employment.
- Students' economic situations improve.
- Employers and students from underrepresented populations provide positive feedback about the program.
- Communities support outreach programs and services.

Manufacturing Technology

Developing Workplace and Entrepreneurial Skills

CHALLENGES

Students' lack of mathematics skills and inconsistent funding for technician education programs are challenges that cut across all advanced technology fields. Key challenges to developing workplace and entrepreneurial skills in manufacturing technology are

- Cultural misperceptions about manufacturing and lack of public awareness about manufacturing career opportunities.
- Disconnections between applied learning and core curriculum requirements.
- Deficiencies in team building among students, between students and faculty, among faculty members, and between community colleges and industry.
- Limited industry participation in education partnerships.
- Faculty resistance to improving the match between what they teach and what students will need to do in manufacturing workplaces.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills in manufacturing technology programs, educators should

- Incorporate extracurricular activities such as Project Lead the Way, First Robotics, and Destination Imagination into mainstream

educational programs for young students.

- Raise awareness of manufacturing technology by sponsoring early career awareness programs for elementary school students; by offering middle school and high school students opportunities for hands-on problem solving and project-based learning in teams; and by connecting career pathways with pre-apprenticeships.
- Cultivate industry partners to help align curriculum with employer demands, industry standards, and portable credentials.
- Learn to use new technologies so they can help students become digital learners.
- Provide professional development to K–14 educators to improve their understanding of manufacturing and entrepreneurship, expand their digital learning and teaching skills, and increase their integration of discipline knowledge and technical skills.

SUCCESS MEASURES

The success of manufacturing technology programs should be measured by

- Gathering feedback from employers.
- Surveying graduates about career satisfaction and whether what they learned in college helps them to accomplish workplace tasks.
- Tracking graduate employment rates, wages, and employment longevity.
- Monitoring graduates' attainment of industry credentials validated or awarded by independent organizations.
- Using standardized test scores.

Increasing Workforce Diversity

CHALLENGES

Parents of students from underrepresented populations often do not advocate for STEM education or for manufacturing careers. The challenges of serving underrepresented populations in manufacturing technology programs include

- Students' lack of awareness about manufacturing career opportunities.
- Students' inadequate basic skills, particularly in math and English.
- Negative student and family views of manufacturing work.
- The nation's insufficient resources for STEM education.
- A shortage of role models and mentors among underrepresented populations.

PROMISING STRATEGIES

To meet the needs of underserved populations, manufacturing technology educators should

- Use case studies that showcase the success stories of women and others who are underrepresented in manufacturing.
- Raise STEM awareness among secondary school guidance counselors.
- Provide support services to students.
- Use social networking as a tool to market programs and for teaching and learning.
- Partner with local manufacturers to align curriculum with industry needs, and obtain support for college programs.
- Infuse applied mathematics into the

secondary school curriculum.

- Involve families in STEM career exploration programs for middle school and high school students.

SUCCESS MEASURES

Progress in serving underrepresented populations in manufacturing technology programs should be gauged by

- Employers hiring more people from underrepresented populations.
- Longitudinal studies that follow students from middle school through college to employment.
- Surveys of students and graduates about their educational and career goals while they are enrolled and afterward.
- Enrollment trends for women and underrepresented populations.

Micro- and Nanotechnologies

The speed of innovation and technical change in the micro- and nanotechnology field makes it difficult for community college programs to keep up. The technical aspects involved in teaching nanotechnology already push 60-credit degree programs to their limit. It often takes longer to set up an industry advisory board than it does for new uses of nanotechnology to hit the market.

Developing Workplace and Entrepreneurial Skills

CHALLENGES

The key challenges to developing workplace and entrepreneurial skills in micro- and nanotechnology programs are

- The speed of technological changes.
- Faculty members' lack of real-world experience in the industry.
- The prevalence of the practice of students taking discrete courses and moving through a program separately, which inhibits students' development of collaborative skills and prevents faculty members from integrating content across the curriculum.

PROMISING STRATEGIES

Without clear definitions of "micro" and "macro" technologies it is difficult to achieve consensus about which technologies students should learn. Because industry credentialing is limited, community college programs may need to set their own skill standards in this field. To develop workplace and entrepreneurial skills in micro- and nanotechnology programs, educators should

- Establish skill standards.
- Implement program- or course-based interventions.
- Create teaching teams that pair full-time faculty members with adjunct instructors to build faculty program capacity.
- Offer credit to students for industry-sponsored certificates.
- Develop modules that cover soft skills and entrepreneurial skills.

