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ASU Insight
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STEM Education

ASU invests in Science, Technology, Engineering, and Math education

ASU's STEM efforts target K-20 students, build pipeline for success

Education in the science, technology, engineering and mathematics (STEM) fields is a vital component to the country's current public education agenda.

The demands of a 21st century knowledge economy not only necessitate America's citizenry to be highly equipped in what remains to determine a nation's ability to compete globally, but warrants a fundamental shift in the country's approach to educating their students.

Arizona offers a microcosmic view of this challenge, as it is a state saddled with a changing economy and substandard student assessment scores, most notably in math and science. Its goals, similar to those of the United States, include improving K-12 math and science education; strengthening the skills and aptitude of teachers through more specialized training; and building a pipeline of students prepared to enter the university and graduate with STEM degrees.

Helping to achieve these goals, Arizona State University has invested more than $100 million in research universitywide and has funded more than 72 official STEM outreach programs that extend to students in the K-12 system as well as its own college students.

"The state's science and technology pipeline currently has two bottlenecks, greatly constricting the number and quality of its work force," says Jim Middleton, associate senior vice provost for STEM education at ASU. "A low number of students are adequately prepared to even begin as a student at a university, as are the number of students that exit science, mathematics and engineering in their first two years of college. ASU must increase its capacity to feed grade schools with quality programs for students and teachers, and we also must implement programs to encourage college freshmen to pursue STEM degrees at ASU and support them through the process of learning and becoming successful."

From increasing the number of first year math classes offered to providing more support, scholarship and research opportunities to freshman students interested in a STEM field, ASU is bulking up its efforts to graduate college students with strong abilities in these core areas. Meanwhile, the university's myriad outreach programs aim to educate and garner enthusiasm among K-12 students, as well as better prepare teachers, to build on a committed interest in STEM education.

Trying to rope in all of the university's opportunities for students and educators in science, technology, engineering and math is nearly impossible; Middleton projects that ASU's reach extends far beyond its STEM programs that are officially on the map.

"ASU is a national leader in developing new models of teaching and learning," says Middleton. "We are leveraging this knowledge to change the face of STEM education in our state and national community."

New director brings fresh ideas to first year math at university

By Carol Hughes

One common denominator for nearly every incoming student at ASU is a first year mathematics class. According to the new director of the program, the student's experience with first year math is a good indicator for overall success in college. Additionally, first year math is the critical foundation for students entering the STEM disciplines – science, technology, engineering and mathematics.

"First year math scores are much better predictors for success in college in any career, not just in science, technology or engineering, than pretty much anything else," says Fabio Milner, a professor in ASU's Department of Mathematics and Statistics in the College of Liberal Arts and Sciences, and the new director of first year mathematics.

Fabio Milner

"In that sense the burden falls upon our shoulders to make the students successful, because that would suggest they would then be successful in getting their degrees," says Milner, who joined ASU this semester from Purdue University to lead the creation and delivery of an innovative curriculum in first year mathematics courses.

"The importance of a successful first year mathematics program cannot be overstated," says Sid Bacon, dean of natural sciences in the College of Liberal Arts and Sciences. "It provides the basis for numerical literacy, a springboard for more advanced mathematics required for many disciplines in the sciences and engineering, and – perhaps most critically – it is crucial for student success and retention."

This academic year, an estimated 18,000 students – incoming freshmen to graduating seniors from all majors – are expected to enroll in a first year math class on the ASU Tempe campus, and another several thousand students on the Polytechnic, Downtown Phoenix and West campuses. First year mathematics classes include College Algebra, College Mathematics, Theory of Elementary Mathematics, Elementary Statistics, Precalculus and several "flavors" of Calculus, including Business Calculus, Engineering Calculus and "regular" Calculus.

If those stakes weren't high enough, government, industry and community leaders, including Arizona Gov. Janet Napolitano and Science Foundation Arizona, are taking steps to increase STEM education, claiming it is critical to the future of each student, as well as the state's.

"The STEM disciplines really start in middle school with mathematics; math underlies all of science, technology and engineering. The importance cannot be stressed enough," says Milner. "There is no possible way to produce an engineer, a scientist or anybody in any kind of technology without some level of mathematics beyond first-semester calculus. For these students, their first year mathematics course provides the basic groundwork."

