

**KENTUCKY’S STEM IMPERATIVE:
COMPETING IN THE GLOBAL ECONOMY**

STEM Taskforce Study Group on Recommendation 5

“Revolutionize how STEM subjects are taught, learned, and assessed and implement a statewide research-based STEM curriculum that is aligned with global workforce and academic standards.”

Subcommittee Members:

**Fariba Bigdeli-Jahed, Chair
Ann Bartosh
Haridas Chandran
Vince DiNoto
Ivory Griskell
Rodney Kelly
Jerry Pogatshnik
Charley Simpson
Jackie Hardison**

**Jim Applegate
Keith Bird
Bill Cloyd
Dale Elifrits
Diane Johnson
Miko Pattie
Owens Saylor
John Yopp
Dianne Bazell, CPE Liaison**

Strategy	Objective	Accountability & Assessment (Responsible Person/Agency)	Timeline for Completion	Funding Source/Estimated Cost
Strategy 1: Integrate a comprehensive, standardized, internationally benchmarked P-16 STEM curriculum to make use of the latest instructional techniques and technologies such as the GE STEM curriculum implemented in Jefferson County or Project Lead the Way Curriculum.	1. Investigate and compare the international standards, NCTM focal points and Kentucky standards to enhance and update the P-12 mathematics curriculum at a high academic level and make it attainable to all students through differentiated instruction. Compare state, national (NSES, AAAS) and international science standards, Program of Studies and or curricula to determine learning progressions P-12 for critical science content.	CPE and KDE, P-16 faculty		
	2. Provide and encourage all Kentucky students with the opportunity to take Algebra I or a similarly demanding course that includes fundamental algebraic concepts in the 8th grade to enable students to take progressively more advanced mathematics and science courses in all four years of high school. The student's individual learning plan should encourage this intent.	KDE, Teachers and counselors		
	3. Provide high school seniors the opportunity to take substantive and progressively challenging post algebra II courses such as precalculus, probability and statistics, discrete mathematics or calculus.	KDE, CPE, College and high school faculty		
	4. Develop a statewide template for creation of dual enrollment (credit) program in mathematics, science, and technical education that incorporates engagement initiative within the institutions of higher education. The template should include elements such as costs, tuition, locus of instruction, and certification of high school participating instructors.	KY Virtual University, Kentucky Universities and colleges, KDE, Dual Credit Taskforce		
	5. Build on the high school mathematics courses completed as a basis for the general education mathematics requirement at the universities and colleges. Strongly encourage students to continue their mathematics sequence immediately upon entering post secondary education.	Kentucky Colleges and Universities, General Education		

		Taskforce		
	6. Create elementary mathematics and science specialties within the elementary education pre-service programs. Require more mathematics and science content for elementary teacher certification. Include differentiated instruction and the interpretation of diagnostic assessment information in the preparation and professional development of all P-12 teachers.	Colleges of Education, Arts and Sciences, AIKCU, KCTCS, and EPSB		
	7. Create a policy-based process for ensuring the content and outcomes-based alignment and the integration of mathematics, science, and technology teacher education programs in the KCTCS and four year colleges (2+2) to ensure equivalency of high quality K-12 teacher training. Incorporate the input from the current CPE mathematics and science committees charged with the addressing this issue.	Universities and Colleges, 2+2 Taskforce		
	8. Develop a common definition of computer literacy for all Kentucky postsecondary institutions. Ensure all graduates from postsecondary institutions within Kentucky will demonstrate computer literacy either through class or certification.	Kentucky public Universities and Colleges, AIKCU, General Education Taskforce.		
	9. Implement the P-12 technology literacy standards.	KDE		
	10. Expand the number of middle schools and high schools implementing Project Lead The Way courses, in order to increase the pipeline of students entering postsecondary education prepared for and engineering technology programs. http://www.pltw.org	CPE and KDE		
	11. Support Project Lead the Way affiliate colleges and universities to provide teacher institutes and other professional development.	CPE and KDE, Kentucky Public	State incentive funding for	\$450,000

