



Integrating STEM into Technology Education Programs

by Sylvia Tiala and Phil Winegar

How do K-12 schools, colleges and universities respond to science, technology, engineering and math (STEM) initiatives that have become a national priority?^{1,2} A Wisconsin high school and university are responding to changes in education policies by using a proactive approach that focuses the development of quality programs.

In the past decade, there has been an increasing amount of pressure to help all students succeed in K-12 school settings, increase graduation and retention rates, and increase a school's accountability for student learning tied to standards.^{3,4} Elections, recessions and fast-paced globalization leave K-12 teachers and administrators operating in educational environments with constantly shifting social, economic and political realities. Universities preparing pre-service teachers are sensitive to the issues and the needs of their K-12 constituents and are subject to the same shifting realities.

STEM initiatives have become a national priority in part due to President Obama's 2009 Educate to Innovate campaign and his Race to the Top initiative.^{5,6} These policies are designed to increase the quality of education while creating employment and advancement opportunities for today's students. Public schools, colleges and universities are supporting these goals by preparing students for college and careers, as well as getting them ready to perform in a global society by including stakeholders in the education process.^{7,8,9}

At the beginning of the 21st century, educators found themselves responding to the No Child Left Behind Act.¹⁰ By the end of the decade, it became clear that educational reform was an ongoing process requiring a focus on long-term goals and improvement using stakeholder feedback. Within this context, Menomonie High School's¹¹ technology education program and the University of Wisconsin-Stout's¹² (UW-Stout) technology education teacher preparation program incorporated Project Lead the Way (PLTW),¹³ a pre-engineering program with a STEM focus tied to standards in their programs.¹⁴

STEM at Menomonie High School

The technology and engineering program at Menomonie High School is best described as a traditional yet progressive program. A quick look at the facilities leads an observer to believe it is a traditional program. With the exception of the communications lab, the facilities do



not appear to be high tech. Communication, multimedia, construction and production courses are included as part of the program. Closer examination, however, shows that instructors in Menomonie's technology and engineering department are also committed to the PLTW program. Principles of engineering, digital electronics and introduction to engineering design classes are offered at the high school, while PLTW's gateway to technology program is offered at the middle school level. Gateway to technology at the middle school is where students get their first taste of technology and engineering. Therefore, it's an important first step for students interested in STEM.

Menomonie's program and course content is hands-on and minds-on, with STEM integration being a key to students' success. The technology and engineering department is in a unique position to apply the math and science knowledge through an engaging, hands-on environment. It is designed to develop excitement and understanding of how to apply technological concepts and systems. All activities use hands-on experiences to motivate students and make connections between math and science core areas and real-world applications. Students are challenged to use the technology and engineering facility to design, fabricate, measure, test and process solutions in an efficient and safe manner.

STEM activities and lessons develop students' problem-solving and decision-making abilities by using human and material resources, processes and technological systems. Students are prepared for lifelong learning in a technological society because they are exposed to activity-oriented laboratory experiences that reinforce abstract concepts with concrete experiences. This combined know-how and the ability to carry out technological work transforms technological understandings, communication skills, language arts skills, social and societal understandings, math concepts and scientific knowledge into reality.

Menomonie's technology and engineering department uses proactive strategies that focus on continuous improvement. Curriculum is tied to state and national math, science and technology standards. Students meeting eligibility requirements can obtain college credit for their high-school courses, which helps create career paths for students interested in STEM careers. An advisory committee includes representatives across the STEM subjects, business and industry partners, and post-secondary representatives. The advisory committee meets several times each year to discuss program direction, improvements and strategies for student engagement.



In 2008, Menomonie's technology and engineering department's efforts earned them recognition as PLTW's Model Program of the Year, as well as the Wisconsin Technology Education Association's 2007-08 Program of the Year Award.¹¹

STEM at the UW-Stout

The technology education program at UW-Stout meets the challenges of preparing teachers to engage today's K-12 students in STEM. UW-Stout's technology education program has a history of serving as a training institution for technology educators¹⁵ and resides within an institution that received a Malcolm Baldrige National Quality Award¹⁶ for demonstrating its ability to institutionalize quality systems thinking. The technology education program's focus dovetails well with UW-Stout's designation as a comprehensive polytechnic university¹⁷ that focuses on career development, applied learning and collaborative experiences for its stakeholders.