First year mathematics also is important for those students who are not STEM-bound.

"Every major at ASU has a math requirement," says Milner.

More importantly, however, many of the first year math courses are designed to teach math skills for students to fend for themselves and become discerning adults, whether it's selecting between car loans or finding the most efficient route for a delivery truck.

"If you are offered two loans to buy a car, and one has a lower monthly payment, you have to understand that with some loans you will be paying twice as much money in interest," says Milner, noting this is a math problem that comes up in the MAT 142 course.

Students who are more engaged with their first year mathematics class are emerging with better understanding and better general problem-solving skills, notes Marilyn Carlson, a professor of math education in the College of Liberal Arts and Sciences. Carlson serves on a national committee wrestling with this problem and says there "is a sense of urgency to get more students to have success in math."

Carlson's research reveals that in both college algebra and precalculus there is a need for a greater coherence and a greater focus on ideas and word problems.

"Such shifts in the curriculum and instructional delivery are needed to empower students, and over time, lead to students' emerging as more confident and powerful thinkers," she says.

(See FIRST YEAR MATH on page M4)

In the name of discovery:

A call for fundamental transformation in K-12 learning

The pursuit of scientific understanding, application of engineering solutions, and continued technological innovation is often credited for the advancement of the world's economies.

Most people don't care about technological or engineering innovation by itself. Rather, we care about whether it makes our lives easier or not.

Behind the obvious products of innovations that enhance our quality of life is a complex and extensive enterprise that is mostly concealed from public view. This enterprise comprises a rigorously developed work force, a well-funded national infrastructure and significant investments in basic and applied research.

The need for thoughtful, creative and pioneering individuals who can engage with the grand challenges of our times will require sustained investment in K-20 education and maintenance of the innovation enterprise. The demand for skills in our future work force is not merely for those exemplified as technological – logical, analytical and technical – but also for those who have value skills – the ability to think creatively and critically and see the big picture, as well as work with diverse individuals.

Children seldom lack curiosity, but as they enter the teenage years their enthusiasm for learning science, technology, engineering and mathematics subjects appears to wane. As an engineering educator, I am convinced that we need to engage learners beginning with the early elementary grades in a learning trajectory that lays the foundation for an informed population, leads to socially responsible innovations, and facilitates a creative and adaptable work force. Engineers in the real world are required to design devices and systems that respond to sudden changes. Yet, we shy away from making transformative changes to our education system.

Decades of education reform have failed to fundamentally alter the way we educate grade-school students. Our notions of schooling have consisted of successive adaptations of what has passed for learning since the inception of schools in the United States. Seat time, age-based grouping and discipline-based departments continue to be the mainstay of middle school and high school. Schooling in the elementary grades, when students are in the formative years of their life, is staffed essentially by generalists.

Tirupalavanam Ganesh

We understand that innovative breakthroughs are made at the convergence of various disciplines. Yet, by and large, we don't approach K-12 schooling in a manner that engages our young people with the grand challenges of our times that require interdisciplinary approaches.

We need to re-examine what we teach and how we teach in our schools. We need schools where we encourage our children's natural curiosity, facilitate discovery, and promote creativity – not schools where we tell children how things are. The need is for learning environments that are intellectually challenging. The role of education is to serve as a catalyst for discovery.

At Arizona State University, we have begun to create new interdisciplinary college programs and research teams where discovery is first and foremost. We need to do the same with our K-12 schools.

– **Tirupalavanam G. Ganesh** is an assistant dean for information systems at the Mary Lou Fulton College of Education. He is the principal investigator of the National Science Foundation funded K-12 outreach and research award "Learning through Engineering Design and Practice."

ASU + STEM

Working to improve statewide education in (Science, Technology, Engineering and Math)

Professor develops groundbreaking online textbook to introduce high school students to engineering techniques, technologies

By Christine Lambrakis

Darryl Morrell has put course notes, assignments and even a short textbook online, but felt that this material was not having much impact outside of ASU. That is why he welcomed an opportunity during the summers of 2007 and 2008 to work with the CK-12 Foundation and several ASU faculty in engineering and education to write "Engineering: An Introduction for High School."

In addition to being one of the first engineering textbooks written specifically for high school students, this book is an online resource that can be adapted, repurposed and extended to help excite high school students about science, technology, engineering and math.

