OC STEM INITIATIVE

Presenters

Michelle Freeman, Samueli Foundation

Michelle Freeman joined the Samueli Foundation in March 2011, and serves as the Foundation's Policy and Research Analyst. In addition to managing the OC STEM Initiative on behalf of Samueli Foundation and OC STEM partners, she focuses on grantee capacity building, initiative and infrastructure development, project management, data analysis and reporting. Before joining the Samueli Foundation, Ms. Freeman was a program associate at Children and Family Futures, where she provided project management, training and technical assistance on policy and practice through the National Center on Substance Abuse and Child Welfare, a resource center co-funded by the Substance Abuse and Mental Health Services Administration and Administration of Children and Families, Children's Bureau. She previously served as the associate director of community school programs at the Comer Science and Education Foundation, where she oversaw community school programs that served students, their families and community residents. Ms. Freeman earned a Bachelor of Science degree in Human Services with a minor in Child and Adolescent Studies from California State University, Fullerton, a Master of Arts from the University of Chicago School of Social Service Administration, and a Master of Public Policy from the University of Chicago Irving B. Harris Graduate School of Public Policy Studies.

Tamika Lang, The Boeing Company

As Community Investor and Education Subject Matter Expert for Boeing, Tamika Lang manages the early learning and primary/secondary education philanthropic investment portfolio in California. Her responsibilities in GCC have grown from local to state-wide reach, including participation in enterprise-wide initiatives during her six years with the Boeing Company. Tamika's work in education was recently acknowledged at the 2010 Women of Color in Technology Conference where she received the Rising Star award. Tamika received her Master of Public Policy at the University of Southern California as a HUD Community Development Fellow and completed her undergraduate work at Loyola Marymount University. Tamika resides in Long Beach with her husband, Dr. Yoshado Lang, and son, Yeshaya.

Nithin Jilla, UC Irvine Student/Mentor

Nithin Jilla is a 19 year old following his passion of giving back and helping others by combining his passions for Technology, Education and Business. He has helped start a nonprofit in high school which he expanded to college level as well as developed some great educational initiatives for UCI students such as Med AppJam, AppJam, TEDxUCIrvine and is currently focusing on finishing his last year at UC Irvine and expanding AppJam+.

OC STEM Initiative

In June 2011, the Commission approved a $250,000 three-year investment to support the OC STEM Initiative in partnership with the Samueli Foundation. The OC STEM Initiative supports Science, Technology, Engineering and Mathematics (STEM) teaching and learning in Orange County. The Initiative is supported by funders that are committed to improving STEM education for all Orange County students, ensuring that students are college and career ready in the STEM fields, and developing a skilled and continuous workforce to meet the scientific and technological needs of the employer base of Orange County.

Three-Year Work Plan
The three-year work plan includes program management, strategic communications, assessment of best practices of innovative programs, fund development, and annual reviews of the program. OneOC is the designated fiscal agent for the OC STEM Initiative and manages grants received, including the Commission's funding which is detailed below:

Year One 2011-12	$100,000	Develop Strategic Plan
Year Two 2012-13	$75,000	Implement Strategic Plan
Year Three 2013-14	$75,000	Continue Implementation of Strategic Plan
Total	**$250,000**	

National, State, and County STEM Education Trends
At the national level, the United States now lags behind other nations in STEM education. Additionally, there is an achievement gap among some ethnic groups and women in STEM. Research suggests that underlying issues include not only the lack of proficiency among students in the United States, but also a lack of interest in STEM fields among many students. California is projecting a growth in STEM careers; however data suggests that the supply of graduates in these fields is shrinking. In 2009, approximately 18 percent of undergraduate degrees granted by Orange County universities were tech related.

Early Math/STEM Education
The National Council for Teachers of Mathematics has urged high-quality math instruction for 3- to 6-year olds. UC Irvine Professor of Education, Greg Duncan, is quoted in the attached article stating that early math skills are the most consistently predictive of academic success. The Commission has responded by investing in early math programs such as the MIND Research Institute, and through the School Readiness programs at the elementary school districts. The Commission's participation in the OC STEM Initiative ensures the inclusion of early math education opportunities for preschool aged children, and a forum to present the early math tools developed by the MIND Research Institute.

OC STEM Initiative Funding Partners
Several other organizations are helping to fund the OC STEM Initiative, which support a comprehensive approach to STEM learning and teaching across the education continuum from preschool through college, and into the areas of career and professional development.

Allergan Foundation
Boeing Company
Broadcom Foundation
Children & Families Commission
Cotsen Foundation
Edward Lifesciences Fund
JP Morgan Chase Bank
Kay Family Foundation
OCTANe
Opus Community Foundation
Orange County Department of Education
Orange County United Way
Samueli Foundation
Tiger Woods Learning Center/Foundation
Time Warner Cab

UNIVERSITY of CALIFORNIA · IRVINE

Early math skills predict later academic success

UCI researcher also finds K-5 students with persistent numeracy issues much less likely to graduate from high school

Michelle S. Kim / University Communications

A study involving 16,387 children showed no correlation between behavioral problems in elementary school and subsequent scholastic achievement, but early math skills played a big role.

Continuing research by UC Irvine Distinguished Professor of education Greg Duncan has shed additional light on what constitutes school readiness and which K-5 skills and behaviors predict later academic success.

"Until recently, there has been little agreement on this topic," he notes. "Most kindergarten teachers recognize the inability to follow directions, trouble working independently or in groups, and a lack of academic skills as factors associated with difficult transition to the school environment."

However, one National Research Council report argues that social and emotional aptitude is just as important as language and cognition in young children's scholastic achievement. Another NRC report emphasizes the importance of early acquisition of linguistic skills. And the National Council of Teachers of Mathematics urges high-quality math instruction for 3- to 6-year-olds.

To address this issue, Duncan and colleagues identified six population-based data sets – involving 16,387 children – that included measures of reading and math competency, attention skills, pro-social behavior, and antisocial and internalizing behavior taken around the time of school entry, as well as measures of reading and math competency taken later in the primary or middle school years.

"We found that only three of the school-entry measures predicted subsequent academic success: early reading, early math and attention skills, with early math skills being most consistently predictive," Duncan says.

"Early behavior problems and social skills were not associated with later reading and math achievement. These patterns generally held both across studies and within each of the six data sets examined."

His analysis is widely viewed as providing a clear answer about the relative role of school-entry skills and behaviors: Early academic skills appear to be the strongest predictor of subsequent scholastic success – early math skills more so than early reading skills.

"A student’s school-entry ability to pay attention and stay on task is modestly predictive of later achievement, while early problem behavior and other dimensions of social and mental health issues are not at all correlated,” Duncan elaborates. “If school readiness is defined as having the skills and behaviors that best predict subsequent academic success, concrete numeracy and literacy skills are decidedly more important than socio-emotional behaviors.”

He and Katherine Magnuson of the University of Wisconsin-Madison recently completed a second study using two large data sets (2,843 children) and the same achievement, attention and behavior measures. They determined that K-5 students with persistently low math skills were much less likely to graduate from high school or attend college.

Surprisingly, chronic reading problems were not predictive of these outcomes, after accounting for the fact that children who struggle with reading tend to also struggle with math. In contrast to the first study’s findings, persistent antisocial behavior was correlated to dropping out of high school and not attending college. But chronic difficulty paying attention and internalizing behavior were not predictive of this.

The math results were quite striking. Children with persistent math problems in elementary school were 13 percentage points less likely to graduate from high school and 29 percentage points less likely to attend college.

“The next level of research should focus on why math skills – which combine conceptual and procedural competencies – are the most powerful predictor of subsequent achievement and attainment,” Duncan says. “Experimental evaluations of early math programs that focus on particular skills and track children’s reading and math performance throughout elementary school could help identify missing causal links between early skills and later success.”

— *Nancy Christensen, Education Communications*

OC STEM Initiative

Michelle Freeman
Samueli Foundation/OC STEM Initiative

Tamika Lang
The Boeing Company

Nithin Jilla
AppJam+/Donald Bren School of Information and Computer Sciences, University of California, Irvine

OC STEM INITIATIVE

ADVANCING SCIENCE, TECHNOLOGY, ENGINEERING, MATH

Session Overview

- Overview – past, present and future planning
- Member perspective
- AppJam+ Overview and demonstration

OC STEM

- As a growing network comprised of local funders, we partner with community stakeholders (students, parents, teachers, businesses, and funders) invested in the improvement of the quality and outcome of Science, Technology, Engineering and Mathematics (STEM) teaching and learning in Orange County to develop the critical thinking, creative and innovative leaders of tomorrow.

Kania & Kramer's Five Conditions of Collective Success

Unlike most collaborations, collective impact initiatives involve a centralized infrastructure, a dedicated staff, and a structured process that leads to a common agenda, shared measurement, continuous communication, and mutually reinforcing activities among all participants.

