STEM Investment Council

March 20, 2014
9:00 – 2:00 p.m.
Board Room 1126, Columbia Gorge Community College
400 E. Scenic Drive
The Dalles, OR

JIM PIRO, Chair

AUBREY CLARK

HERB FRICKE

JESSICA GOMEZ

LISA GRAHAM

DWAYNE JOHNSON

ERIC MESLOW

THOMPSON MORRISON

FRED ZIARI

Staff:
MARK LEWIS

AGENDA

1. **Chair Welcome & Introductions**

2. **Director Updates**
   Mark Lewis, OEIB Director of STEM

3. **Foundations of STEM in Early Learning**
   - Overview of early learning in Oregon – Marina Merrill, Children's Institute
   - Foundations of STEM through playful inquiry – Judy Graves, Opal School

4. **STEM in Out of School Time**
   - Research on STEM in Informal Environments – Scott Pattison, OMSI
   - STEM practitioners in out-of-school programs – Jeri Janowsky, Saturday Academy
   - Oregon Afterschool Network – Beth Unverzagt, OregonASK

5. **STEM Initiatives & Issues in K-12**
   - STEM/CTE teacher supply and demand - Vickie Chamberlain, Oregon Teacher Standards and Practices
   - Implications of the new Standards in Math and Science – Cheryl Kleckner, Dept of Education
   - Computer Science in Oregon Schools – Terrel Smith, Computer Science Teacher, Sherwood School District

6. **Summing it up**
   Mark Lewis, OEIB Director of STEM

7. **Public Comment**

8. **Adjourn**

All meetings of the Oregon Education Investment Board are open to the public and will conform to Oregon public meetings laws. The upcoming meeting schedule and materials from past meetings are posted online. A request for an interpreter for the hearing impaired or for accommodations for people with disabilities should be made to Seth Allen at 503-378-8213 or by email at Seth.Allen@das.state.or.us. Requests for accommodation should be made at least 48 hours in advance.

DRAFT: OEIB STEM Investment Council
STEM Education: Investment & Policy Recommendation Framework

Introduction

Oregon's 40-40-20 goal, adopted into law in 2011, has become a call to action that aligns the efforts of the Legislature, Governor, Oregon Education Investment Board (OEIB), and other state education boards, commissions, and agencies to significantly improve the education achievement levels and prosperity of Oregonians by 2025. The 40-40-20 goal intends to provide a clear target—a "North Star" aligned with Oregonians' economic, civic, and social aspirations—to gauge the State's educational progress. The OEIB and Governor are united in the belief that in order for the 40-40-20 goal to be meaningful, it must be accompanied by the clear understanding that increased levels of attainment of diplomas, degrees, and industry-approved certificates must be achieved equitably—across populations and across regions of the State. In order to meet economic goals, those increased levels of attainment must include a clear emphasis on Science, Technology, Engineering, and Mathematics (STEM) education and credentials.

Fundamentally, 40-40-20 says that *every Oregonian* should benefit from, and strive for, earning at least a high school diploma or the equivalent thereof, and must have the opportunity to enter into the workforce in a meaningful way. Well-executed STEM education with improved skill-building, content, teaching practices, and facilities at all levels is an important contributor to college and career readiness. Oregon's educational systems must inspire and prepare students to meet a spectrum of opportunity ranging from high-wage, high-demand healthcare and computer occupations through middle-skill jobs and trades needing greater numeracy and use of technology, to technical literacy for an informed citizenry.

{Paragraph here about benefits to industry, society, and individuals: job growth, T-shaped people, fostering STEM dispositions (curiosity, critical thinking, problem solving, etc), Innovation, resilience …}

Purpose and Scope

The areas addressed in these recommendations fall, in many cases, within the purview of other agencies, boards, and workgroups. The intention of the STEM Investment Council is not to complicate or replicate these charges, but rather to provide support for, and high-level alignment with, those efforts. The STEM Investment Council advocates for systemic changes and approaches that clearly connect to educational outcomes clearly connected to sustainable prosperity for individuals, communities, businesses, and the State.

Core Beliefs and Values

We believe that in order to be a full participant in an increasingly complex, and technologically rich, global society, each and every student will benefit from essential STEM literacy, dispositions, and mindsets that integrate across traditionally siloed disciplines. Along the educational pathways, research on student learning suggests:

- Pre-K: Laying the foundations for inquiry, persistence, numeracy, literacy, spatial reasoning, observation, communication, and social skills through free- and guided-play, should take precedence over an emphasis on early academics.
- K-3: Fostering curiosity and honoring student questions; increased time on science investigations and experiences inside and outside the classroom; introduction of digital literacy and early coding; increased use of non-fiction texts; and an emphasis on applying mathematical thinking to authentic problems as well as development of foundational computation skills.
- 4-8: Attending to formation of positive STEM identities—particularly for girls and students of color—ensuring environments value intellectual risk-taking and the positive role of "failure;" role models are a source of influence and aspiration; opportunities are provided to explore and test self-generated questions as well as iterative solutions; content understanding and relevancy is developed through rich contextual approaches such as project-based learning; technology is appropriately used to support learning; attention is given to early career awareness and aspirations.
- 9-12: Create culture of high-expectations including a college-going focus and personal planning; deeper exposure to potential careers with more interactions with STEM professionals; solidify College and Career Readiness skills; blur the lines between community and classroom learning with opportunities for students to contribute to community through projects; technology is integrated as a tool for deeper learning; ensure strong attention to relevance of content within authentic contexts; and create a sense of community where each student feels connected and a sense of belonging—especially transitioning from/to other schools.
- Post-secondary: improve math placement processes; Recruiting, access, and improved practices to address overall retention and equity issues; improve undergraduate STEM coursework to attend to application as well as theory; provide internships, research, and projects for connection to careers and workforce preparation; provide incentives for institutions for increased student attainment in high-demand STEM fields.
- Adult: lowering barriers to continuing education; new credentials; and workforce re-entry
- Educators: educator preparation and professional development programs build relevant context and application for content knowledge, supports interdisciplinary content, teacher collaboration with each other and STEM practitioners, a focus on implementation of the new math & science standards, while building intentional connections to workforce and industry norms and needs. Shift dominant teaching paradigm from recall of content to more critical thinking and application.

We believe that sustained and focused attention must be given to the implementation of the Equity Lens to make STEM education and aspirations accessible to, and inclusive of, a greater number and wider diversity of Oregonians—especially those who are currently under-represented in STEM fields. STEM diversity encompasses gender, socioeconomic status, ethnicity, rural/urban, and differently abled. We recognize that this will require us to challenge and change our current educational settings to be more culturally responsive, safe, and supportive of the significant number of elementary, middle, high school, community college and university students who do not see STEM opportunities as accessible to them and who currently opt out of STEM educational and career pathways.

We believe that high quality STEM education is a shared responsibility and that communities, parents, teachers, out-of-school educators, businesses, and community-based organizations can make unique and important contributions toward improving outcomes for our students and the educational system.

We believe every learner should have access to information about, and experiences with, a broad array of career opportunities to help them identify their interests and understand their unique talents.

We believe that resource allocation demonstrates our priorities and our values and that we demonstrate our priorities and our commitment to rural communities, communities of color, English language learners, in addition to STEM education's current base of high-potential, high-achieving youth in the ways we allocate resources and make educational investments.

Policy and Investment Recommendations

Focus Area One: Increase support for Oregonians seeking the General Educational Development (GED) credential

Findings/research:

Specific policy and/or Investment Recommendations:

Focus Area Two: Improving Alignment with Other Systems (Oregon Youth Authority, Department of Health and Human Services, etc.)

Findings/research:

Specific policy and/or Investment Recommendations:

Focus Area Three: Preventing Dropouts by Improving Systems and Services for Students in the Traditional System

Findings/research:

Specific policy and/or Investment Recommendations:

Focus Area Four: Supporting Positive and Successful Options for Students

Findings/research:

Specific policy and/or Investment Recommendations:

Early Education for All

A campaign of Strategies for Children

High-Quality Early Learning Promotes Success in Science and Math

The human brain develops most rapidly from birth through age 5.[2] This is a time of enormous social, emotional, physical and cognitive development when children build either a strong or fragile foundation for future growth and learning.[3] High-quality early education provides essential supports for future success in life and in school[4] and is the basis for children's aptitude in science, technology, engineering and math (STEM) in later years.