CK-12 is a nonprofit foundation launched in 2007 to reduce the cost of textbooks for the K-12 market in the United States and worldwide, using the open-source, collaborative, Web-based Flexbook.

Morrell, an engineering professor at ASU, wants students to appreciate the role engineers have played throughout history, to understand the skills and processes engineers bring to their work, and how their work shapes and is shaped by society.

"It is important for students to realize that fun technologies like video games, MP3 players or cell phones have all been developed using engineering practices and techniques to make the technology and infrastructure work," says Morrell. "With the project, our hope is that students appreciate that engineering is everywhere and will be encouraged to consider it as a career."

Chapters of the online textbook/Flexbook so far include: The Nature of Engineering, Engineering and Society, Engineering Design, Connecting Science and Mathematics to Engineering, and A Brief History of Engineering.

The engineering text can be used in at least two different ways in the classroom.

The first is in a high school engineering course. The book is best suited for a junior- or senior-level course, but could be adapted to freshman or sophomore students as well, according to Morrell. The book provides enough material for a semester-long course that would include an engineering design project.

The text also could be used in math or science courses to provide supplementary material, says Morrell.

"For example, the engineering design chapter could be used to support a design project that would provide an engineering context for math or science topics. The Flexbook structure would allow a teacher to select one or more chapters from the engineering book; these chapters could be used as supplementary material or could be added to a math or science text."

As a Flexbook, the text and content can continually be customized, modified or updated to support specific standards and classroom needs.

To check out the engineering textbook, contribute to it or see some of the other CK-12 textbooks, visit http://flexbooks.ck12.org.

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"One of the outcomes of this project is an understanding of the need for evidence to back up claims and a logical link between claims and evidence."

– Dale Baker, professor, on his current research, the Communication in Science Inquiry Project

University partners with school district to boost K-8 student math skills

By Matt Crum

When does 140 plus one equal 3,870?

When 140 refers to teachers in the Liberty Elementary School District, and "one" is Sue Larson, a lecturer in ASU's College of Teacher Education and Leadership, the impact is improved math instruction for all of the district's 3,870 pupils in kindergarten through eighth grade.

Through a partnership between the Buckeye-based Liberty District and the college's Learning Forever with ASU professional development program, Larson has been working since last June with teachers, pupils and administrators to implement new strategies to help pupils better grasp math concepts.

"Too often teachers in all districts tend to emphasize the process of 'doing math,' and therefore students don't understand the connection between what they are doing and why they are doing it," says Antoinette McLain, a math teacher at Rainbow Valley Elementary School. "The result is students who are not problem solvers; they aren't adequately able to apply their math skills to real-world situations.

"Sue Larson is empowering teachers by building up the teachers' own conceptual knowledge base – the 'why' – so that they can better transfer that knowledge to students. I have no doubt that, as a result of Sue's work with our district, students will be better able to take charge of their own learning because they will be better prepared."

The process started in June, when Larson led two weeklong, hands-on training sessions for Liberty District teachers. Each week focused on a different grade range – kindergarten through fourth, followed by fifth through eighth. For each of Liberty's five schools, at least one teacher from each grade level and one special education, or ELL, teacher participated. School principals also attended, along with Superintendent Andy Rogers and Assistant Superintendent Paul Stanton.

"The sessions were interactive and activity-based," Larson says. "We used manipulatives, games and other tools to work on strategies for helping children learn to look for patterns rather than simply using a formula. If a mathematical principle makes sense, kids will retain that knowledge, versus just learning a rule."

The teachers and administrators who participated in the summer session formed a leadership team that is helping the learning process continue. Larson is visiting two or three schools in the district each month and modeling the teaching of lessons. The day begins with all teachers in a particular grade range meeting with Larson; they then observe as she goes into a classroom and teaches a lesson to pupils. The group then reflects upon what transpired in the class and what next steps should be taken. In the afternoon Larson works with all teachers in that school who teach math. She focuses on problem solving, integrating writing with mathematics, and geometry concepts. She will spend at least three days in each Liberty District school during the current academic year.

"The fact that teachers are able to watch Sue modeling her teaching techniques in a real classroom setting and ask questions afterward makes her work much more powerful," says Rogers.