As President Obama was unveiling his 2009 Race to the Top initiative,¹⁸ calling for quality pathways for STEM educators who are able to work with community partners, UW-Stout's technology education program was addressing the need for STEM educators. UW-Stout committed to upgrading technology education labs and sent university faculty for PLTW training as part of a collaborative partnership with the Kern Foundation. PLTW curriculum, available to more than 30,000 students in 250 schools in Wisconsin,¹⁹ was integrated into UW-Stout's technology education teacher preparation program.

Goals and objectives from six of PLTW's pathway to engineering program²⁰ were aligned with existing content in the technical portion of the teacher preparation program. Pre-service candidates create PLTW portfolios using items similar to what in-service teachers use during two weeks of PLTW summer training. After reviewing PLTW curriculum, compiling portfolios and taking the end-of-course exams, UW-Stout's pre-service teacher candidates are able to leave with the necessary training to deliver the PLTW curriculum in recognized PLTW schools. This training teachers process is designed to help build an infrastructure of PLTW-trained teachers in Wisconsin.

UW-Stout also implemented a dual technology and science education teacher preparation program to serve school districts looking for qualified individuals who can integrate content across STEM fields. After program completion and licensure, these candidates are considered qualified as science and technology education teachers. The dual technology and



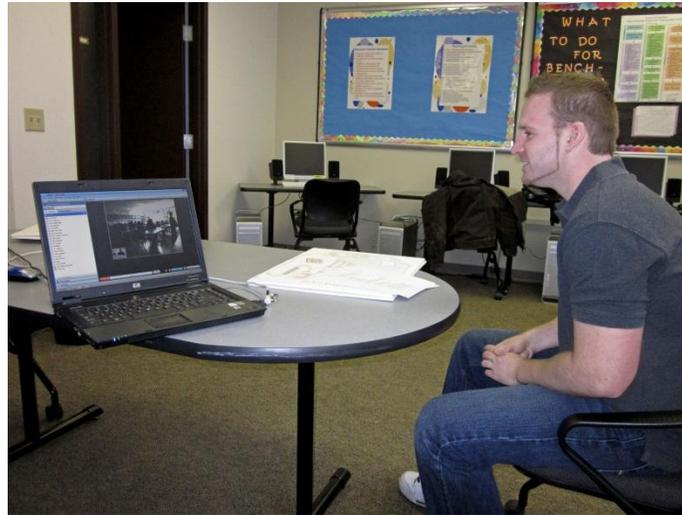
science education program, along with the PLTW training, helps increase the marketability of UW-Stout's technology education graduates and meet the need for STEM teachers in K-12 schools.

Stout's technology education program is expanding its efforts to collaborate with stakeholders. High-school students who meet the criteria can apply for transcribed credit²¹ that applies toward bachelor of science in technology education teacher preparation program in the College of Education Health and Human Sciences and other engineering-related programs within the Science Technology Engineering and Mathematics College. Partnerships and collaborative experiences, such as pre-student teaching and student teaching, are sought out for pre-service teachers in recognized PLTW secondary schools.

Advisory boards for the university's PLTW initiative include industry representatives, pre-service teachers and middle-school and high-school STEM teachers and counselors. Contests—such as the Rube Goldberg and FIRST Lego League that support STEM and PLTW curricula—are sponsored at the university, with technology education majors actively engaged as volunteers and coordinators for the events. These initiatives help the secondary and post-secondary students experience career pathways for teacher preparation in STEM-related fields and the associated engineering-related majors in the STEM college.

PLTW experiences include applied learning opportunities for Stout's pre-service technology education teachers. With the help of UW-Stout's discovery center, PLTW's introduction to engineering design curriculum was integrated into a course focusing on designing exhibits for a children's museum.

Technology education students spent the semester examining topics for museum exhibits. Using multimedia communications technology, the pre-service teachers sought feedback from a focus group of middle-school students to gain insight on topics and activities. The course and related activities incorporated communication and design process elements from PLTW, met objectives for the teacher preparation program and served as a semester-long demonstration of how engineering design could be used to engage secondary students in real-world activities.



Laish Heersma, a pre-service technology education student, uses Skype to get feedback from students as part of a museum design project.