High-quality early education improves math and science achievement

- Low-income children who attended high-quality early education programs on average outperformed those who did not on mathematics tests throughout childhood and young adulthood.[5]
- Research demonstrates that early math knowledge is a powerful predictor of later learning. Early math skills also strongly predict later reading achievement.[6]
- In Georgia and Oklahoma, states with two of the nation's largest state-funded pre-kindergarten programs, children who attend pre-kindergarten demonstrate better kindergarten-preparedness in reading, math and social skills. [7] [8]

How math and science exploration takes place at an early age

Young children are naturally inquisitive learners who ask an average of 76 questions per hour. Young children are also natural scientists—they make sense of the world around them by making predictions, checking them, and using evidence to make inductions and deductions.[1]

Children learn about **science** through play. They blow soap bubbles, for instance, add a block that causes a tower to collapse or refract light through a prism.

Children learn to solve **math** problems as they design and test solutions through the construction of block towers, piecing together puzzles and even dividing up a snack among friends.

High-quality early learning environments provide children a structure in which to build upon their natural inclination to explore.

Research shows the connection between early childhood development and STEM learning

- Neuroscience research shows that critical aspects of brain architecture are shaped by experiences in the first few years of life. It is important to take advantage of these early stages to help develop children's learning capacities.[9]
- The brain is particularly receptive to learning math and logic between the ages of 1 and 4.[10]
- Inquiry and exploration are foundations for math and science and are also the foundations of early learning.[11]

Business, education and policy leaders recognize the critical link between early education and STEM for children's success in school, college and career

- Leaders in business, science and technology support high-quality early education. Among them are Verizon Communications, Inc., Staples, Inc., PNC Bank, Associated Industries of Massachusetts, the Massachusetts Business Roundtable, the National Association of Manufacturers and the American Chemical Society. [12]
- Massachusetts Governor Deval Patrick's STEM Advisory Council set goals for improving students' STEM achievement in the commonwealth. Its recommendations include increasing the number of educators trained in STEM subjects in pre-kindergarten through grade 12.[13]
- Massachusetts recently adopted the national Common Core State Standards, which define the knowledge and skills that students should develop throughout their K-12 careers. The state is currently revising its pre-kindergarten standards in English language arts and math to align with the Common Core.[14]

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[1] National Academy of Engineering. (2010). *STEM Summit 2010: Early Childhood through Higher Education.* Available at: http://www.stemsummit2010.org/wp-content/uploads/2010/10/STEM-summit-2010.pdf

[2] Shonkoff, J. P. & Philips, D. A. (Eds). (2000). *From Neurons to Neighborhoods: The Science of Early Child Development*. National Research Council, Institute of Medicine, Washington: National Academy Press.

[3] Ibid.

[4] Bowman, B., Donovan, M.S. & Burns, M.S. (2000). *Eager to Learn: Educating our Preschoolers*. National Research Council, Washington: National Academy Press.

[5] Campbell, F. A., Ramey, C. T., Pungello, E. P., Sparling, J., & Miller-Johnson, S. (2002). Early Childhood Education: Young Adult Outcomes from the Abecedarian Project. *Applied Developmental Science,* 6, 42-57.

[6] Duncan, G.J., Dowsett, C.J., Claessens, A., et al. (2007). School readiness and later achievement. *Developmental Psychology*, 43, 1428-1446.

[7] Vecchiotti, Sara. (2001). *Kindergarten: The Overlooked School Year*. The Foundation for Child Development, p. 24.

[8] William T. Gormley, Jr. and Ted Gayer, Public Policy Institute, Georgetown University; Deborah Phillips, Department of Psychology, Georgetown University; Brittany Dawson, Center for Research on Children in the U.S., Georgetown University.

[9] National Scientific Council on the Developing Child (2007). *The Timing and Quality of Early Experiences Combine to Shape Brain Architecture: Working Paper #5.* http://www.developingchild.net

[10] National Association of Child Care Resource and Referral Agencies. (1998). "Rethinking The Brain: New Insights into Early Development for parents, caregivers &policy makers" Available at: http://www.dshs.wa.gov/pdf/Publications/22-300.pdf

[11] Massachusetts Department of Early Education and Care, *Guidelines for Preschool Learning Experiences,* (2003). Available at: http://www.doe.mass.edu/els/standards/ple_guidelines.pdf

[12] EEA Campaign Advisory Committee; Verizon Communications, Inc. website: http://innovate.masstech.org/innovate/verizon-announces-grants-to-improve-stem-education/ ; National Association of Manufacturers website: http://www.nam.org/Issues/Official-Policy-Positions/Human-Resources-Policy/HRP-01-Education-and-the-Workforce.aspx; PNC Bank Grow Up Great website: http://www.pncgrowupgreat.com/; and STEM Education Coalition website: http://nstacommunities.org/stemedcoalition/.

[13] Governor's Stem Advisory Council. (2010) *A Foundation for the Future: Massachusetts' Plan for Excellence in STEM Education.* Available at: http://www.mass.gov/Agov3/docs/MA%20STEM%20Plan%209%2028%2010.pdf

[14] Massachusetts Department of Elementary and Secondary Education. (2010). Common Core State Standards for English Language Arts &Literacy in History/Social Studies, Science, and Technical Subjects. Available at http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf

Foundations of STEM

Early Learning in Oregon

March 20, 2014

Marina Merrill
Senior Research & Policy Advisor
Children's Institute

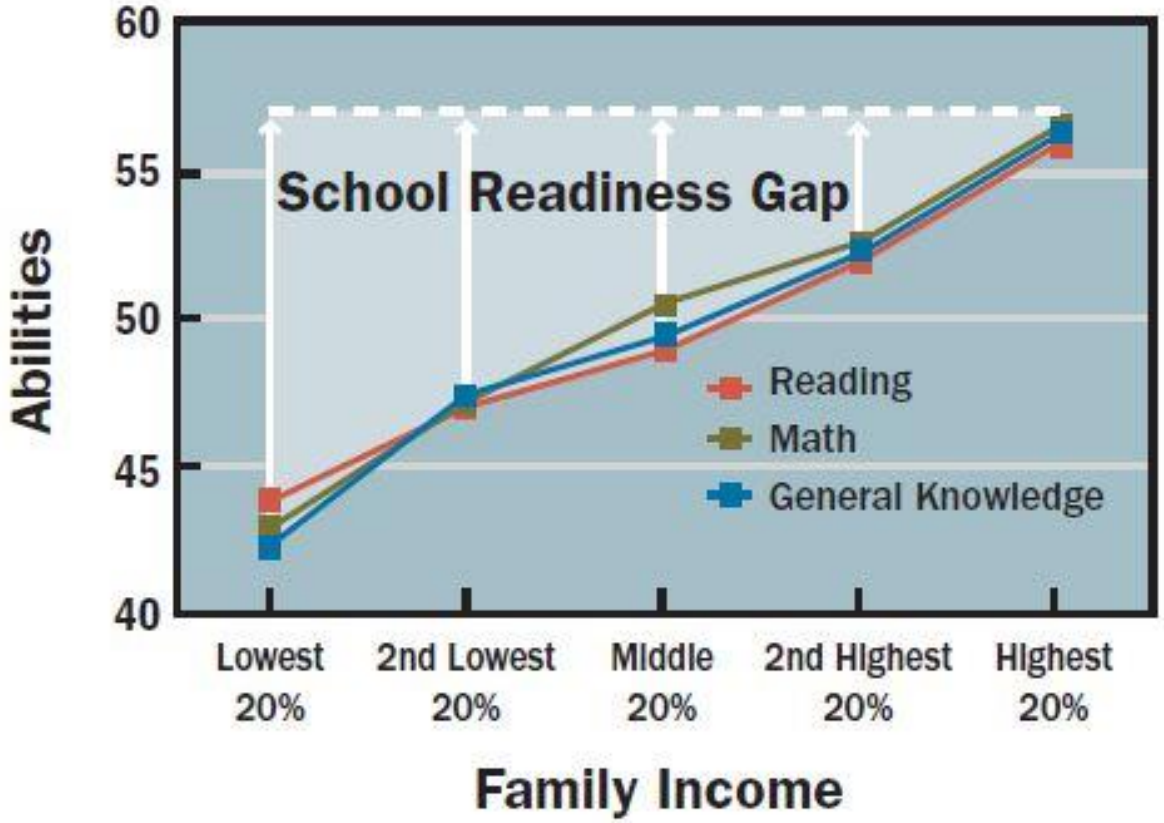
Overview

Children's Institute

- 45,000 children are born in Oregon each year.
- Half of Oregon children are born into low-income families.
- Oregon is in the bottom 25% nationally for reading proficiency in 3rd grade and high school graduation rates.