"Sue is highly skilled in sharing her extensive knowledge about math in a way that teachers can apply directly to improve their practice."

Larson's efforts have already produced at least one "Eureka" moment for pupils. Mary Kay Walters, a special education teacher at Westar Elementary School, tells the story of fourth-grade teachers using one of Larson's methods to teach long division, after the fourth-graders had been struggling with it.

"The teachers were amazed that on the first day using Sue's technique, every single student was able to get the correct answers to their problems," Walters says.

"It's common for fourth-graders to struggle with long division, given that it's a several-step process," Larson says. "My suggestion was to use repeated subtractions as another way to look at division. For example, if you have 25 cookies and are repeatedly putting four cookies on a plate, how many times can you subtract four cookies before you run out?"

Walters, who spends time in various classrooms throughout the day, says she has seen a big difference in the way math is being taught since the project with Larson began.

"There are many more hands-on activities that allow students to develop a deeper understanding of math concepts. The students are really enjoying math and are becoming much more confident of their ability to do math."

Larson's work with the Liberty Elementary School District was arranged through Learning Forever with ASU, one of the college's professional development programs designed by educators for educators.

For more information about the College of Teacher Education and Leadership's Learning Forever workshops, visit www.ctel.asu.edu/community/learning_forever/.

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ASU fuses mathematics with social sciences

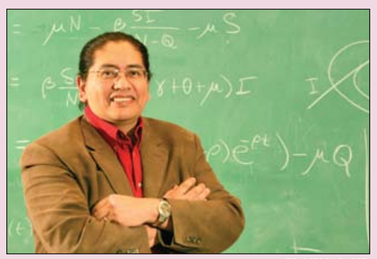
By Jodi Guyot

There's a new kind of math being taught at ASU, and it goes something like this: Take one globalized world, multiply by billions of people and add an influenza virus. Factor in extreme poverty and the fact that there are more people than vaccines. Using massive demographic, climate and health data sets, determine a vaccination distribution plan to prevent a deadly epidemic in rural Mexico. Hint: you can't actually test it to see if you got it right.

This year, two new degrees – a doctorate and a bachelor of science in Applied Mathematics for the Life and Social Sciences – join an array of crosscutting programs administered by the School of Human Evolution and Social Change in the College of Liberal Arts and Sciences.

Carlos Castillo-Chavez, ASU Regents' Professor and Joaquin Bustoz Jr. Professor of mathematical biology, joined the school this summer to direct the new programs. He will share his time with his newly founded Mathematics, Computational and Modeling Sciences Center and the Department of Mathematics and Statistics. Home to several programs under his direction, including the acclaimed Mathematical and Theoretical Biology Institute, the center actively recruits students from disadvantaged backgrounds and mentors them in mathematical sciences for the purpose of improving human lives.

"We face enormous demographic, economic, environmental, health and social challenges," says Castillo-Chavez. "Our goal is to produce a new generation of scientists with an understanding of global issues and vigorous training in quantitative theory and methods. Our graduates come from a wide range of backgrounds and will be able to quickly adapt to the changing employment demands we are already seeing in areas such as homeland security, sustainability and conservation biology, urban system dynamics, public health, disease evolution and addiction, infrastructure and technological research."



TOM STORY PHOTO

Carlos Castillo-Chavez, ASU Regents' Professor, aims to produce a new generation of scientists with an understanding of global issues and vigorous training in quantitative theory and methods.

While best known for its anthropology programs, the School of Human Evolution and Social Change is expanding its expertise in the study of complex adaptive systems.

"The school is a natural home for mathematicians who want to use their skills on social and environmental problems," says Sander van der Leeuw, the school's director. "We are extremely thrilled that professor Castillo-Chavez and his students have come on board. Our social scientists have a long history of working closely with computational scientists and are eager to advance the application of quantitative tools to social science data."

"What's different about applied mathematics in social science is that there is more focus on how to apply various tools and methods to social systems, besides learning the technical aspects of methods. The trick is figuring out which tools and methods are best for which type of problems, and how to use them to produce useful results," says Marco Janssen, assistant professor in the school and associate director of the Center for the Study of Institutional Diversity.

"Whether you are searching for viable strategies to convert a city to sustainable energy or to preserve an endangered rainforest in Indonesia, you better understand cultural and social processes. To develop rigorous models, you have to include knowledge from many disciplines."