		Universities and Colleges, AIKCU	2008-10 biennium	
	12. Expand the number of secondary and postsecondary schools implementing Career and Technical Education Engineering Technology Programs.	KDE and CPE, Kentucky Public Universities and Colleges, AIKCU		
	13. Develop non-mandatory benchmark assessments and student exemplars in science for all non-tested grades to be used by KY schools as indicators of science proficiency.	KDE, Kentucky Public Universities and Colleges, representative teachers K-12		
	14. Make instructional technologies available to STEM classrooms, as well as training opportunities for teachers in effective use.	KDE, Kentucky Public Universities and Colleges, science educators, representative teachers K-12		
Strategy 2: Emphasize depth of learning as well as breadth of learning in STEM subjects.	1. Balance problem solving, reasoning, skill mastery and conceptual understanding with a continually developing and connected base of mathematical knowledge so that the students can use and apply the mathematics they learn within mathematics and connected to other content areas.	KDE, CPE, Universities and Colleges		
	2. Utilize NSTA's, AAAS's Project 2061 ongoing work to organize learning progressions to develop model curricula for P-12 science, which incorporate 21 st Century Skills, technology, and engineering as well as the Kentucky standards.*	KDE, IHE science educators, NSTA,		

		representative teachers P-12		
	3. Partner with industry and IHE to offer on-going professional development academies, which focus on critical technologies, sound instructional practices, and effective use of technology.	Industry, KDE, Universities and Colleges		
Strategy 3: Encourage universities to partner with industry to provide professional science master's degrees tied to industry need.	1. Develop partnerships between universities and industry to create Professional Science Masters (PSM) at Kentucky universities linked to STEM programs at KCTCS through Career Pathways.	CPE and the graduate deans of the universities and KCTCS	.Launch of multiple PSMs by fall 2010	Foundation funding for initial development phase/state incentive funding for 2008-10 biennium. \$800,000 (\$300,000 in foundation funding)
Strategy 4: Upgrade assessment strategies for student learning in the STEM disciplines, such as standardized end-of-the course exam and full use of the ACT Educational Planning and Assessment System (EPAS).	1. Develop and utilize a standard end of the course assessment for Algebra I, II, and Geometry that aligns with the standardized curriculum.	CPE and KDE, P-16 faculty		
	2. Ensure alignment of any assessment with the developing standards-based curricula that may be occurring with separate groups.	CPE and KDE, P-16 faculty		
	3. Utilize Project Lead the Way end of course assessments to validate student learning in those courses.	KDE		
	4. Utilize validated EXPLORE, PLAN, and WorkKeys assessment data and other information to assist students in pursuing STEM related careers as they develop their Individual Learning Plan in preparation for postsecondary education.	KDE and CPE		
	5. Include how to develop and use high quality, sound classroom assessments in all teacher education programs (pre-service and ongoing professional development) and certification procedures e.g., (KTIP).	Schools of education, CPE		
Strategy 5: Create curricular,	1. Develop a plan for publicizing the importance of this activity and the economic benefit to the Commonwealth as well as the nation by pursuit of this	CPE, KDE		

research, and innovation opportunities in environmental and sustainable energy (a unique Kentucky initiative) and other emerging technologies for STEM students throughout the pipeline. (Pipeline = P-20)	Strategy.			
	2. Develop a plan that will bring about an environment of discovery and pursuit of providing new curricular materials which may be used at all levels, <i>e.g.</i> , capitalize on the progress made by such programs Project NEED, FIRST Lego League, JETS-TEAMS, Science Olympiad in the state, to move this and similar current and/or new works to the forefront at all levels.	CPE, KDE,		
	3. Devise the schemes and connections needed to make these new curricular and research activities relevant to the existing education standards and to the public at large including support as needed.	CPE, KDE		
Strategy 6: Improve the quality of teaching in STEM disciplines at colleges and universities, including support for the development of mathematics education and science education faculty.	1. Provide professional development for college and university science and mathematics faculty in the development of integrated applied curricula and inquiry-based contextualized laboratory courses for the non-science majors and science education students.	Universities and Colleges, KDE, CPE		
	2. Provide internships in STEM companies for STEM faculty and science and mathematics education majors to experience real world applications.	Universities and Colleges, KDE, CPE		
	3. Provide assistance to science faculty to restructure the ways in which laboratories are done from data gathering to concentrating on analysis and open ended inquiry based exploration.	Universities and Colleges, KDE, CPE		
	4. Develop an integrated approach for remedial students of mathematics that is based upon real world applications.	Universities and Colleges, KDE, CPE		
	5. Analyze and narrow the gap between the way in which high school teachers and postsecondary faculty teach mathematics and science.	Universities and Colleges, KDE, CPE		