Achievement Gap Starts Before Kindergarten

Children's Institute

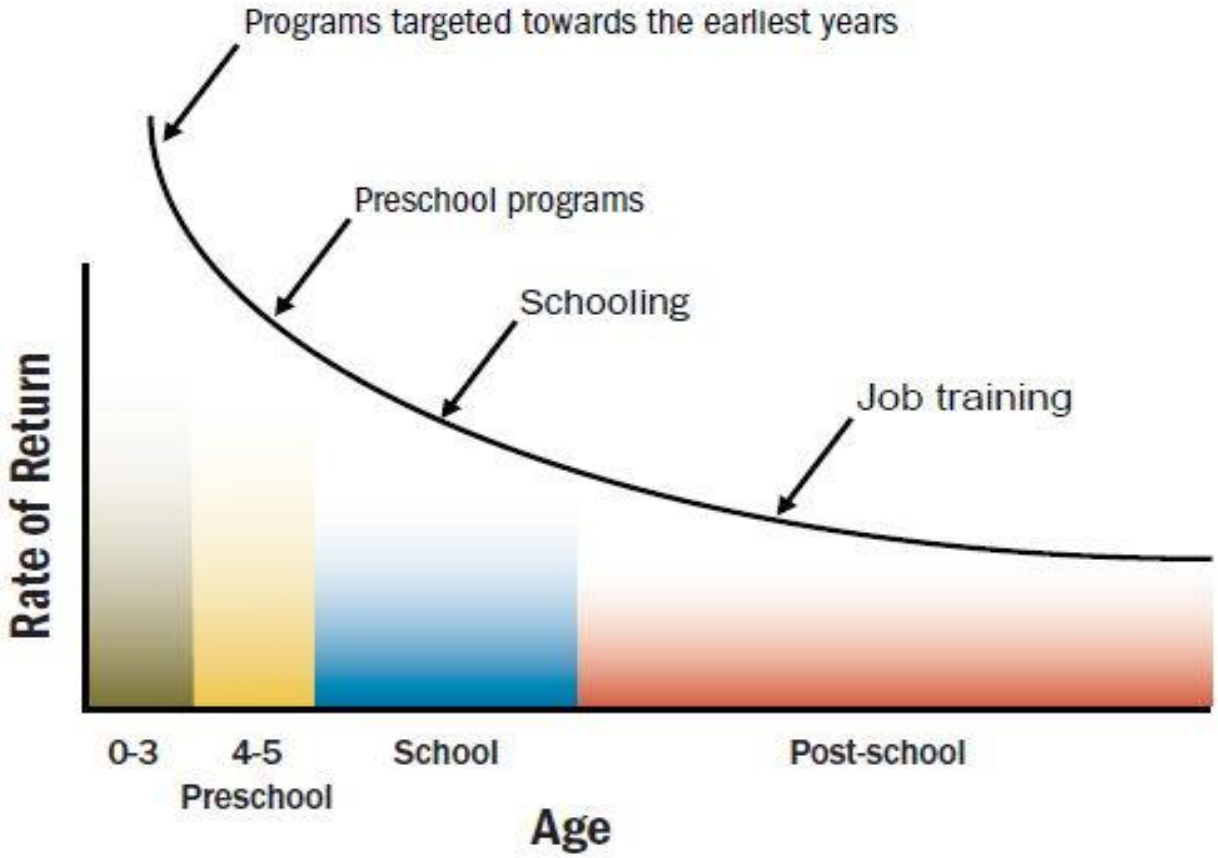


Source: NIEER (2005); Analysis of ECLS-K data

Closing this significant achievement gap becomes increasingly difficult and costly as children age. Research has demonstrated that when children start kindergarten behind they are likely to stay behind.

Big ROI on Early Childhood

Children's Institute



Rates of Return to Human Capital Investment at Different Ages

Source: Heckman, J. "Investing in Disadvantaged Young Children is Good Economics and Good Policy."

Kindergarten Assessment

Children's Institute

- Statewide Operational Field Study launched fall 2013
- Provides statewide data "snapshot" of how Oregon's children are doing when the arrive at school.
- Measures: literacy, early math, social-emotional skills.

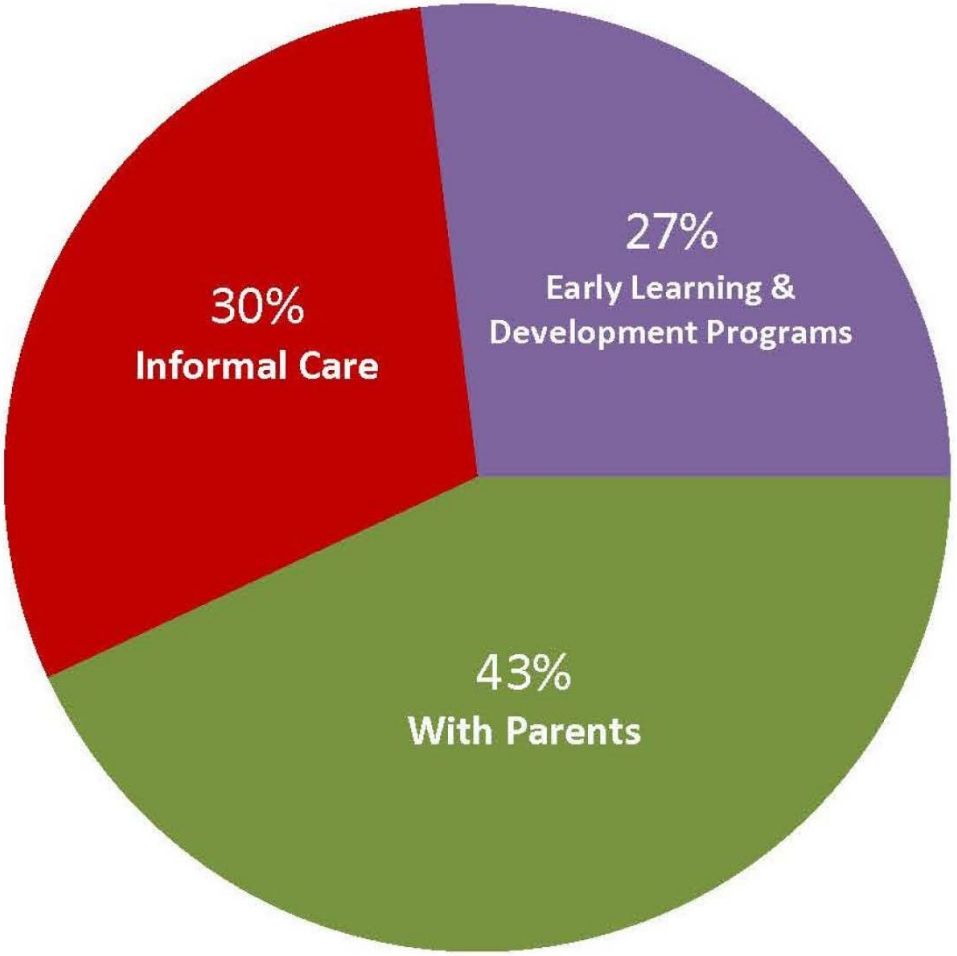
Kindergarten Assessment

Children's Institute

- 37% of entering kindergartners could not identify a single letter sound
- 14% could not name a single letter
- 25% of entering kindergartners did not demonstrate self-regulation skills such as staying on task or following directions.
- Statewide, entering kindergartners scored between the 20th and 50th percentiles on early math.

Where Are Our Youngest Children?