The four mathematicians in the school's faculty know of no other program that trains mathematicians using social science data in an ecological context.

"We just started the Ph.D. program this fall and we have already exceeded our five-year enrollment projections. As soon as it was approved, we were able to enroll 27 highly qualified students, and we are constantly getting inquiries from around the world," says Bate Agbor-Baiyee, academic success specialist for applied mathematics in the life and social sciences.

Not surprisingly, it turns out there is a huge global demand for problem solvers. According to Janssen, the job opportunities for graduates cover just about every field you can think of: health, business, industry, government, environment, entertainment, sports and of course, education.

"In the age of computers and Internet, there are massive amounts of data being collected that require strong computational skills to analyze," says Janssen. "But we are still learning how to use that data in meaningful ways."

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K-12 engineering programs ignite the sparks of ASU's youngest students

By Joe Kullman

Ira A. Fulton School of Engineering leaders know that their challenge to nurture the next generation of innovators needed to maintain the nation's technological and economic edge starts long before students enroll in college.

"Industry experts and educators agree that to prepare students for the rigors of a degree in engineering, we must capture and direct their imaginations and creativity while they are still kids," says Steve Rippon, the school's assistant dean for student affairs.

The engineering school is marshalling its resources to ignite the sparks that will turn young students toward careers in the STEM fields – science, technology, engineering and math.

Almost a dozen programs geared for K-12 students are up and running. In addition, many grants for faculty research projects include funding to support STEM educational outreach in K-12 schools, and engineering school student groups at ASU are helping introduce younger students to opportunities in engineering.

A major expansion of such efforts will be enabled by a $4 million investment in the engineering school made earlier this year by former Motorola CEO Gary Tooker and his wife, Diane. Much of it will be used to endow five engineering faculty positions for professors who will work specifically to strengthen STEM outreach efforts.

The Tookers' investment also will help support partnerships with Arizona's K-12 teachers and education leaders to improve high school graduation rates and student success in college, as well as support public-private partnerships between the industry and school districts geared to inspiring students to pursue science and engineering studies.

The Tooker professors will be part of ASU's Center for Research on Education in Science, Mathematics, Engineering and Technology (CRESMET). The center develops and researches the impact of innovative teaching methods for K-16 teachers to keep students interested in these fields.

Among new and ongoing programs:

• Youth Engineering Summer Program for high school students. A two-week residential program helps high school students better understand engineering and encourages them to pursue studies to prepare them for a major in engineering. It provides a survey of engineering disciplines and careers. Students also engage in engineering projects and competitions.

ASU PHOTO

Mia Spencer (left, holding photo), Jacquelyn Hawes and Gustavo Gutierrez work on rocket design and construction as part of an Ira A. Fulton School of Engineering program to help incoming freshmen transition from high school to ASU's engineering school.

• Youth Engineering Summer Program for middle school students. A one-week commuter program designed to excite middle school students about engineering. Students get involved in projects ranging from Lego robotics to rocket launching.

• Mathematics, Engineering, and Science Achievement Program (MESA). A collaboration between the engineering school and local school districts engages middle school and high school students in engineering-based after-school clubs. MESA culminates in regional, state and national competitions. Eleven schools now participate.

• First Lego League. A robotics-based curriculum geared to teams of 9- to 14-year-old students. The engineering school is the statewide partner for the league, helping train and support teams to participate in regional and state competitions. More than 130 teams, involving 1,300 students, are participating.

• Senior Discovery Day. Arizona high school seniors learn about the Ira A. Fulton School of Engineering and the many engineering disciplines.

• Explore Engineering, Construction and Computer Science! A one-day event geared to Arizona 10th and 11th graders to familiarize them with the disciplines in engineering. Students meet with representatives from each engineering school department, talk with industry partners and tour school facilities and labs.

• Engineering Expo. A one-day event brings Arizona middle school students to ASU's Tempe campus to experience engineering-based, hands-on projects.

• Collegiate Scholars. A partnership with Access ASU and the ASU Polytechnic campus provides engineering courses on high school campuses. The goal is to offer courses in as many as 10 high schools by the 2009-2010 academic year that give students course credit in engineering at ASU.

