Access to Science, Technology, Engineering and Mathematics (STEM)

Across the nation students studying in the science, technology, engineering and mathematics (STEM) fields are on the decline. Predictions are that 75 percent of the future job market will be in STEM fields. Yet fewer than 300,000 college students nationwide are majoring in STEM.

The goal of the Access to Science, Technology, Engineering and Mathematics (STEM) nitiative is to build a continuum of integrated science, technology, engineering and mathematics curricula for prekindergarten (PreK) through 12th-grade students that is research-based, standards-driven and classroom-tested. The initiative includes the following components:

- **Bridge to STEM** (PreK-Grade 1) is a program will introduce the concepts of force and motion while teaching the basics of engineering and design.
- **Engineering is Elementary** (Grades1-4) integrates engineering and technology concepts and skills with elementary science topics and connects with literacy and social studies education.
- **District-wide STEM Field Trips** (Grades 2-3) to LEGOLAND and the Orlando Science Center will provide hands-on, STEM-based learning opportunities to students.
- **STEM Summer Institute** (Grades 6-8) will offer 340 middle school students (10 students per middle school) the opportunity to participate in a five-day summer institute with STEM community partners and high school students from STEM academies.
- **High School Biology I Teacher Professional Development** (Grades 9-12) will consist of four quarterly workshops for high school biology teachers representing all OCPS high schools. Teachers will build on their content knowledge and gain resources to better prepare students for the high-stakes Biology I end-of-course exams.

Budget: $1,116,874

Return on Investment: Improved PreK-12 STEM teaching and learning to prepare students for a global job market.

Predictions are that 75 percent of the future job market will be in the STEM fields. Yet fewer than 300,000 college students nationwide are majoring in STEM.

Targeted Population

Prekindergarten through 12th-grade students and teachers

Needs Statement

Resources are needed to significantly impact student achievement in the Science, Technology, Engineering and Mathematics (STEM) fields while closing the achievement gap among all subgroups of students.

- Across the nation students studying in the STEM fields are on the decline.
- Fewer than 300,000 students are majoring in STEM fields.
- 75 percent of the future job market is predicted to be in the STEM fields.
- Industry will need employees that possess the skills to fill these positions.
- Research shows that waiting until students enter secondary grades to pursue STEM is ineffective.

The Next Generation Sunshine State Standards (NGSSS) for science and Common Core State Standards (CCSS) for mathematics contain the rigor needed to impact future student achievement in STEM fields. The increased rigor requires a focus on inquiry-based learning. Problem-based learning is a hallmark of integrating STEM curriculum into mathematics and science classrooms. One barrier that exists for students pursuing certification in STEM areas through career academies is both basic knowledge of concepts in science and mathematics and the inadequate ability to apply science and mathematics content to specific global applications. Equal proficiency in both science and mathematics is necessary for college-and career readiness in STEM fields. OCPS is working diligently to develop assessment tools that can accurately measure student progress in STEM-related areas.

While there have been increases in student performance on standardized instruments in mathematics, OCPS is currently targeted as a high-need science school district by the Florida Department of Education based on the targeted subgroups scoring at Levels 1 and 2 on the FCAT 2.0 Science in elementary, middle, and high school (See Table A). FCAT 2.0 Science in Grade 5 assesses science standards taught in grades 3, 4, 5 and FCAT 2.0 Science in Grade 8 assesses standards taught in grades 6, 7, 8. It is critical that students entering fifth grade, eighth grade, and Biology I demonstrate mastery of previously taught science benchmarks in order to successfully access content in the current grade or course.

In order to better understand student readiness in science, OCPS has instituted quarterly benchmark assessments in science in grades 5,8, and Biology I this year. These exams are designed to be both predictive of future success on standardized assessments and diagnostic to determine missing building blocks in science knowledge.

The data from these exams has revealed that in fifth grade, only 51 percent of students are predicted to be proficient on the FCAT 2.0 Science. However, 60.91 percent of students entering fifth grade fail to show mastery of the science benchmarks from kindergarten through fourth grades necessary to access fifth-grade science content. In eighth grade, only 46 percent of students are predicted to be proficient on the FCAT 2.0 Science. However, 58 percent of students entering eighth grade fail to show mastery of the science benchmarks from fifth to seventh grades necessary to access

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eighth-grade science content. In Biology I, only 53 percent of studentsare predicted to be proficient on the Biology I End of Course Assessment. However, 76 percent of students entering Biology I fail to show mastery of the science benchmarks from elementary and middle school grades necessary to access Biology content.