Children's Institute



All Children Under the Age of 5

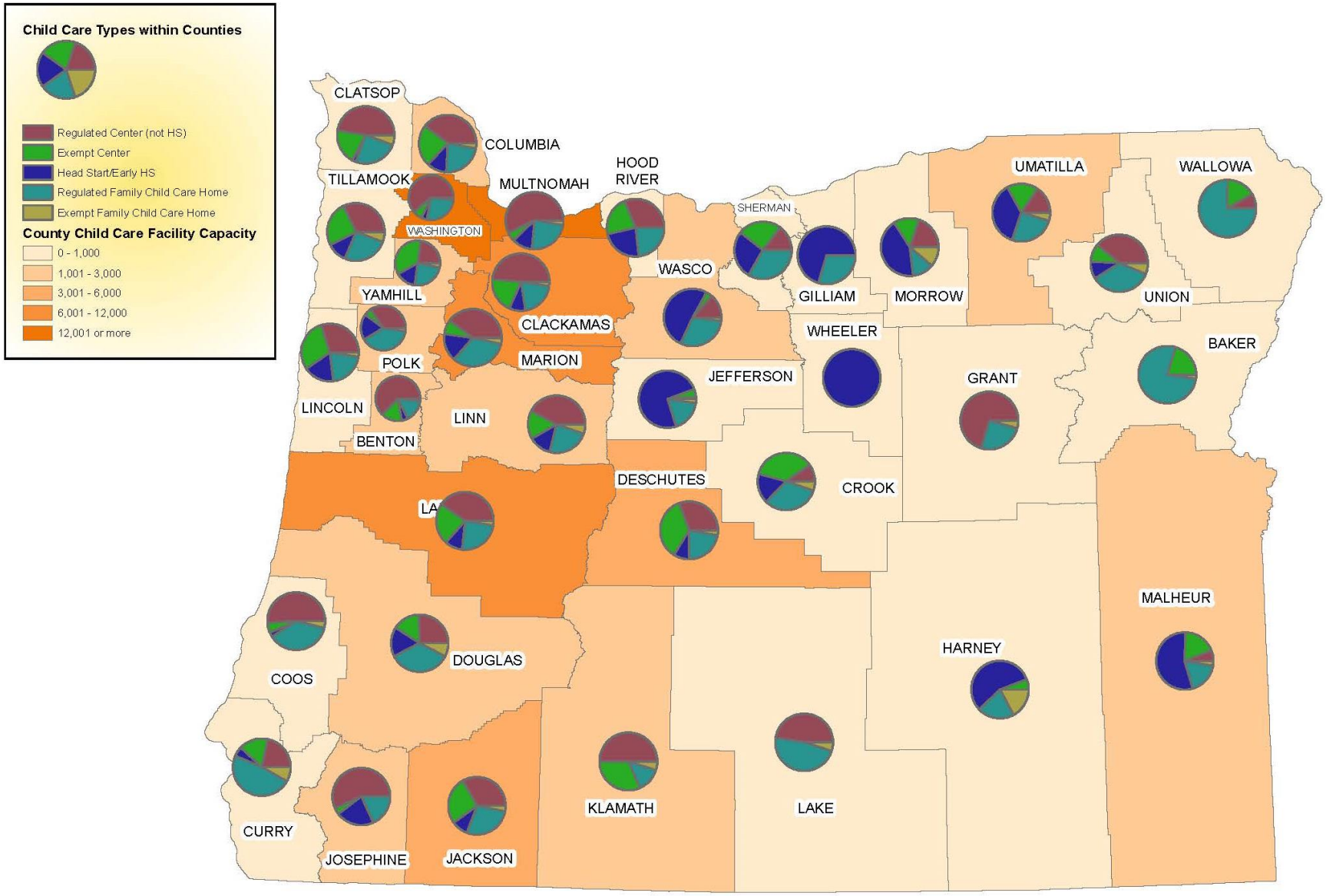
Early Head Start & Head Start

Children's Institute

- 2,034 (6%) income-eligible children age 0-2 enrolled in EHS
- 12,545 (51%) income-eligible children age 3-5 enrolled in Oregon Head Start

Child Care and Education Types and Capacity by County

Children's Institute



Oregon Early Learning: Continuum of Services Birth to K

Children's Institute

Early learning's connection to health care

- Screening;
- Home visiting;
- Ages & Stages Questionnaire;
- Joint ELC/OHPB Subcommittee

Strengthening families and keeping children safe:

- Relief Nurseries
- Connections to DHS

Improving child care:

- Child care & subsidy assistance;
- ERDC;
- QRIS & professional development

Taking a look back to look forward:

- Kindergarten Assessment

Birth → Grades K-20

Promoting a healthy start

- Healthy Start-Healthy Families

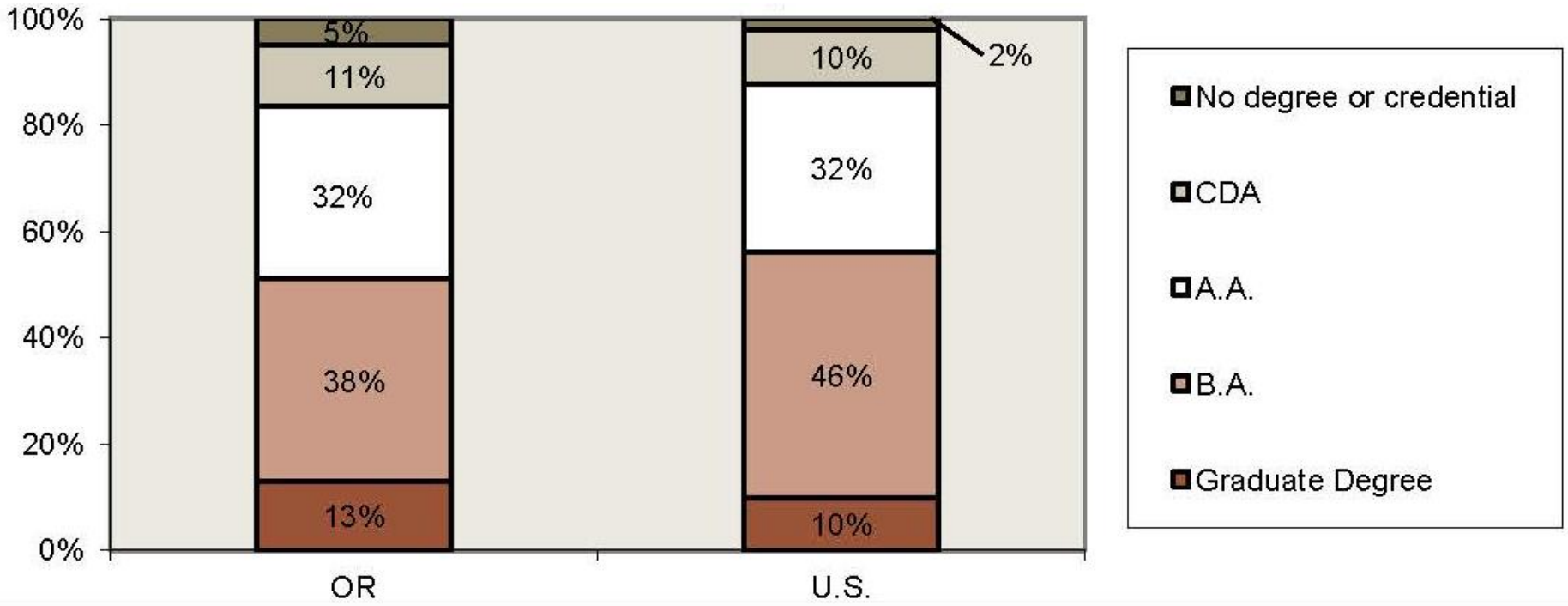
Access to coordinated community services

- Community-Based Coordinators (Hubs)

Access to play and social engagement prior to Kindergarten

- Head Start & Oregon Pre-K

Head Start Teacher Education Level



Math in the Early Years

Children's Institute

- Early math skills are an even greater predictor of later school success than early literacy skills.
- Given opportunities to learn, young children possess an informal knowledge of mathematics that is amazingly broad, complex, and sophisticated.
- High-quality early learning programs incorporate free play that sets the foundation for later match through exploration of patterns, shapes, and spatial relationships.

Source: Sarama, J. & Clements, D.H. (2009*). Early Mathematics Education Research: Learning Trajectories for Young Children* (New York, NY: Routledge)

STEM in the Early Years

Children's Institute

- Play based
- Exploratory
- Reasoning
- Predicting
- Hypothesizing
- Constructing
- Increasing rare vocabulary words

Curriculum & Teacher Qualifications

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- The Quality of STEM education varies across settings, but is typically disappointing.
- Teachers often believe that providing puzzles and blocks is sufficient math instruction, but evaluations show little or no math gains when these are the main focus.
- Early math and science is rarely emphasized in teacher preparation programs.
- Teachers in the early years lack mathematical knowledge for teaching – how mathematical knowledge is interconnected and connected to the real world and how math can be taught meaningfully.