SUCCESS MEASURES

Community colleges should make greater use of qualitative and quantitative institutional research data to determine where efficiency and waste exist in micro- and nanotechnology education programs. ATE programs should work together to monitor the results of programs that include soft skills by using rubrics that determine the purpose of soft skills. Program success should be measured by

- Working with industry technicians to develop performance-based evaluations that benchmark the skills that should be taught and that validate program outcomes.
- Surveying students about whether programs help them achieve their goals, whether the goal is employment, an internship, transfer to a four-year program, or the completion of a few courses.
- Obtaining employer feedback about graduates' job performance, including input from managers and co-workers.
- Comparing students' performance in classes taught by adjunct instructors and in classes taught by full professors.

Increasing Workforce Diversity

CHALLENGES

Colleges should use culturally appropriate marketing strategies that increase awareness of the micro- and nanotechnology field, offer role models or mentors for students, and provide professional development for faculty members and administrators. Professional development should answer the following questions: What should we do when dealing with underrepresented populations? What should we not do? What are the other considerations? The challenges of serving underrepresented populations include

- Institutional structures that do not reward the time and energy needed to implement inclusion efforts.
- A lack of comprehensive, culturally aware marketing.
- Reluctance of students' identifying themselves as part of underrepresented populations, which results in students' need for financial aid, child care, transportation, and other assistance going unmet.
- Cross-disciplinary aspects of nanotechnology that make career paths less obvious.

PROMISING STRATEGIES

To serve underrepresented populations, community college micro- and nanotechnology programs should

- Invest in "seed students" who can serve as role models for other members of underrepresented populations.
- Develop learning communities led by industry mentors.

- Promote industry engagement and outreach.
- Provide financial incentives for companies to hire diverse program graduates who have earned associate degrees.
- Create social contracts with industry that include paid internships, scholarships, and career pathways.
- Create a national marketing plan that defines a nanotechnology skill set and nanotechnology career paths.
- Build strong partnerships among K–12 schools, community colleges, and universities.
- Provide faculty support and professional development in nanotechnology.
- Recruit a diverse faculty population.
- Provide on-site child care, creative scheduling, hybrid courses, evening classes, and off-site locations to reach nontraditional students and to help students from underrepresented populations overcome barriers.

SUCCESS MEASURES

The goal of diversity efforts should be for the population in a nanotechnology program to mirror the college's enrollment, not the demographics of local industry or regional inequities. Participants were concerned about economic equity and the dispersion of nanotechnology knowledge beyond Silicon Valley in California and the Northeastern states. Nanotechnology education programs should incorporate continuous improvement plans and ongoing evaluation metrics. Progress in serving underrepresented populations should be gauged by

- Determining if program growth matches industry expansion.
- Gathering data about graduate diversity, per capita income, satisfaction with the program, sense of inclusion, career opportunities, and cultural empowerment.
- Tracking the geographic and economic distribution of education–industry partnerships.

Research and Evaluation

The research and evaluation group participants discussed soft skills and how to measure them, asking "What does critical thinking look like?" They agreed that soft skills should be assessed in connection with content; that entrepreneurial skills are soft skills; and that adaptability is essential for long-term career success.

Developing Workplace and Entrepreneurial Skills

CHALLENGES

The key challenges to developing workplace and entrepreneurial skills can be grouped into four categories: curriculum, program, pedagogy, and policy. The challenges include the need to

- Improve students' college readiness.
- Raise student awareness of required basic skills and prerequisite classes.
- Fix college placement problems.
- Define soft skills.
- Integrate workplace and entrepreneurial skills into academic curriculum.
- Structure the curriculum to prepare students for long-term careers.
- Eliminate cultural separations between academic departments, students, and students' families.
- Revise models of teaching and learning.
- Create real-world, authentic learning experiences.
- Rally broad support for systemic changes.
- Remedy shortages of time and money.

PROMISING STRATEGIES

To teach workplace and entrepreneurial skills, educators should

- Integrate workplace skills throughout the curriculum by using role playing, scenarios, and virtual workplaces.
- Expose students to workplace situations by using problem-based learning techniques, mock interviews, and group interactions.
- Use focused assessments that make feedback relevant to instructors and students, develop students' skill at applied problem solving, and encourage students to reflect on their learning.
- Provide faculty and administrators with professional development in soft skills, learning centers, professional learning communities for instructors, and intensive experiential learning.
- Incorporate technical content into developmental courses.

SUCCESS MEASURES

The success of technician training programs should be measured by

- Assessing soft skills with student-designed rubrics, hands-on skill tests, and portfolios of student projects.

- Working with industry to establish national norms.
- Gathering information about employers' satisfaction with student interns and graduates.
- Monitoring students' careers with longitudinal studies that track employment, promotions, continuing education, and career satisfaction.
- Gauging program success based on students' time in remedial courses, students' preparation, and enrollment trends.

