

ST. CATHERINE UNIVERSITY



STEM
at ST. KATE'S

SCIENCE TECHNOLOGY ENGINEERING MATHEMATICS

**Answering the STEM Imperative
in Elementary Education**

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Answering the STEM Imperative in Elementary Education: The National Center For STEM Elementary Education's In-Service Program for Current Teachers

Throughout his presidency and notably in his 2013 State of the Union address, President Barack Obama has stressed the need to equip more young Americans with the Science Technology Engineering and Math (STEM) skills to meet the demands of our high tech economy. Following in a line of many presidents, Obama highlighted STEM while setting up a program to reward K-12 schools that develop new partnerships with colleges and employers to get the job done.

As it turns out, St. Catherine University in St. Paul, Minnesota, is currently the only higher learning institution in the country that offers a specific program to assist elementary schools with STEM instruction. The National Center for STEM Elementary Education (NCSEE) at St. Catherine has created these kinds of partnerships with school districts and private sector corporations in Minnesota. Using curriculum developed by a multi-disciplinary team of scholars, the Center has implemented an in-service training program that has shown improvement in test scores in STEM disciplines and increased the proficiency of elementary teachers in science, technology, engineering and mathematics.

If implemented more broadly, this methodology can better prepare elementary teachers to engage students in STEM at a young age and encourage them to stay engaged through schooling and into their adult lives.

A STEM education focuses on science, technology, engineering and mathematics. It is the cornerstone of a national effort to create a more scientifically and technologically-literate population. The reasons for promotion and funding of STEM are clear. Innovation is the foundation of our nation's economic growth now and in the future. The best paying jobs now and into the future are in positions requiring at least some knowledge of science and technology. Among those professions are information technology, health care, sustainability, manufacturing, aerospace, finance, education, transportation and bio-based business.

Since the launch of Sputnik — the Soviet Union's artificial satellite that spawned the "space race" — the American elementary educational system has been working to gain parity in STEM education. Initially, the majority of STEM educational programming was developed for high school students, and, in recent years, STEM educational initiatives for middle school students have drawn support.

But research shows that the missing link, clearly, has been the elementary school curriculum. It is in those early formative years when young minds first encounter the opportunity to practice supervised and unsupervised science and technology: When they first take apart objects to learn how they work; when they see the world and ask how it works — why bridges do not fall down, how Internet magically appears everywhere, how engines operate, how digitally enhanced movies are produced. It can be an age where students first find a love for science and technology that can grow into future university degrees and careers.

The methodology of how STEM is incorporated in some K-6 schools often suffers because third-party curriculum projects are unclear, misdirected or simply not relevant to students. Some school districts have excellent programs for upper grades and not much for K-6 pupils. Or they may employ aspects of STEM without a tested pedagogy. In a handful of cases the results can sometimes backfire by turning off rather than turning on students to STEM subjects.

AN INTRODUCTION TO ST. CATHERINE'S STEM PROGRAM

St. Catherine University in St. Paul, Minnesota launched the National Center For STEM Elementary Education in 2010. The Center evolved from a 3M-funded program development grant in 2003 to prepare elementary teachers to engage younger students in the STEM disciplines and develop life-long interest in science technology, engineering and math.

The Center has built a program and methodology that allows schools and school districts to deliver STEM teaching professional development for elementary school teachers within their own teaching teams.

Two Minnesota school districts, have served as pilot projects for in-service education. Initial test scores of students in both districts show improvement and the promise of more of it. The University has signed contracts to work in six more schools, among them are institutions not only in Minnesota but in other states. With a long record among the top schools in Minnesota for graduating elementary school teachers, St. Catherine is well suited to serve a regional and national role in promoting, developing, researching and delivering STEM education to educational professionals. This white paper will provide background on St. Catherine's approach to STEM education to elementary school teachers in the field and illustrate through examples how the program has succeeded in improving results in STEM disciplines in different school districts.

The St. Catherine Undergraduate Model

St. Catherine created the first university education school in the country to require elementary school graduates to receive a STEM certificate before obtaining a teaching license. A forward-thinking engineering class for elementary school teachers was later developed as states began to require rudimentary skills in that area in K-6 classes. The university also offers undergraduates a minor in STEM, graduate certificates in STEM and has built and tested STEM curricula and materials and, through the NCSEE has begun actively consulting with school districts. The university also offers the nation's first, and one of its only, STEM education programs specifically tailored to Montessori students.