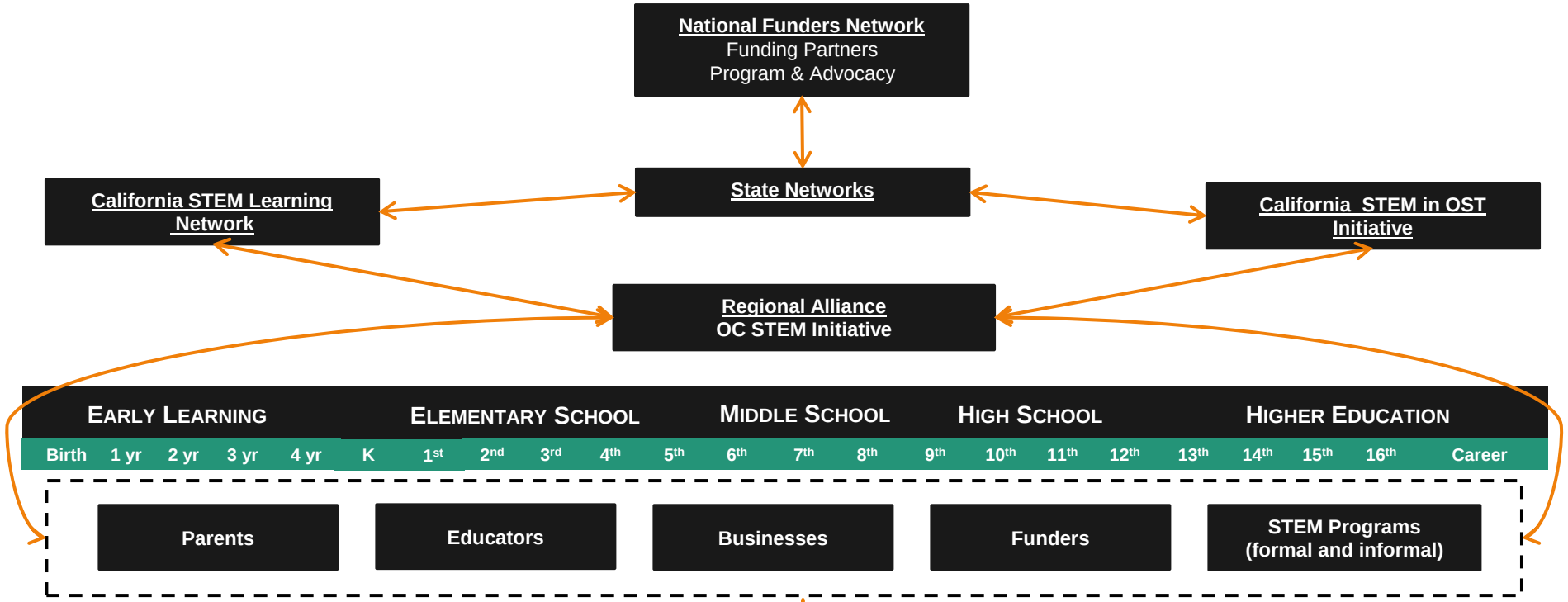
- Common Agenda
- Shared Measurement Systems
- Mutually Reinforcing Activities
- Continuous Communication
- Backbone Support Organizations

Source: Kania, J. & Kramer, M. (2011). *Nonprofit Management Collective Impact*. Stanford Social Innovation Review, 48, Winter.

What is unique to OC STEM?

- Orange County believes that the development of a STEM competent workforce and citizenry begin with preschoolers and continues at every step of the education continuum thereafter.
- Orange County is a proven global leader of innovation with a competitive edge, housing a large number of pioneering high-tech and biomedical industries plus new industries such as advanced transportation, alternative fuels, medical devices and computer gaming.
- Orange County’s possesses a diverse population, with multiple ethnicities and a significant foreign-born population.
- Orange County offers a uniquely high concentration of research centers and institutes of higher education with STEM education and workforce efforts.

OC STEM Initiative Networks and Partners



Current Partners

Allergan Foundation
Broadcom Foundation
Children and Families Commission of Orange County
Cotsen Foundation
Edwards Lifesciences Fund
JP Morgan Chase Bank
Kay Family Foundation
OCTANe
Opus Community Foundation
Orange County Department of Education
Orange County United Way
Samueli Foundation
The Boeing Company
Tiger Woods Learning Foundation/Center
Time Warner Cable

OC STEM INITIATIVE

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Early Learning					Elementary School					Middle School			High School				Higher Education				
Birth	1 yr	2 yr	3 yr	4 yr	K	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	Career

OC STEM Initiative

National Lab Network
STEM professionals in the classroom

MIND Research Institute Algebra readiness

Science @ OC
LASER science

UCI School of Engineering
Freshman recruitment & retention
Faculty recruitment

Pre-K Math MIND Program
Research and development

Discovery Science Center
Science of Hockey exhibit & afterschool science programs

Mathematics, Engineering, Science Achievement (MESA) Schools Program
Science & math programs

Discovery Science Center
Science of Hockey curriculum

UCLA Engineering
ESC online tutoring

Broadcom MASTERS Program
Science fair competition

UCI School of Engineering/Community Colleges
Community college/university transfer pathway (TBD)

Orange County Department of Education
STEM initiatives

California Afterschool Network|Think Together|Discovery Science Center
STEM education programs in out of school

Girls Inc.
Eureka Program

Lead STEM Practitioners (LSP) Program
LSPs in all 28 school districts (TBD)

Cal State University System
STEM teacher preparation & training (TBD)

Math Counts
Math competition

OC STEM INITIATIVE

Academic Milestones: Critical Transitions and Benchmarks

Acquires English language and building vocabulary (oral)
Develops motor and perceptual skills
Stimulates brain and behavior

Good basic reading skills

Receives early exposure to STEM

Students either are or are not comfortable with math & science

Students start losing ground in math

Proficiency in Algebra I

Students start to question relevancy of school learning to their lives

Takes SAT and ACT
Graduates from high school
Passes high school exit program
Completes college preparatory coursework (A-G requirements)

College math/English preparatory attainment to transfer from community college to university

Graduates from college

Enters workforce

Student, Family and School Support

Parental knowledge of early development increases
Has strong parent-child communication
Builds self-awareness and self-regulation
Practices healthy behavior
Develops empathy and cooperation

Has qualified math and science teacher

Attains social and emotional competence

Receives guidance from a non-parent mentor

Participates in community and social organizations

Adopts about a career plan

Has sufficient financial aide
Develops time and stress management skills
Engages in community and campus organizations

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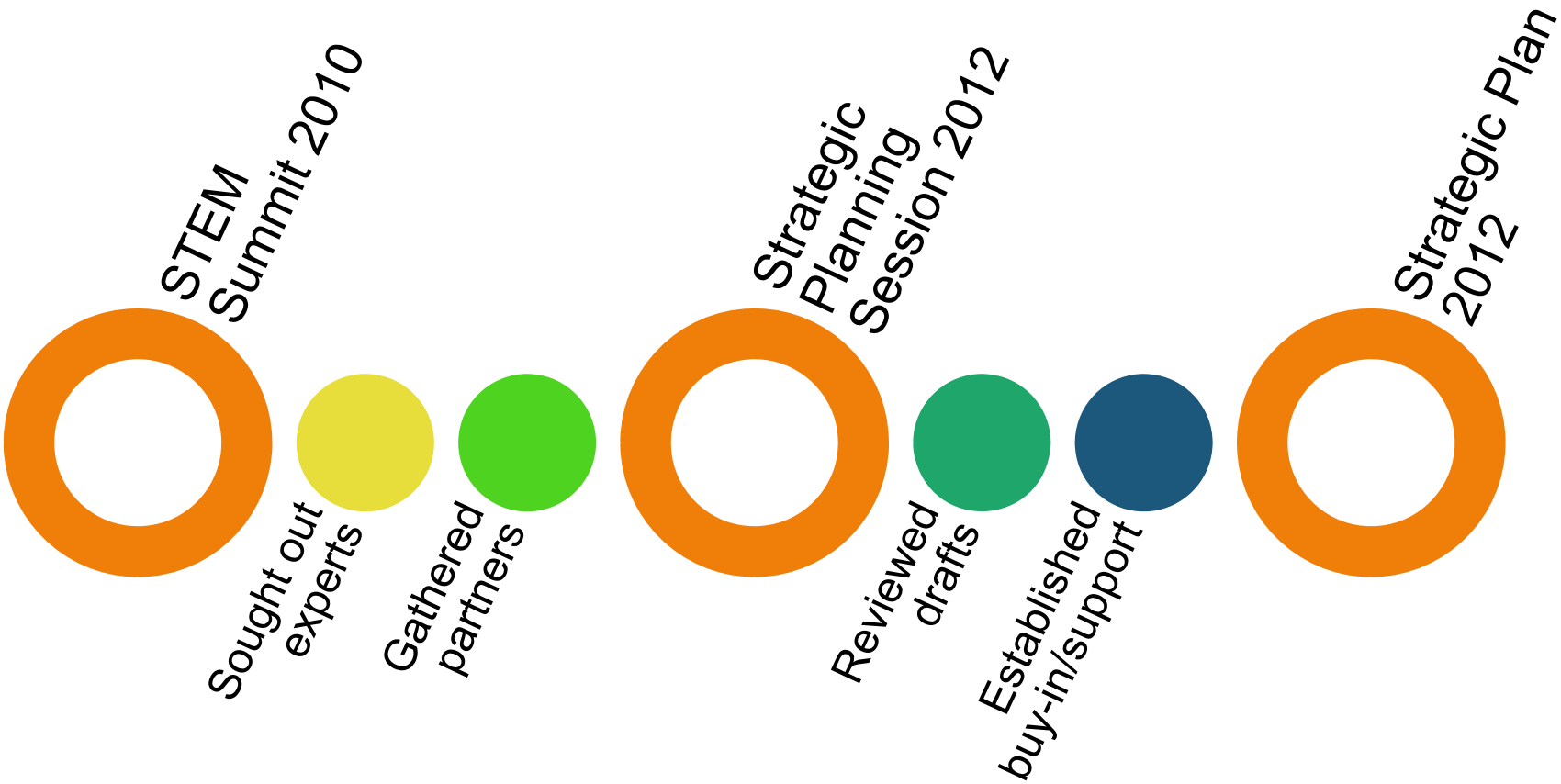
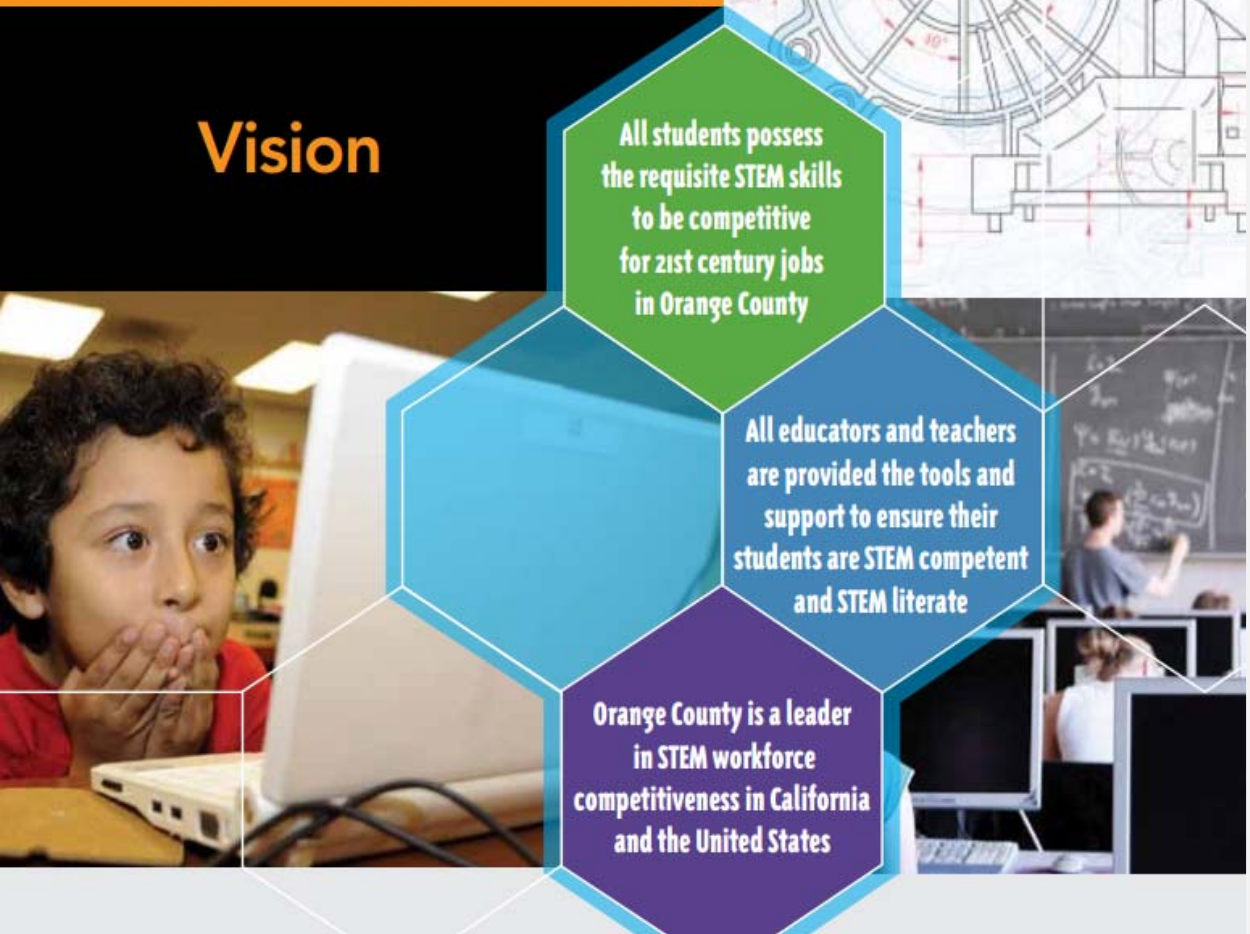
Where we started