Source: Education Commission of the States (2013). Math in the Early Years. *The progress of Educational Reform , 14*(5).

Implications for Policy

Children's Institute

- Home visiting and parent education programs that help new parents develop healthy attachments with their children
- Preschool programs that help narrow the achievement before kids arrive at kindergarten
- Invest in high quality math curricula pre-k -3rd grade.
- Emphasize STEM in teaching preparation programs and professional development for pre-K-3rd grade teachers
- Create seamless learning trajectories from preschool – 3rd grade

THE HEAD START CHILD DEVELOPMENT AND EARLY LEARNING FRAMEWORK

Promoting Positive Outcomes in Early Childhood Programs Serving Children 3–5 Years Old

U.S. Department of Health and Human Services
Administration for Children and Families
Office of Head Start

This document was prepared under Contract no. HHSP233201000415G of the Office of Head Start, Administration for Children and Families, U.S. Department of Health and Human Services, by the Head Start Resource Center, 1000 Wilson Blvd., Suite 1000, Arlington, VA 22209.

DEPARTMENT OF HEALTH & HUMAN SERVICES

ADMINISTRATION FOR CHILDREN AND FAMILIES
Office of Head Start
1250 Maryland Avenue, SW
8th Floor
Washington, DC 20024

December 2010

Dear Head Start Colleague,

I am pleased to share this revision of the Head Start Child Outcomes Framework, renamed The Head Start Child Development and Learning Framework: Promoting Positive Outcomes in Early Childhood Programs Serving Children 3–5 Years Old. The changes to the revised Framework are designed to provide more clarity to the domains and domain elements of the original Framework and do not create new requirements for Head Start grantees.

The original Framework, published in 2000, was a groundbreaking document reflecting early childhood research at the time, as well as requirements of the 1998 Head Start Act. Its release created a wave of activity that focused Head Start grantees on key elements of school readiness and moved many states to develop early learning standards that mirrored elements of the Framework.

The early childhood field has changed dramatically. The population of children served by Head Start and other early childhood programs continues to grow more diverse. New research has improved our understanding of school readiness, and the Improving Head Start for School Readiness Act of 2007 has increased the Framework's role in Head Start programs. In addition, almost every state now has early learning standards. Also, new reporting systems have emerged at the state level and through the Office of Special Education Programs (OSEP) within the U.S. Department of Education. The Framework is revised in light of these realities.

We expect the revised Framework to be used by programs in curriculum and assessment decisions just as the original Framework was intended to be used. It should also continue to be used to connect child assessment data to aspects of Head Start program design, including school readiness goals consistent with state and local expectations, if appropriate. Additionally, we expect it will guide the collection of child assessment data for other early childhood reporting systems, if locally required. When used in these ways, the revised Framework will provide data for program self-assessment and promote continuous quality improvement in programs and child well-being and success.

The Office of Head Start is pleased to lead the field with this work. We hope that the revised Framework will continue to guide all programs serving 3 to 5 year old children, including children who are dual language learners and children with disabilities, on the key elements of school readiness.

Thank you for the work you do every day for children and families.

Sincerely,

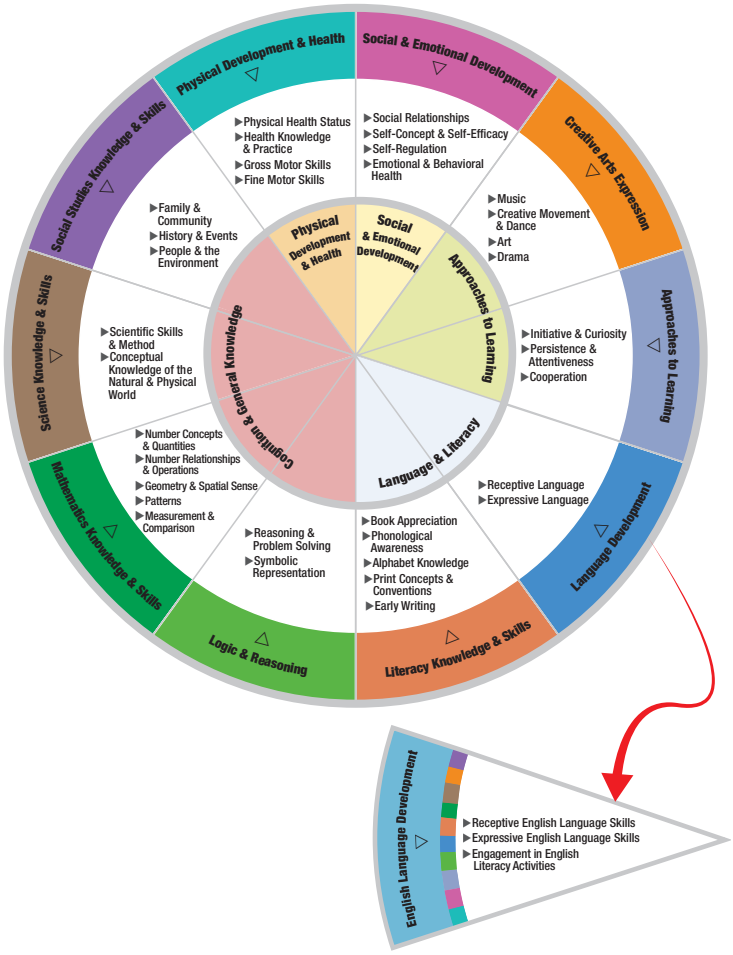
/ Yvette Sanchez Fuentes /

Yvette Sanchez Fuentes
Director
Office of Head Start

THE HEAD START CHILD DEVELOPMENT AND EARLY LEARNING FRAMEWORK

Promoting Positive Outcomes in Early Childhood Programs Serving Children 3–5 Years Old

The Head Start Child Development and Early Learning Framework provides Head Start and other early childhood programs with a description of the developmental building blocks that are most important for a child's school and long-term success. Head Start children, 3 to 5 years old, are expected to progress in all the areas of child development and early learning outlined by the Framework. Head Start programs also are expected to develop and implement a program that ensures such progress is made. The Framework is not appropriate for programs serving infants and toddlers. (The Framework appears below and full-size on page 6.)



THE ROLE OF *THE HEAD START CHILD DEVELOPMENT AND EARLY LEARNING FRAMEWORK* IN HEAD START PROGRAMS

The Framework outlines the essential areas of development and learning that are to be used by Head Start programs to establish school readiness goals for their children, monitor children's progress, align curricula, and conduct program planning. It does not provide specific benchmarks or levels of accomplishment for children to achieve during their time in Head Start. The Framework reflects the legislative mandates of the Improving Head Start for School Readiness Act of 2007 and current research in child development and learning. The Framework also reflects Head Start's core value to promote all aspects of child development and learning in early childhood programs.

This Framework is a revision of the *Head Start Child Outcomes Framework* that was issued in 2000. The original Framework was created to guide programs in curriculum implementation and the ongoing assessment of children's progress. However, the Head Start Act of 2007 makes the Framework significantly more prominent in the operations of programs serving 3 to 5 year olds. The Act requires programs to align program goals and school readiness goals for children to the Framework. Also, their curricula, assessments, and professional development activities are to align with the Framework. In this new context, the elements of the Framework act as beacons that guide all key aspects of Head Start program implementation.

WHAT IS INCLUDED IN THE HEAD START CHILD DEVELOPMENT AND EARLY LEARNING FRAMEWORK?

The Framework is organized into 11 **Domains**, 37 **Domain Elements**, and over 100 **Examples**. The domains and domain elements are organized in a similar way to the original Framework to facilitate a transition to the revised one.

The organization of the Framework into domains and domain elements does not imply that Head Start programs are to compartmentalize learning or learning activities, or organize the daily schedule by the specific domains. Head Start programs are to address the domains in an integrated way, using intentional instruction and scaffolded learning throughout the day. For example, dramatic play can promote language development, literacy, and math skills. And children can learn about science and social studies concepts through literacy activities, as well as through creative arts and outdoor play.