	6. Analyze and ensure uniformity of mathematics and science courses across postsecondary institutions in the state. May be we have too many choices allowing to bypass and take easy routes to graduate -- In a sense raising the bar and plugging loopholes if any.	Universities and Colleges, KDE, CPE		
	7. Increasing practical - industry interaction of teachers enabling them teach closer to industry trends and needs.	Universities and Colleges, KDE, CPE		
Strategy 7: Incorporate innovative and interactive technology-based STEM learning tools and methodologies throughout P-20 education.	1. Require and support continuing professional development for P-16 faculty including membership in state, regional and national STEM professional organizations.	CPE, KDE		
	2. Improve the quality of instruction in teacher education programs by incorporating the use of innovative and interactive technology-based learning tools, such as, podcasting, digital learning objects, Internet2 real-time, interactive tools, course management system (Blackboard) interactive functionalities, Second Life, Web 2.0 tools (Wiki), social networking tools, Kentucky Virtual Library, National Science Digital Library, etc			
	3. Improve the quality of P-20 instruction with innovative course materials that cater to the learning styles of present generation students by incorporating the use of innovative and interactive technology-based learning tools, such as, podcasting, digital learning objects, Internet2 real-time, interactive tools, course management system (Blackboard) interactive functionalities, Second Life, Web 2.0 tools (Wiki), social networking tools, Kentucky Virtual Library, National Science Digital Library, etc			
	4. Provide students exposure to computer and Internet-based problem solving tools to facilitate their transition from academia to industry. Such tools might include podcasting, digital learning objects, Internet2 real-time, interactive tools, course management system (Blackboard), interactive functionalities, Second Life, Web 2.0 tools (Wiki), social networking tools, Kentucky Virtual Library, National Science Digital Library, etc.			
	5. Improve the quality of instruction with state-of-the-art scientific equipment by (a) increasing funding, (b) building an inventory in KY so the P-20			

	community can share it, and (c) using virtual remote instrumentation or simulations as needed for pedagogically sound instruction.			
Strategy 8: Expand and support a statewide STEM competition at the elementary, middle and high school levels to recognize and celebrate accomplishment in STEM learning and application.	<ol style="list-style-type: none"> 1. Kentucky Science Olympiad – Kentucky has been an active participant in KSO for more than 15 years. It is organized with a middle and high school competition, regional, state and national events are held annually. There are events for elementary school but no competitions are organized outside of the local school. Each level of the Olympiad has approximately 22 events that are across the science and engineering areas, most are applied activities some requiring the construction of devices. The state tournament is currently held at Western Kentucky University. One or two teams from each division goes to the national tournament. Kentucky students have won medals at the national. http://www.wku.edu/chemistry/kso/ 2. Kentucky Junior Academy of Science – is sponsored by the Kentucky Academy of Science and holds an annual meeting. http://www.KJAS.org The meetings normal contain research paper presentations by students held at a college or university. The organization elects student officers annually. 3. Intel International Science and Engineering Fair – is an annual international fair, featuring students from across the country and the world. Several regional fairs are hosted within the state of Kentucky. The winners from these local fairs can then compete in the international fair. Louisville has hosted the International fair twice in recent years. Major scholarships are award at the international fair. 4. The various robotics competitions starting with FIRST Lego League (http://www.firstlegoleague.org/) which is for middle school level students. However, competition activities are available for all grade levels and with programmed robots and remote controlled robots. Various organizations work with the different grade levels. However, 			

FRIST is more-or-less the "grandfather" organization. The Campbell County Schools and the Fort Thomas Schools have been involved in these competitions at the secondary levels for a number of years. Brian Mercer at Campbell County is a leader in the senior high level activities with robotic competitions.

5. Junior Engineering Technical Society (JETS) (<http://www.jets.org/>) offers an array of activities and events for STEM disciplines. The major competition is the Tests of Engineering Aptitude, Mathematics, and Science (TEAMS) competitions which enables high school students to learn team development and problem-solving skills using classroom mathematics to solve real-world problems. TEAMS, in some ways, parallel the Science Olympiad competition but with much more emphasis on engineering and design problems.