• Test of Engineering, Math and Science (TEAMS). A one-day competition challenges high school students to work as a team to apply knowledge learned in the classroom to real-world engineering scenarios. Awards are given on local, state and national levels.

The school's Office of Academic and Student Affairs provides campus tours and hands-on projects for K-12 students by request. Staff members also visit K-12 campuses on request to talk with students about engineering disciplines and careers, and to provide hands-on activities to engage students in engineering-based projects. As many as 200 outreach visits are being made each year.

In addition, the School of Computing and Informatics, a part of the engineering school, offers high school students summer programs where they can learn the basics of robotics and computer games.

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Modeling program primes teachers for instruction

Seventy-five percent of Arizona's 275 physics teachers do not have a degree in physics or physics education. Furthermore, the shortage of physics teachers is acute and worsening, and the situation is not much better for chemistry.

A critical need exists for content-centered professional development in the physical sciences. ASU's Department of Physics is addressing both of these needs with a graduate program that attracts 150 teachers each summer. The core of the program is nine modeling workshops.

ASU's Modeling Instruction is an innovative and successful pedagogy that structures inquiry around scientific models. Modeling courses are content-intensive, and integration of physics, chemistry and math is emphasized. The ultimate target is not the teachers themselves, but their students. Therefore each course addresses the subject at a level that prepares them to entice and inform their students.

Recognized by the U.S. Department of Education as an Exemplary K-12 science program, ASU's summer modeling workshops have not only attracted an international roster of physics and chemistry teachers and led 40 teachers to a master's degree in natural science, but also have enhanced the abilities of 700 Arizona science teachers to prepare their students to analyze data, work in teams and independently, think critically, and express themselves more clearly through written and verbal communication.

Other 21st century workplace skills developed include scientific use of computers and probeware.

Through an Arizona Board of Regents Improving Teacher Quality grant, the program funds 100 teachers of physical sciences each summer, the majority out of field. ASU Summer Sessions contribute 55 tuition scholarships each summer.

Additionally, the Salt River Project and Soroptimists International of Phoenix contributed tuitions scholarships this year.

For more information on ASU's Modeling Instruction, contact Jane Jackson at jane.jackson@asu.edu.

Science, engineering fair

The ASU American Indians Programs Office hosts the Arizona Science and Engineering Fair annually in the spring. More than 800 students in grades 5-12 participate from throughout Arizona.

"Science projects give students the opportunity to learn the process of science, develop critical thinking and problem-solving skills, and provide a hands-on approach to learning," says Phillip Huebner, director of the American Indians Programs Office.

Students who are recognized at AzSEF usually go on to participate in the Intel International Science and Engineering Fair. Several past participants have gone onto large competitions, including most recently a student from the Kyrene School District who was named by the Society for Science & the Public as a finalist of its 2008 SSP Middle School Program – America's premiere science competition for middle school students.

The next AzSEF is March 21-24. For more information about AzSEF, visit http://azsef.asu.edu/home.html.

Scientific literacy: The quest for the never-ending – and the evermore important

When we are not educated about something, we can easily become suspicious, fearful or remain blithely unconcerned.

For example, we see or hear: "The stock market is falling below 8500!" We think: Oh no. That's terrible, though I have no idea what it means.

Or: "We had a whole month of higher than normal temperatures!" We believe: Yep. That must mean global warming and methane release in the Arctic.

Or: "Stem cell research will regenerate lost neural function and cure Parkinson's disease patients like Michael J. Fox!"

The problem is that simplistic statements, the kind that often pepper short news reports, obscure the complexity of real-life situations. How do we evaluate what's false or true? What we need are ways to know how to take such claims and work out for ourselves what we need to know to make reliable interpretations and predictions.

It isn't necessary to have knowledge in the sense of having your head stuffed with knowledge-units or what pass as "facts." Understanding, itself, is power. Whether it is understanding of the basic workings of economic and market systems, of science and policy related to global warming, or scientific/bioethics/policy knowledge related to stem cell science and regenerative medicine, knowing how to go about making sense of competing claims is what makes up scientific literacy.

Jane Maienschein

It is this scientific literacy that STEM (science, technology, engineering and math) education seeks to promote. This also is the goal of Arizona State University's general studies requirements and emphases for all students: to achieve an understanding of how to interpret and evaluate scientific claims. It is the heart of the College of Liberal Arts and Sciences requirement that science students study "Science and Society."