The Domains

The 11 **Domains** represent the overarching areas of child development and early learning essential for school and long-term success. The eight domains of the original Framework, listed below, are retained and in some cases renamed. The domains in the revised Framework are:

- Physical Development & Health
- Social & Emotional Development
- Approaches to Learning
- Language Development
- Literacy Knowledge & Skills
- Mathematics Knowledge & Skills
- Science Knowledge & Skills
- Creative Arts Expression

Three additional domains have been added:

- △ Logic & Reasoning
- △ Social Studies Knowledge & Skills
- △ English Language Development

While 10 of the 11 domains apply to all children, one domain—English Language Development—applies only to children who speak a language other than English at home, also referred to as children who are dual language learners.

In the Framework, each domain begins with a short definition and an explanation of why the domain is important for children's development and learning. Figure 1 on page 6 represents all the domains, indicating that they are interrelated and represent the "whole child."

The Domain Elements

Each domain includes **Domain Elements** that more specifically define its components. The domain of Science Knowledge & Skills, for example, is composed of two domain elements: Scientific Skills & Method and Conceptual Knowledge of the Natural & Physical World. The domain elements included in the original Framework have been revised, and domain elements have been created for the new domains.

The areas of child development and early learning included in the Framework are developmentally appropriate across the 3 to 5 year old age range. Children's knowledge and skills within a domain element will vary by age. For example, a 3-year-old's early writing ability may be demonstrated by scribbles and letter-like forms, whereas a 5-year-old nearing kindergarten may be writing letters, his or her name, and short words.

Additionally, within any age group, children will show variation in their abilities and skills. Some 4-year-olds may be making letter-like forms and others writing their names. Head Start programs can expect progress within each domain element, recognizing that the rate of progress and the form it takes will vary depending on factors that affect individual children.

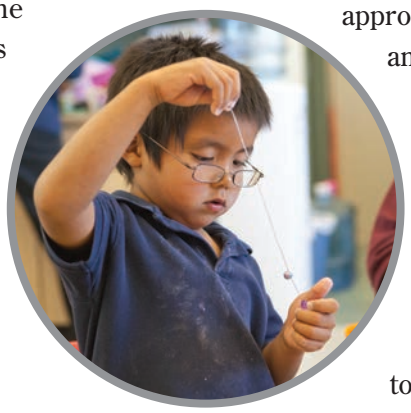
Finally, a number of domain elements in the Framework are closely associated with executive function. Although there is not a standard definition, executive function in young children is used to describe cognitive processes that support a child's ability to regulate attention and behavior and in turn, develop greater social, emotional, and cognitive competence. Executive function is believed to include inhibitory control (the ability to regulate attention and emotion), working memory (the ability to hold and manipulate information in the mind), and cognitive flexibility (the ability to shift attention and modify responses based on new situations and information).

The development of executive function lays the foundation for adaptive, goal-directed thinking and behavior that enables children to override more automatic or impulsive actions and reactions. Research suggests that executive function is strongly correlated with positive developmental and academic outcomes. The Framework does not include a separate executive function domain. However, several domain elements, such as self-regulation and attention, are closely related to executive function. Most domain elements include behaviors or skills that are affected by a child's executive functioning.

The Examples

Finally, a number of **Examples** are included under each domain element to provide more information about the key knowledge, behaviors,

or skills within each element. The examples are not designed to be comprehensive, and there may be other skills and behaviors that also reflect the respective domain element. Equally important, the examples themselves are *not* to be used to assess the progress of children on the domain elements. The Framework is not a checklist to evaluate a child's development and learning. Rather, the Framework guides the choice of assessment instruments and serves as a way to organize the data collected from those instruments.



THE ROLE OF THE FRAMEWORK IN CURRICULUM DECISIONS

A Head Start program needs to make curriculum decisions that take into account a number of factors. A program is required to use a curriculum that is developmentally appropriate, research-based, and aligned to the Framework. Given that the Framework addresses all areas of child development and learning, the requirement to align is meant to ensure that Head Start programming is not narrowly focused on certain domains, or that lesser attention is paid to some domains. In fact, programs may find that curriculum adaptations or additional curricula are necessary to address all the domains or to be culturally and linguistically responsive to children, families, and communities.

Teaching needs to be intentional and focus on how preschool children learn. Investigation and exploration; purposeful, engaged play; and intentional, scaffolded instruction based on the developmental level of each child are essential elements of appropriate practice in Head Start programs. Programs conduct ongoing child assessment throughout the year to determine if instructional strategies need to be adapted to meet children's specific needs.

THE ROLE OF THE FRAMEWORK IN ASSESSMENT DECISIONS

Programs are required to choose child assessment instruments that are reliable and valid; developmentally, linguistically, and culturally appropriate for the population served; and aligned with the Framework. Programs utilize the Framework in determining which child assessment instruments to use and which types of child data to collect. The Framework serves as a lens for analyzing data in order to understand child progress and to identify areas that need additional resources and attention. Multiple assessment tools or procedures may be needed to fully understand children's progress across all areas of child development and early learning.

USING THE FRAMEWORK TO SUPPORT THE DEVELOPMENT AND LEARNING OF CHILDREN WHO ARE DUAL LANGUAGE LEARNERS

Children who speak a language other than English at home—recognized as dual language learners (DLLs)—represent a significant proportion of the children served in Head Start. Programs use the Framework to guide curriculum, assessment, and other programming decisions, keeping in mind that they are serving children who need to continue to develop their first language while they acquire English. Programs are to ensure that children who are DLLs progress on each of the domain elements in the Framework. Also, programs are to ensure that children have opportunities to interact and demonstrate their abilities, skills, and knowledge in any language, including their home language.

At the same time, Head Start programs need

to promote the acquisition of English for children who are DLLs. The domain of English Language Development applies only to these children and contains domain elements that focus on their receptive and expressive language skills and their participation in literacy activities. Children's progress in learning English will vary depending upon their past and current exposure to English, their temperament, their age, and other factors.

Finally, when assessing children who are DLLs, staff needs to understand that the purpose of assessment is to learn what a child knows and is able to do. With the exception of assessing a child's English language development, assessment does not depend on a child's understanding or speaking abilities in English, but on the specific knowledge, skills, or abilities that the assessment measures. For example, a child can demonstrate an understanding of book knowledge or science concepts in the home language. Assessing a child who is a DLL only in English will rarely give an accurate or complete picture of what the child knows or can do.

Programs need to choose assessment instruments, methods, and procedures that use the language or languages that most accurately reveal each child's knowledge, skills, and abilities. The assessment data gathered in the home language can be used to inform instructional practices and curriculum decisions to maximize the child's learning. Programs are to use culturally and linguistically appropriate assessments to capture what children who are DLLs know and can do in all areas of the Framework.

USING THE FRAMEWORK TO SUPPORT CHILD DEVELOPMENT AND EARLY LEARNING OF CHILDREN WITH DISABILITIES

The Framework is designed to support the development and learning of children with disabilities. Programs are to use the Framework to support the development of a child's Individualized Education Program (IEP) and to guide the assessment of the child's progress. Developing the IEP is done in close collaboration with the special educators and related service providers identified on the IEP. Some children may need more individualized or intensive instruction in order to make progress on the domain elements in the Framework. Some may require accommodations in the environment or adaptive or assistive technology in order to participate in learning experiences that promote progress.

