Solving the STEM Education Puzzle One Piece at a Time

By Julie Smiley Foster

The academy provided me a seamless transition to college.” That’s how University of Oklahoma (OU) freshman Abigail Jebaraj summarized the end result of spending afternoons for three years in the Biosciences and Medicine Academy (BSMA) at Francis Tuttle Technology Center (FTTC) in Oklahoma City. Accepted into the Medical Humanities program at OU, Jebaraj earned provisional acceptance to medical school as a senior in high school. She maintains her position in the humanities program and her medical school seat with strong grades, and a test score equal to, or greater than, the incoming class average on the Medical College Admission Test. She was homeschooled, is a National Merit Scholar 2012 and was president of Oklahoma HOSA before leaving the college-preparatory academy for pre-med studies. Despite the obvious academic successes, she was clearly uncomfortable and ill-at-ease answering questions in the required interview for acceptance into the BSMA. By the time she graduated from the academy, she possessed sufficient academic, laboratory, soft and professional skills to pursue her medical school career goal.

The Statistics

In Oklahoma, 38 percent of incoming college freshman who graduated from Oklahoma high schools in 2010 required at least one remediation course, as documented in Oklahoma’s “Promise 2011–2012 Year End Report,” costing students time and money without earning college credit. Nationally, the remediation rate for incoming college freshman was 60 percent, as reported in a 2010 report by the National Center for Public Policy and Higher Education and the Southern Regional Education Board. Math and English often required the most remediation. The report also found that the “majority of students who begin in remedial courses never complete their college degrees.” The report continues: “Even those students who have done everything they were told to do to prepare for college find, often after they arrive, that their new institution has deemed them unprepared. Their high school diploma, college preparatory curriculum and high school exit examination scores did not ensure college readiness.”

Another alarming prediction came from “Oklahoma’s Health Care Industry Workforce: 2006 Report,” indicating a shortage of 3,135 nurses, 606 medical lab technicians, 432 physical therapists and...
303 surgical technologists by 2012. Recommendations from the report included increasing retention and graduation rates in health care education programs, and greater effort to attract students to health care careers at an earlier age.

Other statistics, reported by the Advisory Board Company, a health care research group, show Oklahoma in 2010 ranked among the 10 worst states for the number of physicians per 100,000 residents. Put statistics together, and leaders in Oklahoma wondered about a shortage of health care providers plus incoming college students unable to successfully complete College Algebra and General Chemistry I and II. The state faces a need to not only ready students for university success, but also to find students prepared and motivated to pursue health care careers. Mix the rising cost of university education plus growing student debt, and the puzzle pieces do not fit and become even more difficult to put together.

The Program

In 2003, Oklahoma’s career and technical education (CTE) system joined a conversation that would allow high school sophomores to attend half-day, college-preparatory pre-engineering classes, and permit academic high school science and math courses to be taught at technology centers in the state, said Danny King, an administrator of the FTTC Pre-Engineering Academy. Legislation was passed to clear the way for FTTC to open the state’s first pre-engineering academy in 2003, followed by the first biomedical academy in 2007. Both academies are focused on rigorous academic preparation and hands-on learning for problem-solving and critical-thinking acquisition. In addition, FTTC became part of the Project Lead The Way™ network of schools that teach pre-engineering and biomedical science curriculum. Science, technology, engineering and math (STEM) education and college preparation are now emphasized by the state’s CTE system, along with traditional kinds of vocational and skills training.

The BSMA student comes from one of 11 sending high schools inside the FTTC district. Academy coursework is a choice for homeschooled students who seek upper-level math and science education. Student and parental choice are both the basis for academy enrollment. Students apply and must interview with their parent(s) for a seat in either a morning or afternoon academy class at FTTC. They attend their home high school for English, social sciences, foreign languages and all other required high school coursework, and then board a bus or drive to FTTC for math, science and PLTW elective courses for the remaining half day of school.

In the six years since the BSMA began, student numbers have grown from 43 to 136 pre-enrolled for fall 2013 classes. The staff has grown from two to five full-time instructors who are state certified in math.
and/or sciences. Three instructors are PLTW-trained to teach students the four biomedical science courses: Principles of the Biomedical Sciences, Human Body Systems, Medical Interventions, and Biomedical Innovation.