6. Technology Student Association

Technology Student Association (TSA) is a Career and Technical Student Organization representing middle and high school students enrolled in Engineering and Technology programs. Students can compete in over sixty events at the local, regional, state and national conferences. The organization prepares its membership for the challenges of a dynamic world by promoting technological literacy, leadership, and problem solving skills, resulting in personal growth and opportunities. The Kentucky Department of Education, Division of Career and Technical Education maintains this organization at the state level. <http://www.tsaweb.org/>

7. The Edventures in Robotics Challenge (ERC)

Junkyard Wars, Battlebots, Robot Wars, Sumo Wrestling Robots and more! In the past few years there has been a tremendous surge of interest in mechanical challenges, invention, and robotics. For educators, this phenomenon has provided some wonderful resources for

inspiring and motivating children in the areas of math, science, technology, & engineering. In direct response to this need, PCS Edventures developed a new and exciting competition called "The Edventures in Robotics Challenge" (ERC). The ERC is designed to be used at any time throughout the year to generate enthusiasm, prepare students for problem solving challenges, and create a real-world teamwork scenario for students to experience. The ERC is a challenge program designed to be more "approachable" for ALL educators: 1) it does not require any travel; 2) it is inexpensive; and 3) it allows you to utilize materials you may already own. It is also a great way to get some hands-on experience with this type of learning activity before you commit to one of the more extensive programs. Visit the website to see some examples from the recent competition -- teams from the US, Canada, Korea, Egypt, and Pakistan participated and had an awesome time! <http://pcsims.com/imssc/index.php?&pid=11008>

8. BEST inc.

BEST (Boosting Engineering, Science, and Technology) is a non-profit, volunteer organization whose mission is to inspire students to pursue careers in engineering, science, and technology through participation in a sports-like, science- and engineering-based robotics competition. BEST is organized as hub sites. At the present time there are 32 hub sites in Texas, Oklahoma, Arkansas, New Mexico, Kansas, Missouri, Alabama, Illinois, Ohio, Pennsylvania, Tennessee, Georgia, Mississippi, and Connecticut. Winning teams from the hub competitions advance to the closest Regional Competition hosted in Texas, Alabama, or Arkansas. <http://www.bestinc.org/MVC/>

9. MATHCOUNTS

A national math coaching and competition program that promotes middle school mathematics achievement through grass roots involvement in every US state and territory.

MATHCOUNTS promotes student interest in mathematics by making math achievement as challenging, exciting and prestigious as a school sport. At the beginning of each school year, the MATHCOUNTS foundation provides a complimentary copy of its *School Handbook* to middle schools across the country. Teachers and volunteers use these problems and activities to coach student "Mathletes" (6th, 7th and 8th graders) as part of in-class instruction or as an extracurricular activity.

<http://mathcounts.org/>

10. NEDC

A hands-on national engineering design competition The National Engineering Design Challenge (NEDC) is a cooperative program with the National Society of Professional Engineers and the National Talent Network, challenging teams of students often working with an engineering adviser, to design, fabricate, and demonstrate a working solution to a social need. Here are some resources on competitions and contests for students of all ages that promote awareness about energy technologies and issues, including energy efficiency and renewable energy. <http://www.jets.org/programs/nedc.cfm>

11. ExploraVision

A competition administered by the National Science Teachers Association that encourages K-12 students to create technologies—including energy technologies— of the future.

<http://www.exploravision.org/>

12. Odyssey of the Mind

A world-wide program that promotes creative team-based problem solving for kids from kindergarten through college.

<http://www.odysseyofthemind.com/>

13. Student Technology Leadership Program

The Student Technology Leadership Program (STLP™) uses project-based learning to empower students to use technology to learn and achieve.

School and district coordinators guide students to create products, provide services or carry out projects that help the school and community. Two major events occur in the fall and spring. At those events students compete to demonstrate technology and leadership skills.

STLP is open to all students in P-16. The Kentucky Department of Education maintains this program at the state level. No student should be turned away. [http://www.education.ky.gov/KDE/Instructional+](http://www.education.ky.gov/KDE/Instructional+Resources/Technology/Student+Initiative)

[Resources/Technology/Student+Initiative](http://www.education.ky.gov/KDE/Instructional+Resources/Technology/Student+Initiative)

[s/STLP+Student+Technology+Leadership+Program/](http://www.education.ky.gov/KDE/Instructional+Resources/Technology/Student+Initiative)

15. Ky section of the Presidential Awards for Excellence in Mathematics and Science Teaching for Ky teachers K-12.