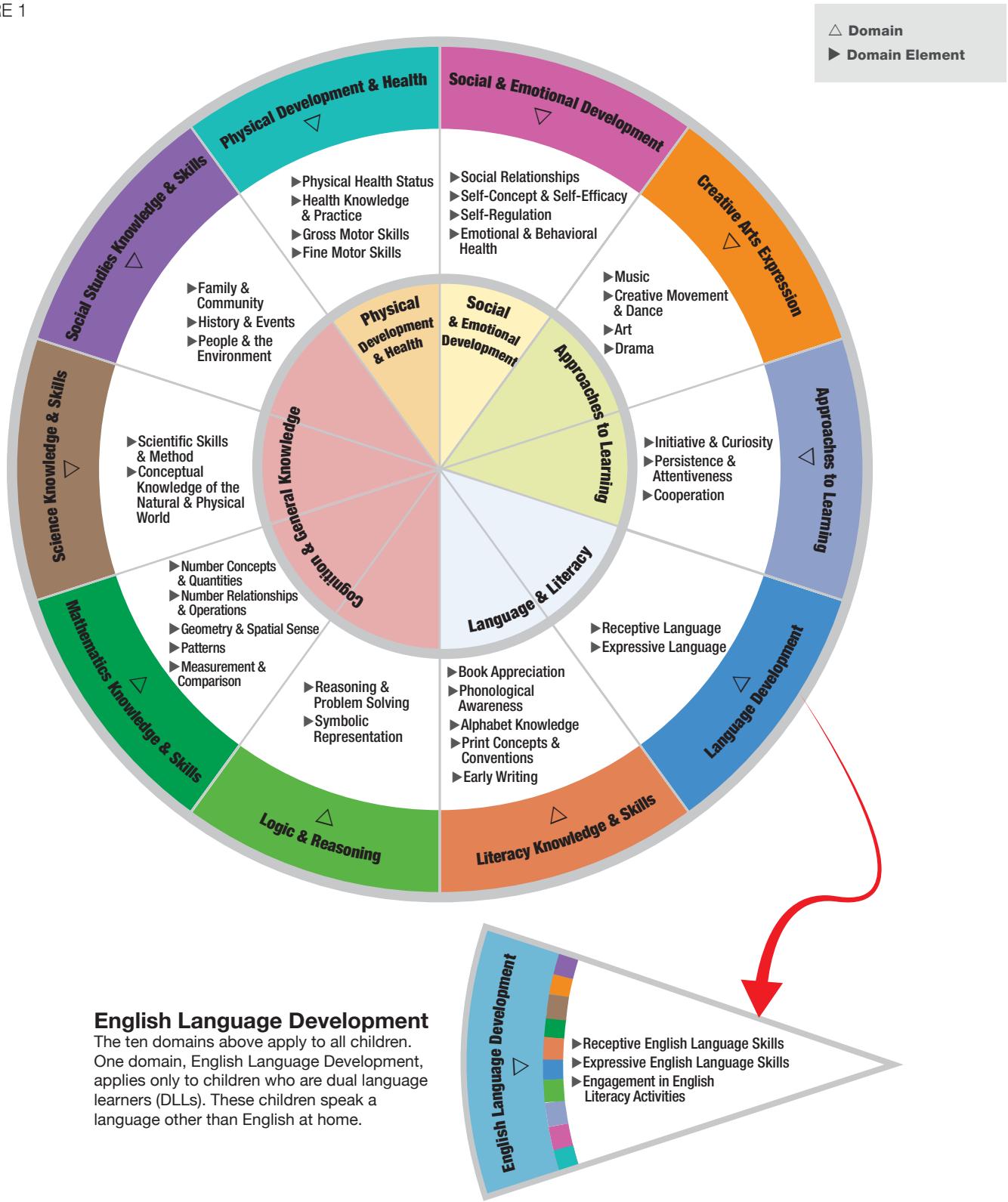
Staff needs to understand that children with disabilities can demonstrate what they know and can do in various ways. Children can make use of individual modifications or assistive technology while being assessed. In some cases, an assessment instrument may not be sensitive enough to detect small changes in development and learning, and the child may not appear to be making progress on a specific domain element. It is important to document small, incremental progress that may not be reflected on a particular assessment instrument. By monitoring the progress of children with disabilities, programs can decide if different or more intensive learning experiences and adaptations are needed.

The Head Start Child Development and Early Learning Framework

Promoting Positive Outcomes in Early Childhood Programs Serving Children 3-5 Years Old

The *Framework* represents the foundation of the Head Start Approach to School Readiness. It aligns with and builds from the five essential domains of school readiness identified by the National Education Goals Panel (see inner circle) and lays out essential areas of learning and development. The *Framework* can be used to guide curriculum, implementation, and assessment to plan teaching and learning experiences that align to school readiness goals and track children's progress across developmental domains. The domains △ and domain elements ▶ apply to all 3 to 5 year olds in Head Start and other early childhood programs, including dual language learners and children with disabilities.

FIGURE 1



English Language Development

The ten domains above apply to all children. One domain, English Language Development, applies only to children who are dual language learners (DLLs). These children speak a language other than English at home.

△PHYSICAL DEVELOPMENT & HEALTH

Physical Development & Health refers to physical well-being, use of the body, muscle control, and appropriate nutrition, exercise, hygiene, and safety practices. Early health habits lay the foundation for lifelong healthy living. Equally important, physical well-being, health, and motor development are foundational to young children's learning. Motor skills permit children to fully explore and function in their environment, and support development in all other domains. Health problems, delays in physical development, and frequent illnesses interfere with children's ability to learn and are associated with a range of poor developmental and educational outcomes. In the domain of Physical Development & Health, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Physical Health & Development for 3 to 5 year olds are:

▶ PHYSICAL HEALTH STATUS

The maintenance of healthy and age appropriate physical well-being.

- Possesses good overall health, including oral, visual, and auditory health, and is free from communicable or preventable diseases.
- Participates in prevention and management of chronic health conditions and avoids toxins, such as lead.
- Maintains physical growth within the Centers for Disease Control and Prevention (CDC) recommended ranges for weight by height by age.
- Gets sufficient rest and exercise to support healthy development.

▶ HEALTH KNOWLEDGE & PRACTICE

The understanding of healthy and safe habits and practicing healthy habits.

- Completes personal care tasks, such as dressing, brushing teeth, toileting, and washing hands independently from adults.
- Communicates an understanding of the importance of health and safety routines and rules.
- Follows basic health and safety rules and responds appropriately to harmful or unsafe situations.
- Distinguishes food on a continuum from most healthy to less healthy.
- Eats a variety of nutritious foods.
- Participates in structured and unstructured physical activities.
- Recognizes the importance of doctor and dentist visits.
- Cooperates during doctor and dentist visits and health and developmental screenings.

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△PHYSICAL DEVELOPMENT & HEALTH

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▶ GROSS MOTOR SKILLS

The control of large muscles for movement, navigation, and balance.

- Develops motor control and balance for a range of physical activities, such as walking, propelling a wheelchair or mobility device, skipping, running, climbing, and hopping.
- Develops motor coordination and skill in using objects for a range of physical activities, such as pulling, throwing, catching, kicking, bouncing or hitting balls, and riding a tricycle.
- Understands movement concepts, such as control of the body, how the body moves (such as an awareness of space and directionality), and that the body can move independently or in coordination with other objects.

▶ FINE MOTOR SKILLS

The control of small muscles for such purposes as using utensils, self-care, building, and exploring.

- Develops hand strength and dexterity.
- Develops eye-hand coordination to use everyday tools, such as pitchers for pouring or utensils for eating.
- Manipulates a range of objects, such as blocks or books.
- Manipulates writing, drawing, and art tools.

△SOCIAL & EMOTIONAL DEVELOPMENT

Social & Emotional Development refers to the skills necessary to foster secure attachment with adults, maintain healthy relationships, regulate one's behavior and emotions, and develop a healthy concept of personal identity. Positive social and emotional development provides a critical foundation for lifelong development and learning. In early childhood, social and emotional well-being predicts favorable social, behavioral, and academic adjustment into middle childhood and adolescence. It helps children navigate new environments, facilitates the development of supportive relationships with peers and adults, and supports their ability to participate in learning activities. Children with emotional or behavioral challenges are likely to receive less adult support for development and learning and to be more isolated from peers. In the domain of Social & Emotional Development, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Social & Emotional Development for 3 to 5 year olds are:

▶ SOCIAL RELATIONSHIPS

The healthy relationships and interactions with adults and peers.

- Communicates with familiar adults and accepts or requests guidance.
- Cooperates with others.
- Develops friendships with peers.
- Establishes secure relationships with adults.
- Uses socially appropriate behavior with peers and adults, such as helping, sharing, and taking turns.
- Resolves conflict with peers alone and/or with adult intervention as appropriate.
- Recognizes and labels others' emotions.
- Expresses empathy and sympathy to peers.
- Recognizes how actions affect others and accepts consequences of one's actions.

▶ SELF-CONCEPT & SELF-EFFICACY

The perception that one is capable of successfully making decisions, accomplishing tasks, and meeting goals.

- Identifies personal characteristics, preferences, thoughts, and feelings.
- Demonstrates age-appropriate independence in a range of activities, routines, and tasks.