A brief history of STEM at St. Catherine starts in 2004, when a team of faculty from different departments, including education and STEM disciplines, came together to create a program generously funded by the 3M Foundation. The team focused on improving STEM education of by combining education methods with the content expertise in biology, chemistry, physics/engineering, and mathematics. The idea was make these courses relevant, insightful and fun not only for university students but elementary school teachers already in the profession seeking to burnish their knowledge and teaching skills.

In the first years the Center focused on developing a methodology for training teachers in the STEM disciplines and teaching methods. Courses were redesigned to improve outcomes. By 2010, St. Catherine established a three course STEM Certificate and five course STEM minor. Required of all elementary education students, the STEM Certificate includes three interdisciplinary, team-taught, lab-based courses in biology, chemistry, and engineering/physics. The courses are aligned with state and national standards while utilizing cutting-edge classroom techniques to engage students in STEM through project-based learning and inquiry-based experiences.

With a well-regarded reputation for offering continuing education credit courses to working professionals, St. Catherine has pioneered a STEM Graduate Certificate program that largely mirrors the certificate students receive but focuses content on working teachers and training district or school based cohorts in order to build sustainable support systems within schools and districts. By deploying classes directly to teachers in the schools where they work, the program allows instructors to participate without having to travel to a university campus

and for those classes to be offered at convenient times in summer and during professional development days. St. Catherine faculty comes directly to host institutions and provides a team-taught, interactive environment where a subject matter expert — a biology professor, for instance — teaches alongside an education professor.

The undergraduate certificate features the following courses: Chemistry of Life, Environmental Biology, and Engineering in Your World. Instructors weave technology and mathematics into all three courses. In addition, elementary education majors are required to take two additional courses in mathematics. Should education majors want to seek a STEM minor they can complete the additional courses on St. Catherine University's St. Paul campus.

The STEM Certificate and minor have earned national and regional accreditations including: Minnesota Standards of Effective Practice in Science/Math; National Science Teachers Association Standards; National Science Education Standards and the International Society for Technology in Education Standards.

In-Service Advantages

With experience teaching the STEM Certificate courses in several schools, St. Catherine staff sees several advantages to in-service learning. The in-service approach offers St. Catherine the ability to work closely with school administrators to tailor the STEM Graduate Certificate to the specific needs of their teachers. Professors who teach the courses see precisely what resources the schools have in terms of supplies, technology and the classroom environment.

School administrators can observe classes and survey their own faculty on what works, and what does not, and make informed decisions on necessary changes in collaboration with St. Catherine's faculty.

STEM in-service instruction offers two other advantages. Professors and fellow teachers offer onsite coaching and ideas on incorporating STEM into their classes. They offer advice, assemble teaching toolkits with supplies and make other suggestions. The Center benefits, of course, too, by collecting data from the learning laboratories of the schools. The University's faculty learns the best practices for example, for teaching engineering by having children create Lego (™) robots or how nutrition works to power the human body.

The in-service STEM Graduate Certificate takes 18 months and is delivered in the following structure:

- Five days of concentrated workshops, 6 hours per day, held in summer.
- Onsite sessions during the school year featuring hands-on STEM activities and discussion.
- Constant review of the existing science curriculum to find optimum ways to integrate STEM concepts.
- Support and mentoring from St. Catherine faculty throughout the academic year both onsite and online.
- Frequent feedback provided by fellow teachers who offer suggestions on modifying and improving STEM-teaching techniques.

The program provides participants with toolkits filled with relevant STEM teaching/learning materials they can use in their classrooms. Credits gained in the STEM Graduate Certificate can be used for continuing education accreditation as well as serve as the basis for further study toward a Master's in Education Curriculum degree.

ST. CATHERINE'S IMPACT ON A RICHFIELD STEM SCHOOL

Richfield is a suburb of more than 45,000 residents that sits adjacent to south Minneapolis. Over the past decade Richfield has been transformed by people of color and by immigrants moving into the city.

Today, the school district reflects that diversity, particularly in the Richfield STEM School. In an effort to train students for a more technological future and to help bridge Minnesota's disturbingly large achievement gap, the school district created the STEM school, which opened in 2010.

With a student population of around 800, more than 70 percent of the students in the STEM school are non-white. Roughly the same percentage of students is in the free-and-reduced lunch program indicating a low family income. Located in a former junior high school, the school's 32 classroom teachers enrolled in St. Catherine's STEM program as the school was opening in 2010.

School principal Joey Page said the teachers took the courses first before the district opened it to staff — such as special education and English as a second language instructors — at the school. Also invited were teachers involved in STEM instruction throughout the district.