**The Pieces of the Puzzle**
Programs come and go, all claiming to increase student academic proficiency and calm parental concerns that students are academically prepared for university study. For the record, the BSMA instructors do not claim success, but do point to four areas of focus they believe draw the jigsaw-edged pieces of student learning together. In order to develop and grow high school students who are college-ready and health care-driven, BSMA math instructor Gary Piercey points to an emphasis on academic preparation, hands-on learning, leadership development and exceptional experiences to put the pieces together for students.

**Academic Preparation**
Academic preparation is a foundation piece for further education. Instructors have documented entering students’ 10th-grade PLAN and 12th-grade exit ACT scores to quantify academic achievement. As a mathematician, Piercey said test scores are just one way to verify the quality of student learning. “If we are not providing a viable alternative to academic rigor students may be able to get at their own high school, then why go out of the way to spend a half day with us?” Focusing on an aggressive math and science curriculum, Piercey said the BSMA saw exit composite ACT scores average 27.8 in 2013. The math average was 27.8 and science was 27.6. For the same group of students, their PLAN composite was 19.8 when they started in the academy. BSMA seniors saw a seven point advantage in their ACT score over the 2013 state composite of 20.8.

Statistics aside, students report being prepared for university studies, particularly as they reflect upon the completion of their first college semester. In August 2012, Jordan Karim began medical school studies in the six-year BS to MD program at the University of Missouri Kansas City. By February 2013, he said he felt prepared for the rigorous medical coursework and confident in his ability to manage his time and responsibilities. “The BSMA created a venue where I could devote time to a specific career field. It also helped me with speech development and public speaking skills … [and] organization and study habits.”

To provide as much academic preparation as possible, academy instructors make themselves available before and after school for personal tutoring. Piercey engages in twice-weekly online math-tutoring webcasts. Chemistry and PLTW instructor Jennie Croslin offers optional Saturday labs once a month. Her students are offered 21 labs for AP Chemistry, with each requiring a written formal lab report. “There isn’t enough time in class to complete 21 labs, so the Saturday labs are optional, and [are] an opportunity for students to get ahead and prepare for the AP Chemistry exam in May,” said Croslin. The extra lab and tutoring time has resulted in students earning qualifying scores in AP Chemistry, and AP Calculus AB and BC that return college credit to the student, as well as student confidence in math and science.

**Hands-on Learning**
Hands-on learning requires added preparation time for instructors, but the results make the extra effort and dedication worthwhile. PLTW instructor Stephanie Harris said students must become problem solvers to be successful in a health care career. Student-centered learning is
the focus of any PLTW lesson or activity. “Students are given a problem or health crisis, and then it is their job to research and propose a solution,” said Harris. “It’s problem solving and critical thinking, and for most high school students, they don’t know how to do that. Most high school students are used to answering the questions with the ‘right’ answer.” Her approach reflects the academy philosophy that allows students to struggle as they solve a medical mystery by proposing and researching a novel intervention. Students use books, Internet sources, video conferencing, laboratory equipment, experimentation and expertise from professionals to refine their academic capabilities; but students also experience what it might be like to work in an emergency room or take someone’s vital signs as part of a health history.

The interlocking piece that drives academic preparation is hands-on learning. Students tend to remember what they have touched with their hands and has engaged the senses. Hands-on learning provides students an opportunity to use equipment, acquire appropriate laboratory skills to experiment and discover, and moves students to higher-order thinking. It is not enough that the book may say 15 potato chips contain 150 calories. Students want to know how that is determined and what that means to their own diets. In a PLTW class, students actually burn the food, measure the amount of heat generated and calculate the calories. It is called calorimetry, and it requires students to use lab equipment safely, collect and analyze data, and propose a conclusion. CTE is famous for hands-on learning and teaching students skills that result in positive employment opportunities. However, some health care professionals require high levels of academic proficiency and lab skills.

In addition to a rigorous human anatomy and physiology study, the BSMA also offers microbiology—a course not often taught in high school. Microbiology not only gives students an opportunity to learn academically about microbes, infectious diseases and biologic processes, but it also requires an in-depth training in aseptic technique, safe handling of live microbes and effective microscope use. These skills set BSMA academy graduates apart from their counterparts.