What do we mean by "sustainability," for example, and how will we know it when we see it? How can we understand "complexity?" How do we make sense of "origins?" These are ASU initiatives at the intersection of where science meets society. It takes STEM literacy and awareness of the relations of science and society to make sense of these complex issues. ASU puts the power of knowing in your hands.

– **Jane Maienschein** is a Regents' Professor, President's Professor and Parents Association Professor in the School of Life Sciences, and director of the Center for Biology and Society at ASU. She and her undergraduate students wrote the only student-written editorial in the journal *Science*, which continues to be a standard on the topic of scientific literacy. The other editorial "To the Future – Arguments for Scientific Literacy," appeared in *Science Communication* in 1999.

Grant supports universitywide STEM 'Pipeline Project'

By Christine Lambrakis

The U.S. trend of a shrinking candidate pool in the science, technology, engineering and math (STEM) sectors was so alarming a few years ago that it sparked a call by the Information Technology Association of America and the National Academy of Sciences for policy to increase the number of STEM graduates and the number of computer specialists.

This fall, the School of Educational Innovation and Teacher Preparation at Arizona State University Polytechnic received $1.35 million in National Science Foundation funding for a three-year year project to grow that candidate pool for the future. The program, Prime the Pipeline Project (P3): Putting Knowledge to Work, intends to increase high school students' interest and achievement in STEM fields, as well as to update mathematics and science high school teachers' knowledge of those subjects.

"The core element of P3 is engaging students in a scientific community where they will work on extensive long-term projects that are of high interest and require application of concepts and skills in mathematics, science, technology and business," says Carole Greenes, principal investigator and dean of the school.

The program will involve students, parents, math and science teachers, administrators and guidance counselors from the Chandler, Gilbert, Higley and Mesa school districts.

The grant includes design of projects or problems that students and their teachers will tackle in partnership with ASU faculty and scientists from business and industry. A number of these projects will involve the use of large databases, like those available from the Center for Disease Control large grocery store sales records, and USDA.

Initial project ideas include the food supply chain, from food safety and production practices to sales data, food consumption and health; biomedical science and health care application, focusing on characterizing the relationship of obesity and diabetes to food-buying patterns; crime mapping; and the economics of certain types of alternative energy.

The sheer scope and size of this program is enormous and will involve Greenes and many ASU faculty, including professors Colleen Megowan-Romanowicz, Sethuraman Panchanathan, Timothy Lindquist, and Lakshmi Munukutla as co-investigators and Deborah Toolson as project director.

"Based on research, we believe our methods will be beneficial because of the collaborative transdisciplinary approach to problem solving," says Greenes. "The program will develop critical thinking, technology, computer and communication skills in high school students, better preparing them for entry into college in the STEM fields."

The program also plans to incorporate a nine-week after-school component, a two-week summer immersion institute, and courses for teachers and mentors.

For more information or to get involved, contact Greenes at carole.greenes@asu.edu or Toolson at deborah.toolson@asu.edu.

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First year math crucial to students' success

(Continued from page S1)

"There is a call both locally and nationally for first year math to engage students in authentic problem-solving activity and to provide more quantitative literacy, for example, how to read graphs in newspapers, in addition to solving computational problems," says Carlson, who, along with her research group, is involved in pilot projects that are looking at more effective ways to use computers to enhance the learning experience.

And, it is in part this connection between teaching first year mathematics and research in math education that attracted Milner to leave Purdue University for ASU.

"Math ed should underlie the delivery mode in which we teach; math ed serves more than one purpose," he says. "The main charge, by definition, is to produce K-12 teachers. On the other hand, on the research side, faculty researchers are looking at delivery modes, how the teaching should be done. They are uncovering ways in which people learn."

Many of the faculty members who teach first year math courses have a background in math education and an interest in what makes people learn, Milner says.

"They enjoy designing projects on how to improve our teaching to help our students learn here in college."

Dean Bacon, who chaired the search committee for the director of first year mathematics, says Milner is a highly regarded mathematician "who impressed us with his interest in bridging research in mathematics education with the delivery of first year math, his vision for how we might do that at ASU, and his strong desire to make a difference in the lives of our students."