This information is just a glimpse into how one high school and one university are incorporating the STEM curriculum into their programs. In each case, the programs attend to career pathways, focus on standards, use relevant experiences and involve stakeholders. The highlighted programs approach integrating STEM into the curriculum is an ongoing process focusing on quality.

The result has been an increase in formal and informal collaborations between K-12 schools, colleges and universities, and business and industry. The highlighted programs and processes are expected to evolve as individuals and institutions strive to provide engaging and applied STEM opportunities for their stakeholders.

References

1. White House Office of the Press Secretary. "President Obama Launches 'Educate to Innovate' Campaign for Excellence in Science, Technology, Engineering and Math (STEM) Education," Nov. 23, 2009, www.whitehouse.gov/the-press-office/president-obama-launches-educate-innovate-campaign-excellence-science-technology-en.
2. United States Department of Education. "Race to the Top Program Executive Summary," www2.ed.gov/programs/racetothetop/executive-summary.pdf.
3. United States Department of Education, "The Elementary and Secondary Education Act." Dec. 6, 2010, www2.ed.gov/policy/elsec/leg/esea02/index.html.
4. White House, "Promoting Innovation, Reform and Excellence in America's Public Schools," www.whitehouse.gov/the-press-office/fact-sheet-race-top.



5. White House, "Promoting Innovation, Reform and Excellence in America's Public Schools," see reference 4.
6. United States Department of Education. "Race to the Top Program Executive Summary," see reference 2.
7. University of Wisconsin-Stout, "UW-Stout Mission and Strategic Plan," Oct. 14, 2009, www3.uwstout.edu/geninfo/stratplan.cfm.
8. School District of the Menomonee Area, "Welcome," <http://msd.k12.wi.us/>.
9. Wisconsin Technical College System, "What We Do," www.wtcsystem.edu/do.htm.
10. United States Department of Education, "The Elementary and Secondary Education Act." see reference 3.
11. Menomonee High School, "Technology Department," <http://mhs.sdmaonline.com/technologydept>.
12. University of Wisconsin-Stout, "Bachelor of Science Degree in Technology Education". www.uwstout.edu/programs/bste/index.cfm.
13. Project Lead The Way, www.pltw.org.
14. *Dunn County News*, "MHS Leads the Way in Engineering for the Future," Dec. 17, 2008, . www.dunnconnect.com/articles/2008/12/17/variety/doc49498bd203d0e443398422.txt.
15. University of Wisconsin-Stout, "What's in a Name," June 17, 2010, www.uwstout.edu/history/names.cfm.
16. University of Wisconsin-Stout, "Malcolm Baldrige National Quality Award," March 1, 2010. www.uwstout.edu/mba/index.cfm.
17. University of Wisconsin-Stout, "Wisconsin's Polytechnic University," March 18, 2010. www.uwstout.edu/polytechnic/index.cfm.
18. United States Department of Education. "Race to the Top Program Executive Summary," see reference 2.
15. Wisconsin Project Lead the Way, "Press Release Template," Sept. 1, 2010, http://pltwwi.org/pdfs/Press_Release_Template.doc (case sensitive).
16. Project Lead the Way, Middle School and High School Programs, www.pltw.org/node/17.
17. University of Wisconsin-Stout, "High School Students," www.uwstout.edu/pltw/hs.cfm.
18. Wisconsin Project Lead the Way, "Press Release Template," Sept. 1, 2010, http://pltwwi.org/pdfs/Press_Release_Template.doc (case sensitive).
19. Project Lead the Way, Middle School and High School Programs, www.pltw.org/node/17.
20. University of Wisconsin-Stout, "High School Students," www.uwstout.edu/pltw/hs.cfm.

Sylvia Tiala is an assistant professor in the School of Education at the University of Wisconsin-Stout (UW-Stout) in Menomonee. She is trained in Project Lead the Way's (PLTW) gateway to technology, introduction to engineering design and digital electronics curriculum. Tiala coordinates PLTW pre-service training at the university. Learn more about [UW-Stout's Technology Education program](#) and [PLTW at UW-Stout](#).

Phil Winegar teaches at Menomonee High School in Menomonee, WI. He teaches communication technology, multimedia, architecture and engineering courses. He is a Project Lead the Way Instructor for in-service teachers during summer training sessions, as well as the Menomonee High School technology club advisor. Learn more about [Menomonee High School](#) and its [technology education department](#).