OC STEM Initiative

Vision



Objectives

- Foster Orange County's economic competitiveness and sustainability
- Create effective partnerships between community stakeholders, including but not limited to families, education, businesses, government, and philanthropic, organizations
- Promote STEM competencies across the educational continuum in Orange County from PreK through college
- Prepare our children and future workforce to meet the dynamic requirements of a rapidly changing world
- Produce college- and career-ready graduates who possess critical thinking skills and creativity that enable them to make productive choices in work and life

OC STEM INITIATIVE

ADVANCING SCIENCE, TECHNOLOGY, ENGINEERING, MATH

Organizational Structure

- **Goal**: Build a sustainable structure to support the ongoing implementation of successful STEM programs

STEM Communication Strategy

- **Goal**: Promote awareness of STEM competencies and why they are important

STEM Learning

- **Goal**: Create an ongoing interest among PreK-college students to pursue the practice and reinforce the development of STEM knowledge, skills and abilities

Professional Development

- **Goal**: Promote educator's STEM knowledge, competencies and pedagogy

Workforce Development

- **Goal**: Bridge the gap between an educated workforce and Orange County businesses' demands

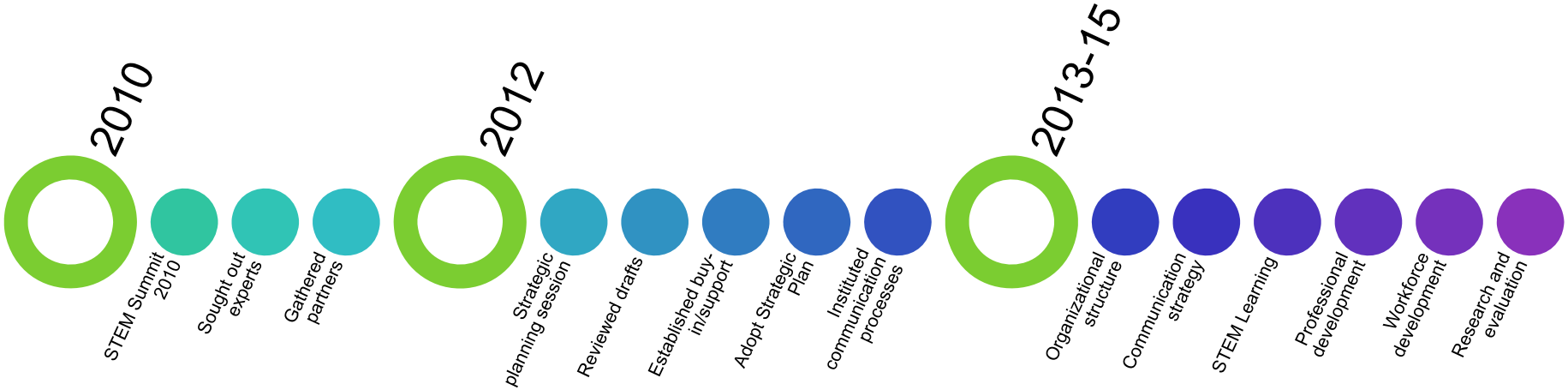
Research and Evaluation

- **Goal**: Promote rigorous research-based approaches to STEM teaching and learning

Sampling of activities and deliverables

Organizational Structure	STEM Communication Strategy	STEM Learning	Professional Development	Workforce Development	Research and Evaluation
Blueprint for Success	Quarterly STEM Series	Preschool curriculum	Lead STEM Practitioner	Convene workforce/ industry leaders	Dimensions of Success Tool
Funders network structure	Awareness campaign	Project-based, hands-on learning	Leaders workshop		STEM database

Where do we go from here?



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The Boeing Company

TAMIKA LANG

OC STEM INITIATIVE

ADVANCING SCIENCE, TECHNOLOGY, ENGINEERING, MATH

AppJam+/Donald Bren School of Information and Computer Sciences, University of California, Irvine

NITHIN JILLA

appjam+

AppJam+

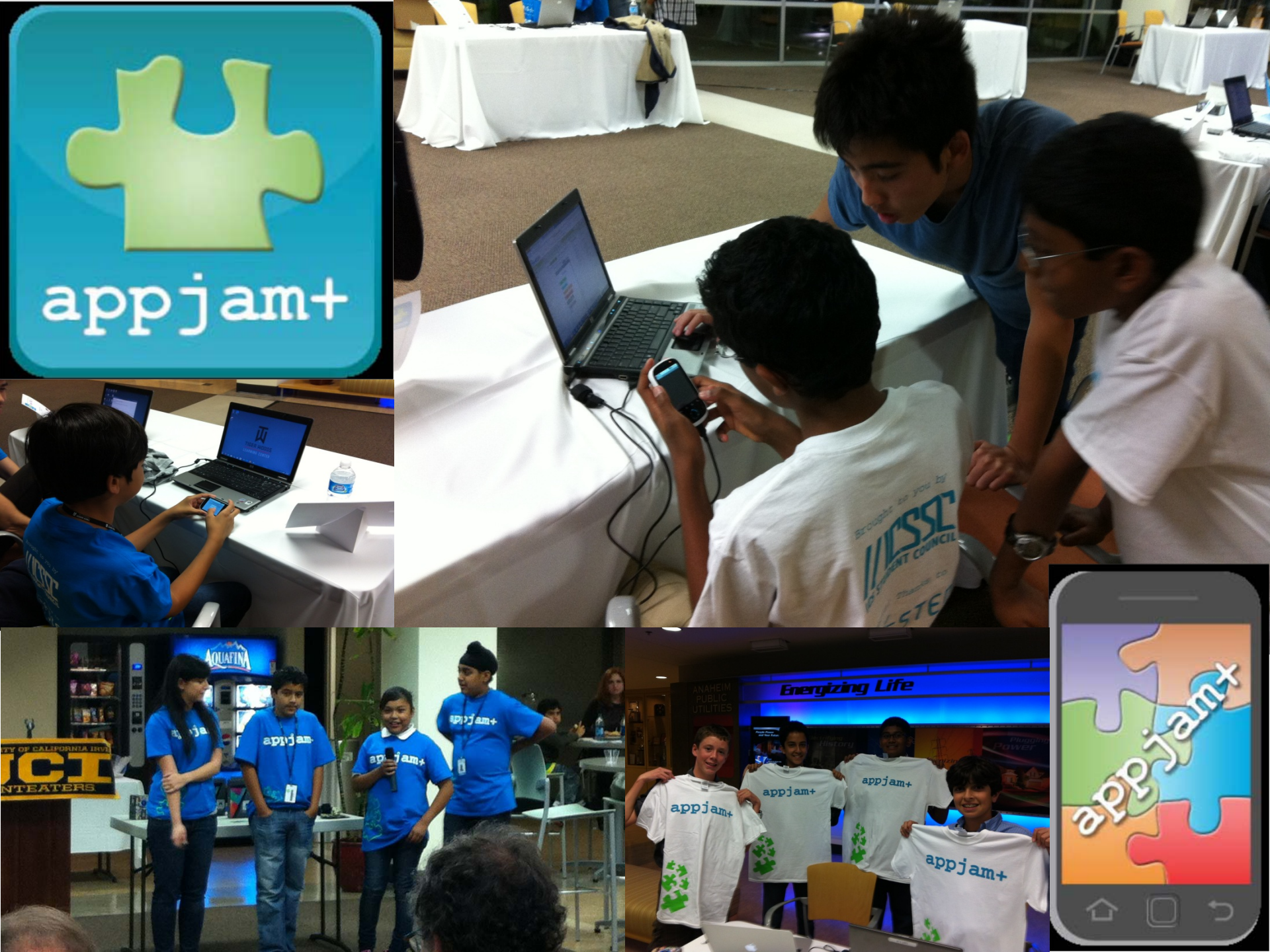
- AppJam+ is a program in which we used the concept of building software in a short period of time as a tool to excite and inform middle school students about STEM fields while teaching them the creative and hands on technical process of mobile application development.