Student Performance on FCAT Science 2.0 in Grades 5, 8, 11

	2011	2012			2010-12			2011-12
grades	Student Group	% Level 1	% Level 2	Total %	% Level 1	% Level 2	Total %1-2	
5	Total Students	21	30	51	21	29	50	-1
5	Black	32	37	69	33	35	68	-1
5	ELL	49	36	85	50	35	85	+0
5	Total ESE Other Than Gifted	49	31	80	54	28	82	+2
8	Total Students	25	34	59	24	21	45	-14
8	Black	40	39	79	38	35	73	-6
8	ELL	68	28	96	68	26	89	-7
8	Total ESE Other Than Gifted	53	30	83	53	29	82	-1
11	Total Students	30	32	62	Transition to Biology I EOCA			
11	Black	49	32	81				
11	ELL	78	20	98				
11	Total ESE Other Than Gifted	61	24	85				
		2012			2010-12			2011-12
					Biology EOCA Baseline			
					Thirds			
9-12	Total Students	Biology Field Test No Data Available*			% third 1	% third 2	Total %1-2	+/-
9-12	Black				30	32	52	N/A
9-12	ELL				TBA	TBA	TBA	N/A
9-12	ELL				TBA	TBA	TBA	N/A
9-12	Total ESE Other Than Gifted				TBA	TBA	TBA	

*No data available (field test only) for the Biology End of Course Assessment (EOCA). During a field test year FL DOE only provides overall scores.

Proposal

The goal of the Access to Science, Technology, Engineering and Mathematics (STEM) initiative is to build a continuum of STEM curricula that is research-based, standards-driven, classroom-tested and will integrate science, technology, engineering and mathematics into core content areas.

- **Bridge to STEM (PreK - Grade 1)**

The research used to develop the OCPS Bridge to STEM program originated in the **University of Northern Iowa's Early Childhood Education Department**, funded by the **National Science Foundation**. Kindergarten and first-grade students will have increased access to early opportunities in STEM through developmentally-appropriate problem-based learning. The Bridge to STEM program will introduce the concepts of force and motion while teaching the basics of engineering and design. Students will need to design solutions to challenges that increase in complexity monthly, using Child Craft wooden blocks, marbles and wooden ramps. By applying concepts of force, motion and geometry, students will independently design ways to make the marble move. Note: Bridge to STEM exists in 22 out of 125 schools. We hope to be able to expand the program to all eligible teachers in the district. Orange County Public Schools' work on Bridge to STEM is being scaled up by Region One of the Differentiated Accountability Model and Hillsborough County.

• Engineering is Elementary (Grades 1-4)

Engineering is Elementary (EiE) was developed by the **National Center for Technological Literacy** and the **Boston Museum of Science** to change the way elementary teachers approach mathematics and science. EiE has created a research-based, standards-driven, and classroom-tested curriculum that integrates engineering and technology concepts and skills with elementary science topics. EiE lessons not only promote STEM learning in grades 1-5, but also connect with literacy and social studies. To date, EiE has reached over 2.7 million students and 32,000 teachers and is presently used in all fifty states. The design and inquiry-based approach enables elementary teachers to engage in truly open-ended instruction and learning where there is no single correct answer. Curriculum Services would like to include one EiE unit per grade level to augment the existing limited STEM lessons and ensure a rigorous vertical articulation. Note: Fifth grade currently has access to one Engineering is Elementary unit. OCPS has two sets of EiE binders that are available to check-out on a two-week rotation. There has been an extensive waiting list for the EiE binders over the past three years.

• District-Wide STEM field trips (Grades 2-3)

Many students lack out-of-school experiences in STEM. While students in OCPS have district-wide experiences that promote the arts, they lack access to district-wide experiences in STEM. District-wide STEM field trips to **LEGOLAND** and **Orlando Science Center** will provide a precise hands-on foundation for second and third graders, thus inspiring students to pursue future studies in STEM industries. Both **LEGOLAND** and the **Orlando Science Center** have developed STEM-design-based field trip experiences that directly support the STEM design challenges provided in the Curriculum, Instruction, and Assessment (CIA) Blueprints by Curriculum Services. Note: Surrounding Central Florida districts have funded STEM field trips for elementary students. Current research indicates that middle school grades are too late to introduce STEM concepts to students. Research suggests that STEM interest must be piqued by mid-elementary years to capture students.