All told, 50 teachers participated and earned STEM Graduate certificates. The instruction began in the summer of 2010 just before school opened and on every staff development day for the subsequent two years. "Every staff development day we had in the district St. Catherine was here, meeting with us eyeball to eyeball," he said. "There were online forums where our staff was submitting their work. And when the school year was done we met again. We loved it and I think St. Catherine staff really enjoyed it because we're a captive audience."

The teachers sought help in particular with engineering since many had experience teaching math, a strong subject at the school. "Engineering was new to us and they helped us build a strong foundation of the understanding of engineering, the principles and the elements of design," Page said.

The program focused less on technology the school possessed — such as iPads, digital cameras and electronic white boards — and more on teaching children to build technology such as flashlights and solar ovens out of pizza boxes. The hands-on projects were important for children in understanding how products and devices are put together, he says, while offering teachers a chance to move from lecturing to creating things.

"We're seeing improvement in our state schools for reading, math and science," he says. "They've never been higher than in reading and science. The results are pretty much the same with math. There's been a high level of engagement with the kids, and a lot of enthusiasm."

Data from the Minnesota Department of Education confirm the increases, most dramatically in science.

In 2010 Richfield's STEM school saw only 16.5 percent of students reach proficiency in science but by 2012 that number shot up to 44.6 percent. The gain was made despite a greater number of students taking the state exam, which usually has a negative impact on scores.

Reading scores jumped 10 percent to 62.5 percent proficiency from 2010 to 2012. Math scores, meanwhile, stayed steady, above 50 percent proficiency. In all of those topics the STEM school scored above Richfield district averages and only slightly below the state as a whole.

A final benefit of the STEM involvement has been a positive reaction among parents who have students at the school. They have spread the word and enrollment continues to climb, says Page. "The STEM training really helped us move forward as a school."

LAUNCHING BROOKLYN PARK'S STEM PROGRAM

In Brooklyn Park, a Minneapolis suburb of 76,000, Brooklyn Junior High began a STEM training program with St. Catherine in 2012 during the school year.

The idea was to test STEM out with students in a pilot project and then roll it out to the full school afterward. The reason for the focus on STEM was simple. "Our mindset was if we keep doing things the way we're doing them we keep getting the results we've gotten — we wanted to enrich our kids and gave them the skills they need to survive," says Dana Truth, curriculum integration specialist.

The richly diverse school has around 950 students and many come from challenging circumstances. More than half are on the free and reduced lunch program. More than one third of the school's students move into or out of the school annually.

After months of planning, the school deployed STEM in two classes of 66 seventh and eighth graders last year. Then the school took the next step by enrolling 14 teachers in the onsite STEM Graduate Certificate program offered by the National Center. Elementary schools in the school district added another 13 teachers to the program. Participation in the program was funded by Boston Scientific, a med-tech company with a large presence in the region.

Brooklyn Junior plans to roll out STEM for all 7th and 8th graders in the Fall of 2013. Unlike a pure STEM school, Truth says the teachers being trained by St. Catherine come from a variety of disciplines such as foreign language, science, math, social studies and art. They like the opportunity to learn how engineering can be incorporated into music, math and other subjects, he says.

Despite being in place for only a single semester, progress can be seen in the results of the "Explorer" test taken by 7th and 8th graders. Scores jumped 12 percent school-wide and Truth expects the state scores to increase too.

St. Catherine has helped make the STEM curriculum a lot more relevant for students and staff. Truth made a connection to a local architecture firm that will use students to assist in designing a new bike path through the city. "We're looking at extending another bike path from the school to Shingle Creek Parkway and having an outdoor classroom," he says. "The STEM program has turned out to be a positive experience for all of us."

CONCLUSION

St. Catherine's success in Brooklyn Park and Richfield reveal that a platform based on teaching on a university campus can be delivered just as effectively in an in-service environment. The painstaking development of the St. Catherine undergraduate STEM minor, STEM Certificate and STEM Graduate Certificate has led to a new cadre of professional educators armed with the content and materials, and able to jumpstart their students' understanding of science, technology, engineering and math.

Having a STEM education may be no guarantee of success in the academy or in life but it is clear, from the evidence, that employment related to those skills will only grow. Planting the seeds of a love of science, technology, engineering and math early will help prepare students for a growingly complex world. St. Catherine's program holds the promise of making major contributions to bridging the achievement gap and creating a trained workforce able to fill the growing number of technical jobs being developed as our global society undergoes a fundamental transformation.

For more information or copies of this report, contact: stem@stkate.edu.



**ST. CATHERINE
UNIVERSITY**

2004 Randolph Ave.
St. Paul, MN 55105
stkate.edu