Key Core Aspects

- Team Building
- Projects based learning (learn by doing model)
- Exposure to Mobile & Technology at a young age
- Mentorship from undergraduates in University
- Inspires leadership

Key Core Aspects

- Pushes teaching, innovation and learning
- Growth of STEM knowledge in areas of Design, Technology, Computers and more
- Growth of STEM skills in Critical Thinking, Active Learning, Technology Design, Analysis, Programming and more.


appjam+
AQUAFINA
appjam+
Energizing Life
appjam+

For more information, contact
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or visit our website at:
www.ocstem.org

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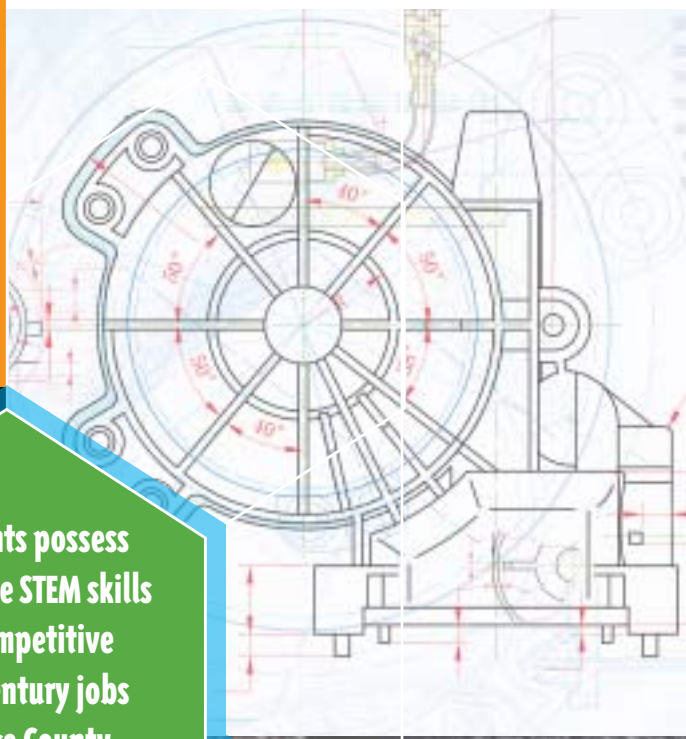
OC STEM Initiative



Vision

All students possess the requisite STEM skills to be competitive for 21st century jobs in Orange County

All educators and teachers are provided the tools and support to ensure their students are STEM competent and STEM literate

Orange County is a leader in STEM workforce competitiveness in California and the United States

Objectives

- Foster Orange County's economic competitiveness and sustainability
- Create effective partnerships between community stakeholders, including but not limited to families, education, businesses, government, and philanthropic, organizations
- Promote STEM competencies across the educational continuum in Orange County from PreK through college
- Prepare our children and future workforce to meet the dynamic requirements of a rapidly changing world
- Produce college- and career-ready graduates who possess critical thinking skills and creativity that enable them to make productive choices in work and life

What Sets Orange County Apart?

Orange County possesses unique attributes to establish itself from an advantageous STEM position.

- **Orange County** believes that the development of a STEM competent workforce and citizenry *begin with preschoolers* and continues at every step of the education continuum thereafter.

- **Orange County** is a proven global leader of innovation with a competitive edge, housing a large number of pioneering high-tech and biomedical industries plus new industries such as advanced transportation, alternative fuels, medical devices and computer gaming.

- **Orange County's** possesses a diverse population, with multiple ethnicities and a significant foreign-born population.

- **Orange County** offers a uniquely high concentration of research centers and institutes of higher education with STEM education and workforce efforts.

Situation Analysis

Keeping Orange County Competitive and Prepared for the Future – the Need for STEM Competent Students and Workers

The United States is undergoing a critical economic transformation, moving rapidly from a low-skill, low wage economy to a high-skill, knowledge-based economy driven by technology and innovation.

STEM permeates Orange County life – from its miles of coastline and many cities, to its Fortune 500 and 1000 companies, to its K-12 public school districts, community colleges and public and private universities. In fact, Orange County has fared better in the Great Recession compared to surrounding counties and the state because of many STEM-related factors such as the county's role as a leader of innovation, its large number of high-tech industries and global corporations, its leadership in emerging industries, and its high concentration of research and higher education institutes, business incubators and venture capital investments.

Yet, in order to maintain Orange County's innovation and competitive edge in the changing global economy, Orange County jobs will require a higher number of STEM proficient students than is currently being prepared.[i] At the national level, business leaders are warning that once the recession ends, they could face shortages in areas ranging from construction and energy to information technology, health care and the STEM fields.[ii] Even local STEM businesses have taken notice. One CEO from a Fortune 500 company with headquarters in Orange County has stated *"If we can help keep students excited about mastering science, mathematics and engineering, we are helping to insure that our company and other great companies will benefit from the good works of these future scientists, engineers and innovators."*[iii]

The Georgetown University Center on Education and the Workforce has found that **"the education system is not producing enough STEM-capable students to keep up with the demand both in traditional STEM occupations and other sectors across the economy that demand similar competencies."** Moreover, the demand for STEM competencies outside STEM occupations is growing.

These economic demands at the national, state and county levels will require an adaptable workforce – one with STEM competencies with a foundation of 21st Century skills required for citizenship, career development and lifelong learning.

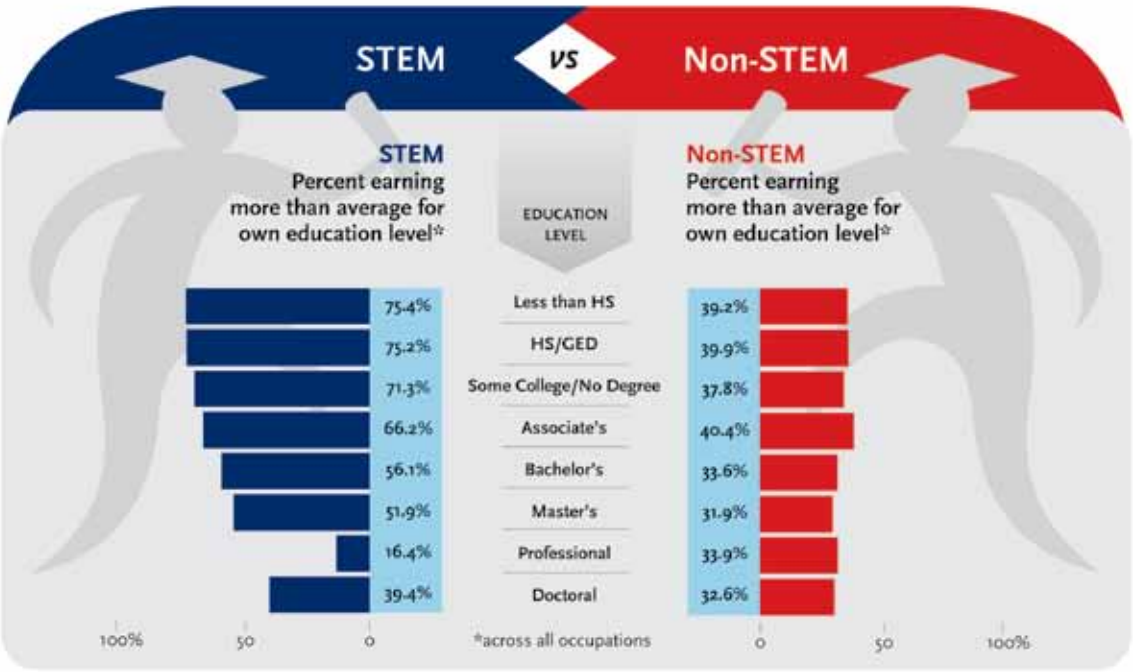
Source: Georgetown University Center on Education and the Workforce, 2011

The demand is not restricted to the fields of science, technology, engineering and math. Rather, workers with "STEM competencies" are needed across a broad range of occupations. STEM competencies include knowledge, skills and abilities such as active listening, critical thinking, problem solving and the ability to work collaboratively.

The United States is not producing enough STEM workers to compete successfully in the global economy, despite the fact that STEM workers are in demand and paid comparatively higher wages.

Nationally, STEM occupations are projected to grow more quickly than the economy as a whole (17% versus 10% through 2018) and will be the second-fastest growing occupational cluster, after Healthcare occupations.[iv] In total, Orange County is expected to add approximately 135,500 jobs from 2008-18.

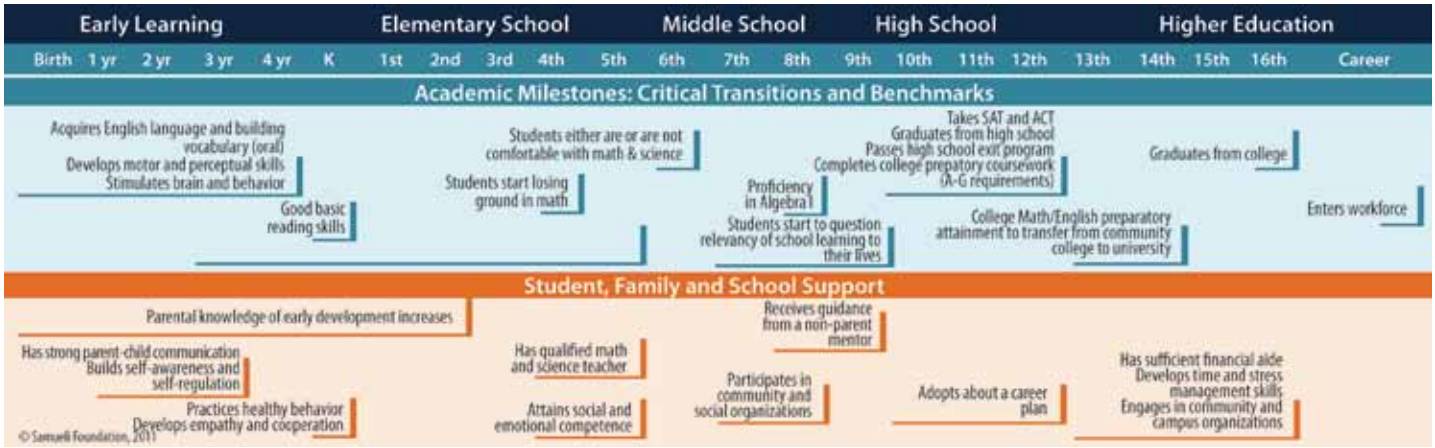
Overall STEM occupations pay well at all educational levels. **People in STEM occupations with a high school diploma or less have higher lifetime earnings than people in other occupations with similar education levels (approximately $500,000 more).** Similarly, STEM majors make substantially more over their lifetime than non-STEM majors.[v]



Source: Georgetown University Center on Education and the Workforce

Situation Analysis

Creating a Continous Pathway for STEM Teaching and Learning in Orange County – The Need for a Continuum Approach



To develop STEM competent students and meet the demand of the 21st century economy, it will be critical to develop a framework that address the continuum of STEM teaching and learning from early childhood through higher education to employment in STEM related fields in Orange County. This continuum identifies those student, family and school supports and academic milestones for a child as he or she progress through each grade as a framework for STEM education in Orange County and recognizes the various pathways for students to attain STEM competencies.