• STEM Summer Institute (Grades 6-8)

The institute would allow all middle school students who are interested in learning more about STEM to participate in an interactive program that would be in collaboration with community partners and high school students who are in the STEM Academy.

- The institute is held over a five-day period.
- Participants include 10 students per middle school recommended by their teachers for a total 340 students.
- Host high schools are those with a STEM Academy in place.
- Quarterly Engineering Design Challenges in Science are included in the district's Instructional Management System (IMS). These challenges are used as a performance-based assessment to determine if students can apply the standards in a novel situation.
- High school academy students determine the integration of math and science project.

• High School Biology I Teachers Professional Development (Grades 9-12)
*Funded 2010-2013 by Lockheed Martin
Four professional development workshops for 19 lead high school biology teachers (at each of the 19 OCPS high schools) and 19 science coaches or an additional biology teacher from each high school will help teachers master 21st century teaching skills. Having two representatives from each school increases the sustainability of the knowledge learned and shared among colleagues. Each quarterly workshop enhances teachers' STEM skills and further prepares them to effectively implement the biology curriculum with high rigor and relevant materials for today's students. Workshops are held at the Orlando Science Center Learning Labs.

Workshop participants receive in-depth professional learning and time to create resources to successfully prepare students for the high-stakes Biology I end-of-course (EOC) assessment and for future scientific inquiry-based learning. Participating teachers are expected to share what they learn with their colleagues. A biology curriculum specialist facilitates the workshops and participants are grouped by learning community to allow further collaboration within their consortia.

Additionally, these quarterly workshops provide pedagogical strategies to help move current biology classrooms, which are predominantly teacher-centered, to highly engaging learner-centered classrooms. This includes creating and using culminating assessments that are not just paper and pencil tests, but assessments representative of 21st century thinking skills.

OCPS STEM Career Academies (Operating Outside Magnet Programs)

Middle Schools
- Corner Lake - Project Lead the Way
- Freedom - Project Lead the Way

High Schools
- Apopka – Agricultural Biotechnology
- Colonial – Industrial Biotechnology; Academy of Information Technology (PC Support)
- Cypress Creek – Institute of Science, Technology, Engineering, and Mathematics(Information Technology)
- East River – Animal Biotechnology; Agritechnology
- Evans – Project Lead the Way
- Freedom – Project Lead the Way
- Oakridge – Project Lead the Way
- Ocoee – Agriculture, Food, and Natural Resources (Agricultural Biotechnology); Building Construction Technology
- Timber Creek – Academy of Agricultural and Animal Science (Agricultural Biotechnology) Project Lead the Way; Business Academy (Business Computer Technology; Business Computer Programming); Gaming Simulation and Animation

- Wekiva – Plant Biotechnology
- West Orange – Computer Systems Technology
- Winter Park – Academy of information Technology (PC Support; Network Support Services)

OCPS STEM Magnet Programs
(Some Magnet Programs may also include a career academy)

Elementary Schools
- Durrance – Aerospace & Aviation
- Lake Silver – Mathematics
- Mollie Ray – Digital Technology
- Princeton – Science

High Schools
- Apopka – Advanced Engineering Applications
- Colonial – National Academy of Finance (NAF) Information Technology
- Edgewater – Engineering, Science and Technology
- Oak Ridge – Aviation and Aerospace Engineering; Digital Gaming and Media
- University – Global Technologies
- Wekiva – Laser Photonics Academy

Current Partners

These current partners actively collaborate with OCPS to write curriculum and provide hands-on and job-related experiences at each level, thereby ensuring that teaching stays current with the demands and requirements in STEM fields:
Central Florida STEM Education Council
LEGOLAND
Lockheed Martin
Metro Orlando Economic Development Commission (EDC)
NAVAIR – Naval Air Warfare Center Training Systems
Northrop Grumman
NASA – Kennedy Space Center
Orlando Science Center

Return on Investment

Collectively, the proposed STEM initiatives will impact every OCPS student from prekindergarten through 12th grade and will:
- Provide engaging STEM curriculum and activities, community partnerships and real-world experiences to students;
- Reduce the achievement gap among racial, ethnic and economic subgroups in science and mathematics;
- Increase student enrollment in rigorous mathematic and science courses, leading to college and career STEM opportunities;
- Increase enrollment of females in STEM high school programs, particularly in career academies and magnet schools; and
- Increase interest in STEM careers.