Milner's research is in applied mathematics, mathematical biology, mathematical modeling, nonlinear partial differential equations and numerical analysis.

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Get SMART: Senior wins prestigious Department of Defense scholarship

By Steve Des Georges

Tim Nolen, a senior pursuing an applied computing degree in Arizona State University's New College of Interdisciplinary Arts and Sciences, has been awarded a Science, Mathematics and Research for Transformation (SMART) Scholarship by the U.S. Department of Defense. The prestigious scholarship service program was established to support undergraduate and graduate students pursuing degrees in science, technology, engineering and mathematics (STEM) disciplines.

"This is very rewarding, to be provided the opportunity to be in this program," says Nolen, who expects to receive his bachelor's degree in May. "I'm excited about this because I think serving your nation is an honorable thing to do, and this will give me the chance. I'm also looking forward to experiencing the great programs the government has for advancing education while you work."

Nolen will get his chance. Part of an effort to improve the flow of new, highly skilled technical labor into Department of Defense facilities and agencies, and to enhance the technical skills of the work force already in place, the SMART scholarships include placement in paid summer internships. Upon graduation, SMART award recipients are placed in civilian jobs in the department's laboratories and agencies. As the post-degree service commitment is commensurate with the length of the scholarship award, Nolen's will be a guaranteed one-year employment stint.

"New College and this (applied computing) degree have given me the tools and the knowledge I need," says the resident of nearby Glendale who graduated from Ironwood High School in 2004. "There aren't too many database-specific degree programs at colleges, so this has been a real advantage and a benefit."

The bachelor's degree in applied computing encourages students to learn approaches from a multi-disciplinary perspective. It focuses on the creation, use, dissemination and administration of information to users in government, nonprofit, academic, business, library and other settings through the merger of technical and other approaches. The degree curriculum emphasizes the selection, evaluation, description, storage, retrieval, manipulation and presentation of information in all its forms, including text, image, sound and numbers.

Tim Nolen

As a senior in New College's Mathematical and Natural Sciences division, Nolen notes among his coursework accomplishments a pair of projects exploring technologies related to databases and the Web.

In the fall of 2007 he used Microsoft technology with ASP.NET, a free technology available to any user to create a modern Web site, and SQL Server, a relational database system. In an independent study course this spring, Nolen was part of a team that investigated the teaching of databases in conjunction with Web programming. His piece was to investigate the open source technology of php, a general-purpose scripting language suited for Web development, and mySQL, a database management system popular for Web applications. In the summer he was part of a team that wrote a paper that compared the two approaches.

He worked on the project with Suzanne Dietrich, New College associate professor of applied computing, and Mahesh Chaudhari, one of Dietrich's doctoral students from ASU's Tempe campus where she is an affiliate faculty member in the Department of Computer Science and Engineering. The paper is being used this semester as an introduction to databases and the Web in a third-year applied computing course, Database Systems and Transaction Processing, with an eye toward publication in the future.

"Tim is a student who consistently accepts the challenges presented to him, either through coursework or independent study," says Dietrich, who received her doctorate in computer science from the State University of New York at Stony Brook in 1987. "He is not daunted by the amount of effort required, and he goes beyond the requirements, verifying his understanding each step of the way."

Dietrich says Nolen, whose study concentration is advanced database systems, is perfectly suited for the SMART award, one that recognizes an advanced aptitude and interest in conducting theoretical and applied research.

"He definitely demonstrates those qualities," she says of her first SMART recipient. "He is an independent thinker and a problem solver who works very well in a team environment.

"He will gain hands-on database experience through employment with his sponsoring Department of Defense lab for at least a year after graduation. Beyond that, he has so many opportunities to consider, including furthering his education and continuing research in graduate school."

Elizabeth Langland, dean of New College, says the research done by Nolen is indicative of the college's opportunities.

"This is the first year we have posted the SMART scholarship, and it is not surprising to see one of our students rewarded. What separates New College from other liberal arts schools is this very opportunity to conduct research alongside faculty."

Nolen doesn't yet know the specifics of what his assignment with the Department of Defense will entail, but knows it will be in the database area in the Army.

"As long as I am satisfied and feel like I am accomplishing something important, I'll be happy, though I imagine I'll strive toward some sort of higher degree – a master's or Ph.D., perhaps."

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