Increasing Workforce Diversity

CHALLENGES

The key challenges to serving underrepresented populations in research and evaluation training programs are

- Students' misunderstanding of college and STEM careers.
- Limitations to access and opportunity that result from prohibitive class sizes and unaffordable tuition.
- Lack of support structures for teacher preparation, parental guidance, student mentoring, and early STEM career pathways.
- Negative attitudes among students, particularly low self-confidence.

PROMISING STRATEGIES

There are so many ways to define diversity—by race, gender, socioeconomic class, and more—that no one single strategy can have an across-the-board impact. To meet the needs of underrepresented populations, educators should

- Reach out to underserved populations through churches and other trusted community institutions.
- Market programs with media blitzes.
- Reach out to middle school faculty, high school faculty, and targeted communities to focus on both recruitment and retention.
- Work with industry and professional organizations.
- Offer mentoring, job shadowing, holistic support, and supplemental instruction.
- Provide discipline-specific professional development to improve teaching and learning.
- Address micro-inequity within classrooms with professional development about what teachers do to foster students' feelings that "the teacher doesn't like me."

SUCCESS MEASURES

Progress in serving underrepresented populations should be gauged by

- Stakeholder data such as focus group interviews of students, surveys of graduates, and feedback from employers and advisory board members.
- Student job placement and employment outcomes.
- Program enrollment and graduation rates.
- Intermediate assessments of students' intentions, academic performance, and persistence from semester to semester and year to year.

Teacher Preparation

Participants in the teacher preparation disciplinary group expressed concern about the preparation of instructors at all levels, and particularly about potential teachers' inclusion in STEM courses and faculty members' ongoing STEM learning.

Developing Workplace and Entrepreneurial Skills

CHALLENGES

The key challenges to developing workplace and entrepreneurial skills in teacher preparation programs are

- Insufficient qualifications of instructors, particularly if they lack work experience in the advanced technology field they are teaching.
- Instructors' lack of ability to keep students engaged while teaching soft skills such as a good work ethic, time management, and teamwork.
- Lack of connection between industry and educators.
- Deficiencies in community college systems for collecting, analyzing, and using data.
- Administrative obstacles to bringing in the best teachers and disseminating best instructional practices.

PROMISING STRATEGIES

Promising strategies for developing workplace and entrepreneurial skills in teacher preparation include

- Developing interdisciplinary learning communities for both faculty and students.
- Partnering with industry to provide mentoring, student internships, faculty externships, and faculty development.
- Involving industry in curriculum development.
- Using best practices for instructing with authentic scenarios and workplace situations.

SUCCESS MEASURES

Teacher preparation program success should be measured by

- Tracking student completion data.
- Surveying industry partners about students' performance as interns and employees.
- Monitoring the number of students who choose STEM careers, majors, or courses.
- Using social networks to gather information from graduates about how well college programs prepared them to meet workplace expectations.
- Testing students' employability skills before and after the program, and analyzing the results with rubrics.

Increasing Workforce Diversity

CHALLENGES

The key challenges to serving underrepresented populations include

- Lack of math and science skills acting as gatekeepers to students' future career success.
- Generational gaps between faculty members' and students' learning styles and media preferences.
- Teachers' and students' fear of STEM.
- Concerns about access to and keeping pace with technology.

PROMISING STRATEGIES

To meet the needs of underserved populations, educators should

- Teach toward a common core of standards.
- Understand that no one instructional strategy or program of study will fit all students.
- Use a range of methods for teaching and learning.
- Infuse work content and real-world applications into lessons.
- Develop fast-track tools to help young students and older adults from underrepresented populations close their academic skills gaps.
- Examine what STEM educators in other countries are doing.

SUCCESS MEASURES

Teacher preparation discussion participants suggested that ATE programs should help build consensus about ways of measuring the development of creativity and critical thinking skills. Progress in serving underrepresented populations in teacher preparation education should be gauged by

- Determining desired student outcomes and measuring progress toward them.
- Student attainment of work-ready skills.
- Data on student employment and articulation to four-year colleges and universities.
- Feedback from students and employers about their satisfaction with the program.

Closing

The American Association of Community Colleges and the National Science Foundation appreciate the time, efforts, and intellectual contributions of all who participated in the Birds of a Feather sessions. Both organizations hope that the session findings will facilitate greater collaboration within and across disciplines in the ATE community and among community colleges nationwide. As Charles Fadel, Global Education Research Lead at Cisco Systems, pointed out in his conference keynote address, "real life is interdisciplinary." The ATE program strives to educate students for "real-life" and rewarding careers as technician in advanced technology fields.

For More Information

Visit the following Web sites for more information:

- National Science Foundation's ATE Program
  www.nsf.gov/ate
- 2010 ATE Principal Investigators Conference:
  www.aacc.nche.edu/2010ATE
- ATE centers and projects:

  www.atecenters.org

  www.ateprojectimpact.org

  www.aacc.nche.edu/ateprogram

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