A continuum that encompasses all aspects of student development, including family and school support, is needed to develop STEM competent students and ensure a growing STEM competent workforce.

Early Learning – Early Opportunities that Build the Foundation of STEM Competencies

Currently, California does not have a common standardized measure or any statewide data regarding school readiness in kindergarten. However, compelling evidence suggests that the achievement gaps that exist between student groups in 2nd grade are foreshadowed at kindergarten entry.[vi]

Research also suggests that very young children are ready to learn a broad array of mathematics content that will give them a solid base for future learning.[vii] Six longitudinal studies showed that early math skills are the most powerful predictor of later school success.[viii]

The development of STEM skills, such as critical thinking, is being formalized into preschool curriculums and within the early childhood development community, there is a greater emphasis on training teachers to teach STEM activities. According to one leading early childhood development expert, "Children are strong and natural explorers and even have some surprisingly abstract abilities for grasping basic scientific principles."[ix] In a survey conducted in 2010, Californians reported seeing early science as foundational to success in high school.[x]

Elementary, Middle and High School – Reinforcement and Practice of STEM Competencies

According to the 2006 Programme for International Student Assessment (PISA), U.S. students performed much worse in science and math than students from other industrialized countries. Of the 30 countries tested, students from 16 countries performed higher than U.S. students in science, and students from 23 countries performed higher than the United States in math.[xi]

In comparison, Orange County students outperform their statewide peers in mathematics and science, however disparities among districts remain. In 2010, 68% of 2nd grade students and 57% of 7th grade students in Orange County scored proficient or above on the Mathematics California Standards Tests (CST) compared to 62% and 49%, respectively, statewide. Orange County 5th, 8th and 10th grade students had a higher percentage of proficient and above performance on each of the Science CSTs than their peers statewide. Although Orange County students appear to outscore their statewide counterparts in Mathematics and Science CSTs, the results are inadequate.

It is imperative to understand the intersections between the development of STEM competencies and the support children need from their family and school environments to meet the academic milestones identified in the continuum graphic.

Notwithstanding that Californians believe that science education is important and should be a priority for their, 40% of elementary teachers say they spend 60 minutes or less teaching science each week and nearly one-quarter of middle school teachers may not have an adequate background or preparation for teaching the subject.[xii] Something needs to change.

Research from the 2011 report "High Hopes – Few Opportunities: The Status of Elementary Science Education in California" indicate that at the elementary school level, teachers are under pressure to meet the accountability goals in mathematics and English, which limits time for science education.[xiii] In addition, elementary teachers and schools do not have the infrastructure to support quality science learning.

Although middle schools offer dedicated time for science, access to facilities and teachers who have been prepared for science instruction, often times students arrive to middle school unprepared and uninterested in science.[xiv]

Elementary School Science Education Findings

- Only one-third of elementary teachers say they feel prepared to teach science.
- 85 percent of teachers say they have not received any professional development in science during the last three years.
- Nine in ten principals say science education is very important and should start early.
- Less than half of principals (44%) believe it is likely that a student would receive high-quality science instruction in his or her school.

Source: The Center for the Future of Teaching and Learning at WestEd

Middle School Science Education Findings

- Nearly half (47%) of principals report students' lack of preparation as a major or moderate challenge.
- Nearly one-quarter of middle school teachers may not have an adequate background or preparation for teaching the subject.
- Nearly 60 percent of surveyed teachers identified insufficient professional development as a barrier to high-quality science instruction.
- Just 14 percent of middle school teachers provide a pattern of classroom practices that support regular engagement of students in the practices of science.

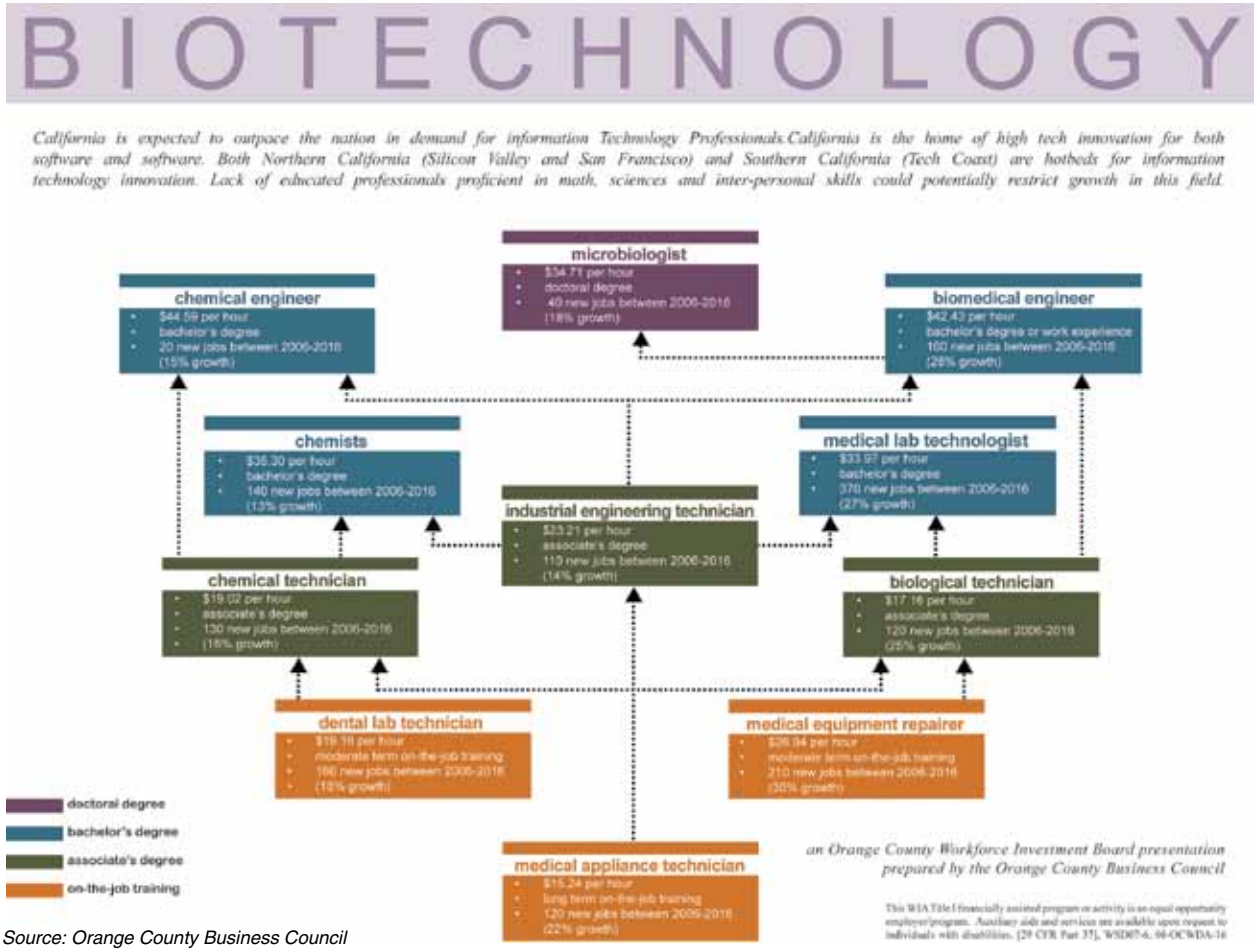
Source: The Center for the Future of Teaching and Learning at WestEd

Yet by high school, only 20% of Orange County students enroll in upper level math courses; while 14% of students enroll in Chemistry and 6% in Physics. There is ethnic disparity in both enrollment and performance. For example, Hispanic students comprise approximately 40% of the K-12 population, with a disproportionate rate of under-enrollment and under-performance in upper level math and science coursework.[xv]

In 2009-10, approximately 36.2% of Orange County high school students were eligible for entry into the UC/CWU university systems, higher than the California rate of 35.6%.[xvi] Asian students had the highest level of eligibility at 63% followed by Filipino students at 49.9% and White students at 40.8%. Latino students had the lowest rates of eligibility at 19.8%.

Higher Education

The "Biotechnology Career Ladder" graphic illustrates the importance of an education pathway from K-12 through higher education to workforce development.[xvii] For this example, a person interested in the Biotech industry could meet job requirements through job training after high school. As the person advances, more knowledge and skills are warranted.



Source: Orange County Business Council

But, how is this accomplished with only 40% of 27 year olds nationally having earned an associate degree or higher?[xviii] Experts project that there will still be job openings for people with just a high school degree but the jobs will make up a small percentage of total job openings. In fact, over the past century, all of the net job growth in the United States has been generated by positions that

require at least some post-secondary education (community colleges, a four-year school, career technical education, or an apprenticeship).

In Orange County, 33.6% of students enrolled in Career Technical Education programs represented STEM related disciplines in 2010. Of the STEM disciplines, the three programs with the highest number of student enrollment were: Electrical, Electronics and Communications Engineering; Civil Engineering; and Mechanical Engineering. The California Community Colleges' Career Technical Education provides education for technical skill demands of emerging industries, as well as basic work readiness skills that California's employers need.[xix]

In 2010, only 4.8% of total associate degrees granted by Orange County Community colleges and WASC accredited non-public institutions were STEM related.[xx] Of those STEM related associate degrees, Mathematics, Chemistry and Biology accounted for 55.5% of all the STEM disciplines awarded.