Leadership Development
A third puzzle piece engages students in leadership development. HOSA: Future Health Professionals is part of the BSMA, just as academic, hands-on learning and skill preparation contribute to student development. Cierra Thomas, a 2012 graduate and Vassar College student, said the academy helped her decide upon an anthropology major and biology minor, helped prepare her for college by writing lab reports, and helped her to feel “confident in what you are doing.” CTE calls these soft skills, but BSMA labels them essential to the development of a complete student. Academy students regularly present to their peers and speak publicly as they present what they have learned to the class. Over the course of two or three years, academy students are comfortable telling their story and collaborating with other students and adults.

The ability to project self-confidence is invaluable to young people who are able to engage with a screen, phone, Facebook, Instagram and Twitter, but who also must be able to talk to patients and work for a generation of adults who are more verbal and do not rely on social media and technology to the same degree to communicate. Parents, the unsung partners of the BSMA, notice a change and maturity in their own children. Kay Harsha, a businesswoman, advisory committee member and parent of a 2012 graduate, said she and her husband could not be more pleased with the academic and leadership development they witnessed in their son over the three years he flourished in BSMA. “It’s the best-kept secret in education.” She said they tell anyone who will listen that FTTC and BSMA offer great college preparation. Before students complete academy studies, the students have developed a professional resume and cover letter in addition to a portfolio, with examples documenting their experiences and achievement.

Exceptional Experiences
A fourth component to the STEM education puzzle is BSMA’s commitment to offer students exceptional experiences. Jody Wemhaner, FTTC health science instructional director, recalls BSMA’s beginning in 2006 and the emphasis on health education and health career exploration as key to academy genesis. “Exceptional experiences are intended to provide academy students with real-world opportunities to see firsthand what medical professionals are doing. We want students to develop a relationship with a professional mentor and to be inspired through job shadowing or experiential learning related to their chosen profession,” Wemhaner said.

Between cross-curricular lessons that include math, writing, biology and chemistry, and exceptional experiences, BSMA instructors encourage and challenge their students to develop academically and personally …
Two academy students shadowed physicians and support staff in a hospital emergency room, and “exceptional” is the only way to describe their experiences with a “code” and standing nearby as medical residents treated acutely ill patients in the emergency room. Experiences change students’ minds about what is possible in their own lives. As one teacher said, “Sometimes you have to dream for your students because they don’t know what dreams are possible.”

Valuable Advice
Dreaming may offer inspiration, but academy instructors rely upon advice from the BSMA Advisory Committee members. University partners advised early on that successful university students must be able to read effectively and critically, comprehend and compose. Heeding good advice, formal laboratory reports, essay test questions and well-written personal statements are emphasized and taught in the academy. In addition to writing skills, advisory members remind instructors that students must have a strong foundation in math and biology. Doing upper-level math well and understanding how cells work seem obvious for someone pursuing a health care degree, but students must develop deep academic roots for university success. As the BSMA was being formed and teachers hired, always understood was a necessary collaboration between science, math and PLTW-trained instructors. The discussions, ideas and cross-curricular lessons that arise from a balanced collaboration between academy instructors have proven successful in the development of the “total student.”

Preparing Students
Between cross-curricular lessons that include math, writing, biology and chemistry, and exceptional experiences, BSMA instructors encourage and challenge their students to develop academically and personally as these future health care providers work through the issues of growing up and high school. It is not easy for students to push their own intellectual limits and perhaps fail at an inquiry. But instructors believe the total student is a problem-solver and critical thinker. Successful BSMA graduates are skilled in many lab techniques appropriate for university success. Not only do most students have an improved ACT score upon graduation, but they have received career direction and soft skills training to help them navigate rigorous prerequisite university math and science coursework leading to a health care career. CTE emphasizes hands-on, real-world training. The BSMA has added academic proficiency to the experiences and, in the process, may have solved the puzzle, one piece at a time, of STEM education.

References
8. HOSA: Future Health Professionals is a CTSO endorsed by the U.S. Department of Education and the Health Science Education Division of ACTE. HOSA’s two-fold mission is to promote career opportunities in the health care industry and to enhance the delivery of quality health care to all people. HOSA provides a unique program of leadership development, motivation and recognition exclusively for secondary, postsecondary, adult and collegiate students enrolled in HSE programs. Retrieved from: www.hosa.org/node/11 To find out more about HOSA, visit: www.hosa.org/