Evaluation Plan

Formative Evaluation:

Bridge to STEM
- Rubrics for each monthly design challenge
- Developmental Block Play Assessment

Engineering is Elementary
- Pre- and post-assessments that align with the Next Generation Sunshine State Standards (NGSSS) in science and Common Core State Standards (CCSS) in mathematics and English/language arts are provided with each unit.

District-Wide STEM Field Trips
- Pre- and post-assessments will be provided by LEGOLAND and the Orlando Science Center.

Benchmarks Edusoft Exams
- Students in grades 3, 4, 5, 6, 7, 8, Algebra I and Geometry will participate in district benchmark progress monitoring exams in mathematics.
- Students in grades 5, 8, and Biology I will participate in district benchmark progress monitoring assessments in science.

Monitoring of the STEM programs
- Monitoring will occur throughout the academic school year on a quarterly basis through the school-based coordinators (6-12), district STEM coordinator (K-8), and data provided on number of students participating, demographics, grades, assessment data, college applications and acceptances.

Biology I Professional Development
- The Biology I end-of-course assessment will continue to be the primary assessment tool to measure the success of this program. Participating teachers will complete a survey at the end of the school year to provide feedback regarding the program and make suggestions for the upcoming school year. Data will be collected as to how many STEM design challenges are completed over the course of the school year.

Summative Evaluation: A compilation of quarterly reports and end of year results will be provided to principals, area superintendents, district personnel and investors.

Sustainability

This is a district-wide initiative supported by the school board and superintendent. All principals as well as the Curriculum Services and Career and Technical Education departments support the STEM intiative. They will continue to seek funding through district resources, grants, federal and state sources and community partners.

Key Personnel

Key personnel include:

- Existing highly-qualified teachers who demonstrate an interest in the science and mathematics fields will implement the programs within their classrooms.
- Principals and assistant principals will ensure involvement of their schools in STEM initiatives.
- Middle school and high-school-based STEM liasions will support content integration through career academies and the development of summer institutes.
- The district STEM coordinator will support STEM integration into core content areas at the K-8 level.
- The district high school science resource teacher and district senior administrator supervising mathematics and science will support high school Biology I professional development.

Budget

Personnel & Fringe Benefits, Materials & Supplies:

Grade	Activity	Cost per classroom/school	Total
PreK-1st	Bridge to STEM Project/Blocks and Molding	$103 x 700 classes/18 students per class	$72,100
2nd	LEGOLAND Field Trip	22 students per class @ $12= $264 X 700 classes	$184,800
3rd	Orlando Science Center Field Trip	22 students per class @ $8=$176 X 700 classes	$123,200
3rd and 4th	Engineering is Elementary/Teacher Guide Guided Readers	2 EiE units per school@$90= $180 x 125 schools $40 per teacher x 1400	$22,500 $56,000
6th - 8th	School-based STEM /Teacher Liaison Supplement	$5415.84 x 35 middle schools	$189,555
9th - 12th	School-based STEM Summer Institute Salary/Teacher Liaison	$5415.84 x19 high schools salary plus benefits	$102,901
6th - 12th	STEM Summer Institute startup funds	$2,323.60 x 54 middle and high schools	$125,474
6th -12th	STEM Summer Institute startup funds	$2,000 x 54 middle and high schools	$108,000
6th -12th	STEM Training and Staff Development materials	$2,000 x 54 middle and high schools	$108,000
9th -12th	High school Biology I professional development (19 high schools)	Teacher substitutes – 2 per high school ($17,480) Engineering design challenge materials ($3,800) Trainer fees ($3,064)	*$24,344
			$1,116,874

*Funded 2010-2013 by Lockheed Martin

OCPS Strategic Objective(s)

Intense Focus on Student Achievement
Increase the participation and performance in rigorous curriculum

Contacts

Dr. Anna Diaz, Associate Superintendent
407-317-3229
anna.diaz@ocps.net

Mark Hunt, Director, Career and Technical Education
407-317-3200, x2708
mark.hunt@ocps.net

Ruth Brus, Senior Administrator, Mathematics and Science
407-317-3200, x2662
ruth.brus@ocps.net

Mariel Milano, Coordinator, Science, Technology, Engineering, and Mathematics
407-317-3200, x2066