In 2010, roughly 17% of total undergraduate and 22% of graduate degrees granted by Orange County universities were tech related.[xxi]

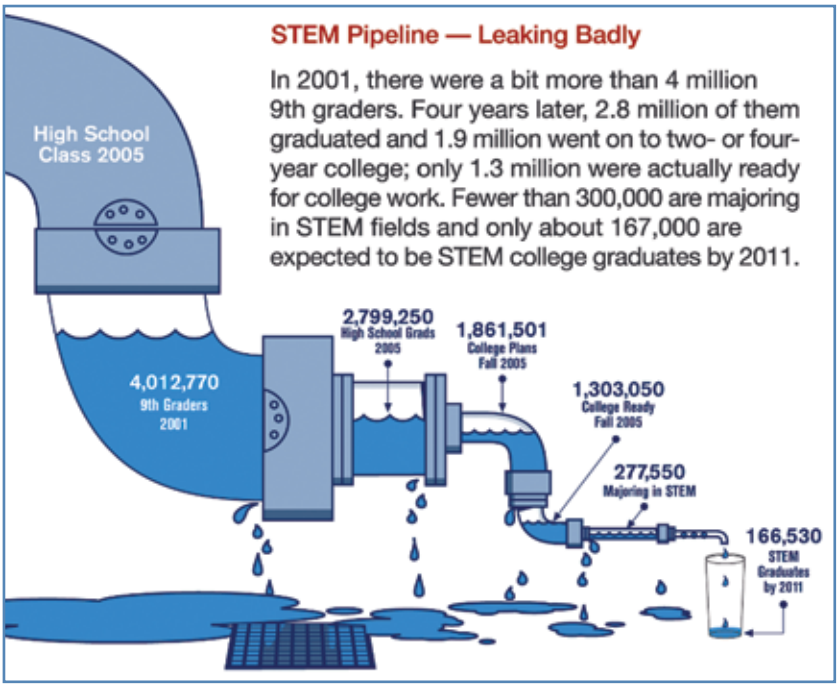
STEM Degrees Granted by Orange County Universities, 2009[xxii]

	2009		2003-2009 % Changes	
Discipline	Bachelors Degrees Granted	Graduates Degrees Granted	Bachelors Degree Change	Graduates Degree Change
Biological Sciences	894	70	70.6%	66.7%
Biology	140	11	14.8%	-38.9%
Engineering	530	348	47.6%	96.6%
Information and Computer Sciences	178	70	-46.2%	0%
Computer Sciences	70	126	-43.5%	207.3%
Physical Sciences	388	161	114.3%	159.7%
Other Sciences	8	54	-74.2%	42.1%
Total	2,208	840	32.1%	87.5%

Source: 2011-12 Orange County Workforce Indicators Report

The Problem: A Leaky Pipeline

The STEM pipeline carries students from high school through university and on to jobs in STEM. However, in Orange County and across the nation, the pipeline leaks students at multiple stages. This leakage is critical to understanding the need for a comprehensive education continuum approach for students to attain STEM competencies.



Courtesy of the Bill and Melinda Gates Foundation

Preparing Our Future Workforce – Orange County and Beyond

The number of STEM jobs in the United States is projected to grow by 17 percent between 2008 and 2018, compared with only 10 percent U.S. job growth overall.[xxiii] The number of jobs requiring STEM skills is even greater!

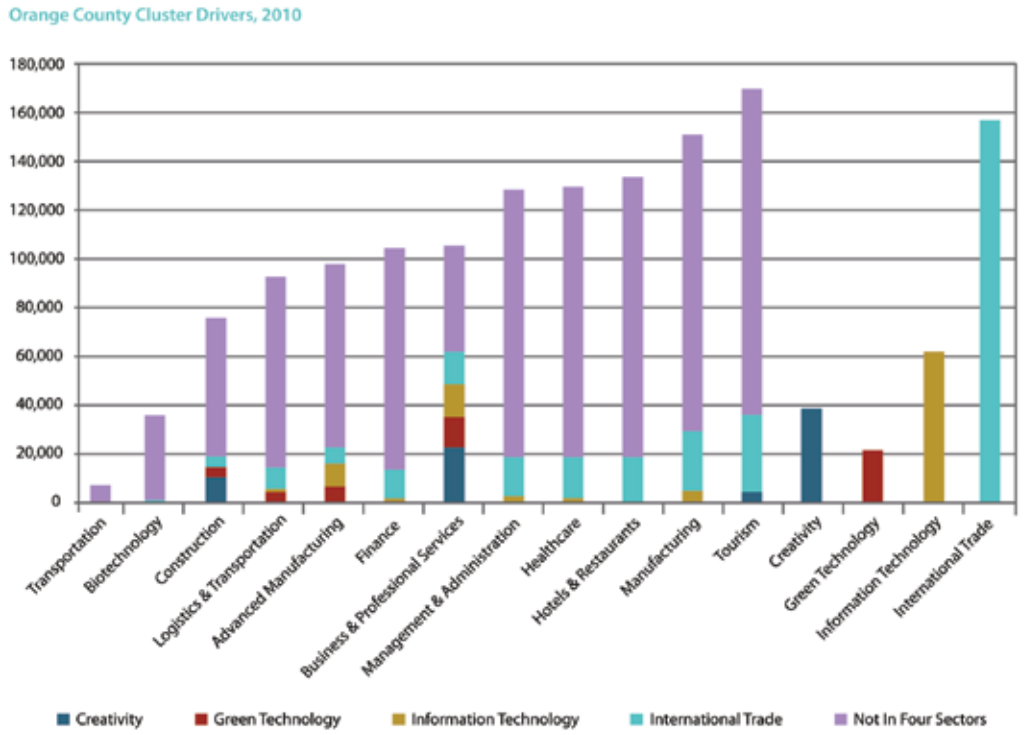
California's economy is also becoming more knowledge-based, with STEM employment increasing at a faster rate than non-STEM employment. Between 1999 and 2007, STEM employment increased by 25% while non-STEM employment increased by only 16%.[xxiv] And even those traditional non-STEM jobs, such as those in the medical profession or business sector, will require a high level of critical thinking, and collaborative and innovative skills that can only be derived from a solid STEM-based education.

In order to compete in the global marketplace, Orange County needs a competent and growing workforce with the highest level of STEM skills and capabilities.

However, data suggests that the state's supply of graduates in these fields is shrinking. While California ranked 4th on the 2010 State Technology and Science Index – performing well in risk capital, entrepreneurial infrastructure, and research and development inputs – the state's lowest ranking was in human capital capacity, at 13th out of 50.[xxv]

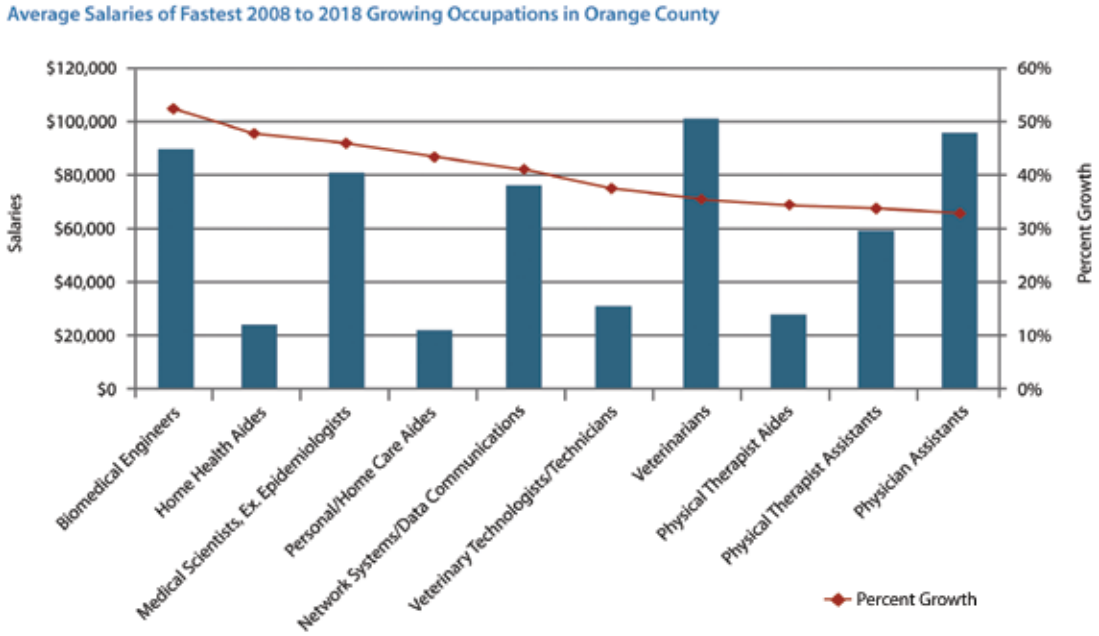
In Orange County, professions in eight of the 10 industry clusters as identified by the Orange County Workforce Investment Board require STEM competencies and skills.[xxvi] These industry clusters include: Management & Administration; Energy, Environment & Green Technologies; Construction; Finance, Insurance & Real Estate; Healthcare; Information Technology; Manufacturing; and Biotechnology & Nanotechnology. According to the 2011-12 Orange County Workforce Indicators Report, as many as 85 percent of all new jobs in Orange County from 2010-2020 will be in following six economic sectors: Healthcare, Business Services, Leisure and Hospitality, Construction, Manufacturing and Retailing.[xxvii]

The Orange County Business Council has identified International Trade, Information Technology, Creativity and Cleantech as emerging cluster drivers among the traditional clusters in 2010. These are clusters that created high-paying jobs and initiated economic growth throughout the County.[xxviii] **Each of these clusters will require a STEM competent workforce to continue to meet the growing demand.**



Source: 2011-12 Orange County Workforce Indicators Report

According to the 2011-12 Orange County Workforce Indicators Report, five of the 10 high growth occupations have salaries above $70,000. These occupations represent the High-Tech, Management and Administration, and Healthcare clusters.[xxix] All of which require a level of STEM proficiency and skill.



Source: 2011-12 Orange County Workforce Indicators Report

Despite the potential lucrative nature of STEM careers and the increasing rate of STEM jobs, during this decade, the United States will produce twice as many graduates in social sciences and business as in STEM degrees. Orange County is no different. The rate of increase is outpaced by the rate of Orange County employers' need for even greater numbers of STEM workforce.[xxx]

Blue Print for Success

Organizational Structure

Goal: Build a sustainable structure to support the ongoing implementation of successful STEM programs

Activity	Deliverables	Short Term Benchmarks (1 - 3 years)	Long Term Benchmarks (4-6 years)
Develop a funders' network Develop a funding strategy Adopt an action plan and logic model Develop staff and operational support Create a process for organizational evaluation	Funders network structure including bylaws, meeting protocol, governance, budget, and membership roster Case statement Annual fund development plan Blueprint for OC STEM success Online, dynamic Blueprint for OC STEM success Branding session/outcomes to develop OC STEM branding moving from "initiative" to established program Executive Director and administrative and operations staff members in place Office space and equipment secured Annual evaluation or audit report prepared by outside firm assessing the organization, including staff positions, expertise needed, etc.	Increased number of funding partners supporting STEM in Orange County Established Governing Directors for OC STEM network and criteria Increased dollars dedicated to STEM operations and programs through philanthropy and government grants Increased number of funding partners adopt/approve Blueprint for OC STEM success Regular updates on OC STEM programs/progress on website OC STEM becomes an established, branded program Executive Director and at least one staff members hired Temporary office space for OC STEM program operations identified Funders review and implement recommendations from organizational evaluation annually Organizational Success Indicators identified, tracked and show improvement	Increased number of funding partners providing sustainable capacity and support for the STEM Initiative in Orange County OC STEM network considers becoming its own 501(c) 3 Regular updates on OC STEM program progress on website OC STEM becomes countywide, recognized program for STEM success Expanded staff if needed Permanent office space and operating equipment secured Funders review and implement recommendations from organizational evaluation annually Organizational Success Indicators identified, tracked and show improvement

Blue Print for Success

STEM Communications Strategy

Goal: Promote awareness of STEM competencies and why they are important

Activity	Deliverables	Short Term Benchmarks (1 - 3 years)	Long Term Benchmarks (4-6 years)
Design and implement awareness campaign(s) for various audiences Gather business, educators, government, funders, community organizations on a regular basis to share STEM-related information, resources, and results	Strategic Awareness Campaign/ communications materials targeting all audiences including hard to reach populations Quarterly STEM-related lecture series for network members Annual STEM gathering for STEM programs across the educational continuum and workforce development OC STEM Website	Public awareness consultant hired to design and implement STEM-focused public awareness campaign(s) Increased number of awareness campaigns conducted Increased traffic/data analytics for the newsletter Increased number and breadth of participants at quarterly and annual gatherings. Increased awareness about STEM throughout various sectors (private, public, education) in Orange County Increased traffic/data analytics for the website, create intranet for lead STEM practitioners	Increased awareness about STEM throughout various sectors (private, public, education) in Orange County Question about STEM awareness added to a countywide survey

STEM Learning

Goal: Create interest among students, preschool through college, to pursue the development of their STEM knowledge, skills and abilities

Activity	Deliverables	Short Term Benchmarks (1 - 3 years)	Long Term Benchmarks (4-6 years)
Introduce and implement STEM curricula in preschool classrooms. Increase the opportunity for K-12 students to experience project-based, hands-on STEM learning, for in-school and out-of-school environments Expand a career and college ready pathway with STEM disciplines taught linking high schools and community colleges with higher education Expand the number of students who pursue advanced certifications and degrees in STEM fields	A continuum of STEM programs targeted to preschool through college-aged students that align with common core and next generation science standards, and meet established best practice standards.* **Each program will have its own detailed summary sheet of the program and related activities/deliverables.*	Increased number of STEM programs, preschool through college Increased number of out-of-school (OST) STEM programs Increased number of informal learning opportunities for families and communities Increased number of STEM professionals and volunteers in preK-12 classrooms Increased number of students taking AP classes in STEM subject areas Increase in student achievement in STEM subject areas Increased number of ROP certificates related to STEM awarded to high school students in Orange County Increased number of STEM career pathways from high school and community colleges to four-year institutions	Increased number of quality/effective STEM programs in Orange County Every student PreK-12 experiences project-based, inquiry-based learning Increased number of schools providing fully integrated STEM approach bridging out-of-school and in-school platforms Increased student achievement in STEM subject areas Increased number of students taking AP classes in STEM subject areas Increased number of ROP certificates sought after by students Increased number of STEM programs offering pathways to community college and higher education Decreased number of students requiring remedial math for college entry Increased number of college graduates with STEM majors

Blue Print for Success

Professional Development

Goal: Promote educators' STEM knowledge, competencies, and pedagogy

Activity	Deliverables	Short Term Benchmarks (1 - 3 years)	Long Term Benchmarks (4-6 years)
Develop STEM-related professional development strategies targeted to educators at all levels of the educational continuum for both formal and informal learning environments: • PreK • K – 6 • Middle School • High School • College Promote integration of STEM-related disciplines and competencies into the curriculum of educational institutions with education credentialing or early care disciplines	A robust online professional development platform on STEM for all educators and teachers in STEM disciplines A Lead STEM Practitioner program established at Orange County school districts A STEM internship and mentoring program between businesses, community colleges, and four-year institutions A workshop for leaders at Orange County universities, colleges and community colleges that have a credentialing or early education career program to begin the discussion of the importance of STEM education and competencies	Increased number of STEM-related professional development opportunities Increased number of educators attending professional development opportunities Increased number of educators utilizing the online professional development platform Increased number of internship and mentoring programs between business, community colleges, and four-year institutions Increased number of mentors/mentees participating in internship and mentoring programs per year Increased number of preschool through college educators with STEM teaching competency	Change in PreK through college educator attitudes about the necessity for teaching and learning STEM competencies Increased number of preschool through college educators with STEM teaching competency Change in educator, administrator, and after-school staff attitudes towards an integrated approach to STEM teaching and learning between out-of-school and in-school platforms STEM disciplines and competencies become standardized into the curriculum for educators and early care providers A continuing education (CE) professional development program with incentives Every Orange County teacher has participated in a STEM-related professional development workshop Every student in an educational/ early care discipline has taken a STEM-related workshop/course

Blue Print for Success

Workforce Development

Goal: Bridge the gap between a STEM-educated workforce and Orange County businesses' demands

Activity	Deliverables	Short Term Benchmarks (1 - 3 years)	Long Term Benchmarks (4-6 years)
Improve linkage between Orange County's STEM-related industries/businesses and educational institutions	Bring workforce/industry leaders (e.g. Workforce Investment Board, OCBC, OCTANe) together with educational institution leaders on a regular basis to facilitate dialogue about emerging workforce needs, regional occupational shortages, and to reinforce STEM competency needs and proficiency requirements	Orange County Workforce Indicators Report is used to inform dialogue between STEM businesses/ educational institutions Reduced shortage of locally-trained STEM-capable workers	Reduced shortage of locally-trained STEM-capable workers Provide a tangible pathway for locally educated OC students to remain in OC in gainfully employed STEM positions that meet the needs of local STEM employeers, while providing a quality standard of living for the employee

Research and Evaluation

Goal: Promote rigorous research-based approaches to STEM teaching and learning

Activity	Deliverables	Short Term Benchmarks (1 - 3 years)	Long Term Benchmarks (4-6 years)
Create a process for research and evaluation related to STEM activities in Orange County	A regularly updated database of STEM programs in Orange County A metrics tool for assessing outcomes and programs	Increased number of quality/effective STEM programs in Orange County	Increased number of quality/effective STEM programs in Orange County Develop a grading or rating type system to assess quality and comparison of STEM program providers

Early Action Projects

While a comprehensive strategic plan is foundational to the long-term success of any endeavor, there is also great **value in identifying early success projects** that can coalesce supporters, gain momentum for the movement, and move the initiative forward with new partnerships, positive outcomes, and insights gained from practical lessons learned. In this context, the following projects are early action projects for the first year of the OC STEM network.

Learning from the Best of the Best

Quarterly Lecture Series: Quarterly meetings bring together members of the OC STEM Initiative and individuals interested in expanding and promoting STEM education in Orange County on a regular, scheduled basis. The series includes innovative speakers presenting on the newest technology and programs in the areas of Science, Technology, Engineering and Math and provides a platform for discussions among participants.

Building Partnerships, Building STEM

National Lab Network – Orange County: The existing STEM Volunteer and Mentor program was created to expose PreK-12 students and teachers to STEM professionals and project-based, inquiry-based learning. This early action project includes marketing the National Lab Network – Orange County, recruiting STEM businesses and educators to register on the website, assisting in the "matches" between STEM professionals and educators, and designing an evaluation.

STEM Learning and Teaching Resources for PreK-12 Educators: Through a partnership with the Silicon Valley Education Foundation, Gooru and OC STEM Initiative, this project will build upon the infrastructure of the Lessonopoly website and provide a more robust design, search engine power and increased functionality to Orange County educators.

Setting Teachers Up for STEM Success

Lead STEM Practitioners: This effort will launch a program wherein each Orange County school district designates a Lead STEM Practitioner (LSP) through an application process. Each LSP will participate in STEM-related trainings, be equipped with a tablet, and have access to an intranet site through the OC STEM website. The website will house STEM lesson plans, activities, and social networking functionality. LSPs will become the conduit for STEM information flowing from OC STEM to the districts and back, helping to increase awareness of STEM throughout all districts.

STEM for Preschoolers? There's Jr. Higher-created App for That!

App Jam 2.0: In collaboration with the Donald Bren School of Information and Computer Sciences Student Council, this is designed to educate Orange County middle school student in the creation of mobile applications and in doing so, excite them about the opportunities available to them in the STEM fields. The project pairs undergraduate level computer science students with middle school students in the creation of STEM related mobile applications for early learners. The winning apps would be brought to market through the Android or Apple platforms.

ocstem.org: the Go-To Place for STEM in Orange County

ocstem.org is Orange County's comprehensive website for all things STEM – programs, events, partners, articles, news and more. The website acts is the main conduit of STEM information in the county. In the next year, the website will house the Lead STEM Practitioner Program's intranet site, OC STEM Initiative member's intranet site for schedule of meetings and events plus other additional project management information, and a fully functioning National Lab Network database with links to YouTube, Facebook and other social media platforms.

Leveraging Our Dollars and Relationships to Bring STEM to Orange County

An important role for the OC STEM Initiative will be to seek funding and support for STEM programs within Orange County. This includes seeking funding opportunities at the Federal, state and local levels by leveraging relationships and expertise. This includes supporting the Santa Ana Unified School District's grant submission for the Investing in Innovation Fund (i3) through the US Department of Education, which, if awarded, would expand MIND Research Institute's PreK Math Program throughout the Santa Ana Unified School District.

The OC STEM Initiative is a regional alliance of the California STEM Learning Network, whose mission is to build a network of educators, business leaders and other stakeholders committed to establishing the world's best STEM education system in California. As a member of the network, the OC STEM Initiative is able to leverage key relationships with other STEM regions throughout the state. For example, the OC STEM Initiative was able to support 10 Orange County Boys & Girls Clubs participation in the Boston Museum of Science's national pilot study of a four unit curricula that exposes 3rd-5th grade students on the engineering design process through hands-on activities. The pilot began in January 2012, concluding by the end of the school year.

The OC STEM Initiative is also part of the California Afterschool Network's STEM in Out-of School Time program which is working to increase opportunities for high quality STEM learning for youth throughout the state. Because of the involvement of the OC STEM Initiative in the program, Orange County was a pilot site for an afterschool STEM program, which will run 2011-12.

Starting the Drumbeat

The OC STEM Initiatives looks to support STEM focused events and meetings that help support its vision. For example, in February 2012 in partnership with the National Science Resources Center, Science@OC, Orange County Department of Education, , the Synergy for Success in Science Education brought together 15 leadership/district teams, consisting of superintendents, science educators, science curriculum specialists, and local business partners, to begin a dialogue and framework that addresses science education across their districts. In April, in partnership with the California STEM Learning Network and the Heising-Simons Foundation, the Early Math Learning and Teaching convening was hosted at the University of California Irvine's Department of Education. The full day event brought together early math research experts with professionals representing counties throughout southern California to discuss the latest findings and begin to dialogue about next steps at the state and local levels. The OC STEM Initiative will continue to look for opportunities to support such events.

OC STEM Initiative Funding Partners

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THE ORANGE COUNTY REGISTER

Published: Nov. 13, 2012 Updated: 12:47 p.m.

O.C. middle school kids learn to build their own apps

By IAN HAMILTON / THE ORANGE COUNTY REGISTER

Appjam judge Gerald Solomon, 2nd from right, of the Samueli Foundation listens to the presentation of Irvine's Rancho Middle School Type 5 Productions team at the first annual Appjam competition Thursday. Team members from left are Saichandra Kalvakota, 13, Karl Jabczynski, 12, John Burnham, 13, Onyexx Chukwumerij, and UCI student mentor Chethana Nair, right.

Two times seven equals ... ? Twelve-year-old Daniel Le enters "14" on his smartphone emulator, causing a sword on the screen to collide with a robot. Something went wrong, though. The robot should have disappeared, and a rocket ship should show up to take him to the next level of the game.

Using a laptop, Daniel investigates the code running his Android phone app and moves around interlocking puzzle pieces that visually represent its logic. With a little help from UC Irvine students showing him where to look, Daniel finds a piece in the wrong spot and drags it to the correct area, fixing the logic and allowing the game he created to progress.

The Anaheim student is among more than 100 middle-schoolers who built apps over the last two months under the direction of UC Irvine computer science majors. The program, called AppJam+, grew out of similar college-level app-building events at UCI, the latest of which is happening this week.

AppJam+ is designed to expose 12- and 13-year-old students from Tiger Woods Learning Center in Anaheim and Rancho Middle School in Irvine to career opportunities they might not otherwise find.

"The chance for them to actually work with young people in college that are a little closer to their age allows them to see themselves differently and see what the possibility is for their own future," said Kathy Bihr, vice president and executive director of the Tiger Woods Learning Center.

Jacqueline Perez, 12, worked with two other children to make Ninja Math, an app that features a sensei trapped by an evil dragon. To free the sensei, players answer a series of math questions and tap the screen rapidly. She found the characters for her app by doing a Google image search.

Jacqueline and her classmates worked two hours a day twice a week learning the basics of app development. The Google app-development platform, called App Inventor, replaces complicated code with interlocking puzzle pieces representing different functions. The students coded their apps using the puzzle system, loaded them on phones and prepared presentations about their app for parents and judges.

"I think I learned how to make apps," Jacqueline said. "That's cool." She added that her ambitions for the future are to be a teacher or professional softball player. The app she helped create won second place in the middle-school event.

UC Irvine has held two AppJam competitions for university students and launched a third on Friday, a day after the conclusion of the middle-school event. The first two events were focused on Android development, but the latest is for iPad apps.

The UCI medical school handed out more than 100 of Apple's tablets to incoming medical students each year for the past three years and, for this year's competition, computer-science students are teaming up with the medical students. They'll be working together to build, in a week, new medical iPad apps that can help physicians and patients.

The Bob Amigos team from Rancho Middle School in Irvine walk up to receive their first place award at the first annual Appjam competition at the Tiger Woods Learning Center Thursday. They are from left, Anish Neervannan, 12, Toy Feng, 12, mentor Bryan Lam, Vikram Vijayakumar, 12, Anna Zeng, 12, and Naman Bhushan, 12. They won with the app called Math Olympics they created. More than a dozen UCI undergraduates mentored middle school teams in developing smartphone apps that will in turn help even younger kids learn math, technology and science

The latest UCI competition has 19 teams, while previous events had 10 or fewer; the winner will be selected Monday. Previous winners included Awktalk, an app with conversation prompts to spur discussion between socially awkward students, and an appointment app that provides reminders based on location.

"Our educational system at UC Irvine, or a lot of schools, is not project-based learning. It's theoretical learning," said 19-year-old Nithin Jilla, a mentor for the middle-school competition and organizer of the university-level version.

"Students get better at things by doing."

UNIVERSITY of CALIFORNIA • IRVINE

College prep via app design

Coached by UCI students, middle school teams learn STEM skills by creating educational smartphone games

UCI junior Naren Sathiya (in red) assists students at Irvine's Rancho Middle School in an after-school mobile phone app competition against seventh- and eighth-graders from the Tiger Woods Learning Center in Anaheim.

On a balmy autumn afternoon at exactly 3:20 p.m., the door to Michael Politiski's empty classroom at Irvine's Rancho Middle School opens. Students run for seats in front of computers.

Eyes darting between the instructor and their screens, fingers clicking on keys, the 12- and 13-year-olds work doggedly to complete data code and geometric equations – much of it disguised as jigsaw puzzle pieces that can be locked together to create sound effects, animated cartoons and other parts of mobile phone applications.

It's not their teacher at the whiteboard issuing instructions, though – it's 18-year-old Chethana Nair, a UC Irvine computer science & engineering student. She's one of more than a dozen UCI undergraduates who are mentoring after-school teams of middle schoolers in Anaheim and Irvine, helping them invent smartphone "apps" that will help even younger kids learn math, technology and science.

"I am really enjoying it. These kids are so bright; we're just amazed at how much they know. Building these apps gives them motivation to learn many skills," Nair says. "And if the younger children play the game, they take the subject more seriously too."

The middle schoolers put it differently: "We're doing this because we love computer games, and we all want to be quadrillionaires!" says Souhail Siddaqi, 13. "But for the little kids, we'll give it to them for free."

Seven weeks of this work culminate Nov. 8 at Anaheim's Tiger Woods Learning Center with nearly 100 students from the center and Rancho Middle School displaying their creations for judges. A variety of prizes will be awarded, including one for best overall product.

The program grew out of "AppJams" started in 2011 by the ICS Student Council at UCI's Donald Bren School of Information & Computer Sciences, believed to be the nation's first such tournaments. The objective is simple: Teams design a fully functional mobile application in a week.

Impressed, the Samueli Foundation and the Kay Family Foundation asked the college students to help middle schoolers design educational apps. Along the way, the undergraduates learn teaching skills, and the seventh- and eighth-graders learn geometry, computer code, animation and a host of other skills.

"This is the future of education," says Mark Percy, executive director of the Kay Family Foundation, which helped fund summer teacher training and pay stipends for the UCI students.

The goal at both the Irvine and Anaheim locations is to prepare richly diverse students for college and beyond by honing their science, technology, engineering and math (STEM) skills.

"This is the first time I've ever seen something like this. These are 12-year-olds getting the chance to design apps. The kids love it!" says Rancho principal Scott Bowman, who also praises the positive use of computers. "The nice part is this comes out of UCI. We have a world-renowned university in our backyard. The biggest thing is to have eight student teachers from UCI who really know how to do this. It has a huge impact. The kids see them and think, 'I can go there too.'"

Katherine Bihr, vice president and executive director of the Tiger Woods Learning Center, agrees: "We are always working to provide young people with new and authentic learning opportunities. The AppJam class lets our students learn valuable skills in programming while having fun and creating tools that countless children can use to improve in school."

At the end of one Irvine session, UCI mentor Naren Sathiya, 20, and his team of four boys and two girls huddle at the whiteboard. A 13-year-old explains the code that he and Sathiya have written. It allows a ball to bounce off a wall in the maze game mobile app they're designing – rather than passing through it.

"Okay, if 'y' is minus 5, what would 'x' be on the other side of this plane?" the mentor asks. A 12-year-old rattles off the answer effortlessly.

There are classic kid moments too. When instructed to "unzip" a file, they erupt in giggles. "Eew, that sounds so wrong!" one says.

At 5:20 p.m., the excited Rancho students head out into twilight as Politiski exhorts them to "beat the tiger."

Nineteen miles north at the Tiger Woods Learning Center in Anaheim, more kids work on their mobile phone applications – mazes, dance contests, Angry Birds-style showdowns.

Jimmy Dang, 12, joyfully plunges into the story of his app, a long and winding tale of a princess in prison who is gradually released as ever harder arithmetic questions are correctly answered. Students nearby shriek with laughter as he adds layer upon layer to the saga.

A little later, UCI mentor Daniel Tenorio offers a step-by-step guide to creating a "high scorer" feature. As Jimmy listens, his hand shoots up. "Couldn't you do it this way and have a shortcut?" he asks, outlining a quicker route.

Tenorio listens and then concedes, "I guess you could."

As the kids file out clutching candy treats, he says, "It's awesome. They know exactly what they're doing once we explain it. They're also very funny."

— Janet Wilson, University Communications