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△SOCIAL & EMOTIONAL DEVELOPMENT

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- Shows confidence in a range of abilities and in the capacity to accomplish tasks and take on new tasks.
- Demonstrates age-appropriate independence in decision making regarding activities and materials.

▶ SELF-REGULATION

The ability to recognize and regulate emotions, attention, impulses, and behavior.

- Recognizes and labels emotions.
- Handles impulses and behavior with minimal direction from adults.
- Follows simple rules, routines, and directions.
- Shifts attention between tasks and moves through transitions with minimal direction from adults.

▶ EMOTIONAL & BEHAVIORAL HEALTH

A healthy range of emotional expression and learning positive alternatives to aggressive or isolating behaviors.

- Expresses a range of emotions appropriately, such as excitement, happiness, sadness, and fear.
- Refrains from disruptive, aggressive, angry, or defiant behaviors.
- Adapts to new environments with appropriate emotions and behaviors.

△APPROACHES TO LEARNING

Approaches to Learning refers to observable behaviors that indicate ways children become engaged in social interactions and learning experiences. Children's approaches to learning contribute to their success in school and influence their development and learning in all other domains. Children's ability to stay focused, interested, and engaged in activities supports a range of positive outcomes, including cognitive, language, and social and emotional development. It allows children to acquire new knowledge, learn new skills, and set and achieve goals for themselves. Many early learning experts view approaches to learning as one of the most important domains of early childhood development. In the domain of Approaches to Learning, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Approaches to Learning for 3 to 5 year olds are:

▶ INITIATIVE & CURIOSITY

An interest in varied topics and activities, desire to learn, creativeness, and independence in learning.

- Demonstrates flexibility, imagination, and inventiveness in approaching tasks and activities.
- Demonstrates eagerness to learn about and discuss a range of topics, ideas, and tasks.
- Asks questions and seeks new information.

▶ PERSISTENCE & ATTENTIVENESS

The ability to begin and finish activities with persistence and attention.

- Maintains interest in a project or activity until completed.
- Sets goals and develops and follows through on plans.
- Resists distractions, maintains attention, and continues the task at hand through frustration or challenges.

▶ COOPERATION

An interest and engagement in group experiences.

- Plans, initiates, and completes learning activities with peers.
- Joins in cooperative play with others and invites others to play.
- Models or teaches peers.
- Helps, shares, and cooperates in a group.

△LOGIC & REASONING

Logic & Reasoning refers to the ability to think through problems and apply strategies for solving them. Logic and reasoning skills are an essential part of child development and early learning and a foundation for competence and success in school and other environments. Children's ability to think, reason, and use information allows them to acquire knowledge, understand the world around them, and make appropriate decisions. In the domain of Logic & Reasoning, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Logic & Reasoning for 3 to 5 year olds are:

▶ REASONING & PROBLEM SOLVING

The ability to recognize, understand, and analyze a problem and draw on knowledge or experience to seek solutions to a problem.

- Seeks multiple solutions to a question, task, or problem.
- Recognizes cause and effect relationships.
- Classifies, compares, and contrasts objects, events, and experiences.
- Uses past knowledge to build new knowledge.

▶ SYMBOLIC REPRESENTATION

The use of symbols or objects to represent something else.

- Represents people, places, or things through drawings, movement, and three-dimensional objects.
- Engages in pretend play and acts out roles.
- Recognizes the difference between pretend or fantasy situations and reality.

△LANGUAGE DEVELOPMENT

Language Development refers to emerging abilities in receptive and expressive language. This domain includes understanding and using one or more languages. Language development is among the most important tasks of the first five years of a child's life. Language is the key to learning across all domains. Specific language skills in early childhood are predictive of later success in learning to read and write. Also, children who are skilled communicators are more likely to demonstrate social competence. In the domain of Language Development, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Language Development for 3 to 5 year olds are:

▶ RECEPTIVE LANGUAGE

The ability to comprehend or understand language.

- Attends to language during conversations, songs, stories, or other learning experiences.
- Comprehends increasingly complex and varied vocabulary.
- Comprehends different forms of language, such as questions or exclamations.
- Comprehends different grammatical structures or rules for using language.

▶ EXPRESSIVE LANGUAGE

The ability to use language.

- Engages in communication and conversation with others.
- Uses language to express ideas and needs.
- Uses increasingly complex and varied vocabulary.
- Uses different forms of language.
- Uses different grammatical structures for a variety of purposes.
- Engages in storytelling.
- Engages in conversations with peers and adults.

△LITERACY KNOWLEDGE & SKILLS

Literacy Knowledge & Skills refers to the knowledge and skills that lay the foundation for reading and writing, such as understanding basic concepts about books or other printed materials, the alphabet, and letter-sound relationships. Early literacy is the foundation for reading and writing in all academic endeavors in school. It is considered one of the most important areas for young children's development and learning. Early literacy learning provides children with an opportunity to explore the world through books, storytelling, and other reading and writing activities. It is a mechanism for learning about topics they enjoy and acquiring content knowledge and concepts that support progress in other domains. It is critical for supporting a range of positive outcomes, including success in school and other environments. In the domain of Literacy Knowledge & Skills, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Literacy Knowledge & Skills for 3 to 5 year olds are:

▶ BOOK APPRECIATION AND KNOWLEDGE

The interest in books and their characteristics, and the ability to understand and get meaning from stories and information from books and other texts.

- Shows interest in shared reading experiences and looking at books independently.
- Recognizes how books are read, such as front-to-back and one page at a time, and recognizes basic characteristics, such as title, author, and illustrator.
- Asks and answers questions and makes comments about print materials.
- Demonstrates interest in different kinds of literature, such as fiction and non-fiction books and poetry, on a range of topics.
- Retells stories or information from books through conversation, artistic works, creative movement, or drama.

▶ PHONOLOGICAL AWARENESS

An awareness that language can be broken into words, syllables, and smaller pieces of sound.

- Identifies and discriminates between words in language.
- Identifies and discriminates between separate syllables in words.
- Identifies and discriminates between sounds and phonemes in language, such as attention to beginning and ending sounds of words and recognition that different words begin or end with the same sound.

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△LITERACY KNOWLEDGE & SKILLS

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▶ ALPHABET KNOWLEDGE

The names and sounds associated with letters.

- Recognizes that the letters of the alphabet are a special category of visual graphics that can be individually named.
- Recognizes that letters of the alphabet have distinct sound(s) associated with them.
- Attends to the beginning letters and sounds in familiar words.
- Identifies letters and associates correct sounds with letters.

▶ PRINT CONCEPTS & CONVENTIONS

The concepts about print and early decoding (identifying letter-sound relationships).

- Recognizes print in everyday life, such as numbers, letters, one's name, words, and familiar logos and signs.
- Understands that print conveys meaning.
- Understands conventions, such as print moves from left to right and top to bottom of a page.
- Recognizes words as a unit of print and understands that letters are grouped to form words.
- Recognizes the association between spoken or signed and written words.

▶ EARLY WRITING

The familiarity with writing implements, conventions, and emerging skills to communicate through written representations, symbols, and letters.

- Experiments with writing tools and materials.
- Recognizes that writing is a way of communicating for a variety of purposes, such as giving information, sharing stories, or giving an opinion.
- Uses scribbles, shapes, pictures, and letters to represent objects, stories, experiences, or ideas.
- Copies, traces, or independently writes letters or words.

△MATHEMATICS KNOWLEDGE & SKILLS

Mathematics Knowledge & Skills refers to the conceptual understanding of numbers, their relationships, combinations, and operations. Mathematics also includes shapes and their structure; reasoning; measurement; classification; and patterns. Because math is also about generalizations and abstractions, math skills during the early years help children to connect ideas, develop logical and abstract thinking, and to question, analyze, and understand the world around them. Math knowledge, interest, and skills are basic to children's success in school and later life. Early math skills are highly predictive of later academic achievement in multiple subject areas. In the domain of Mathematics Knowledge & Skills, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Mathematics Knowledge & Skills for 3 to 5 year-olds are:

▶ NUMBER CONCEPTS & QUANTITIES

The understanding that numbers represent quantities and have ordinal properties (number words represent a rank order, particular size, or position in a list).

- Recognizes numbers and quantities in the everyday environment.
- Recites numbers in the correct order and understands that numbers come "before" or "after" one another.
- Associates quantities and the names of numbers with written numerals.
- Uses one-to-one counting and subitizing (identifying the number of objects without counting) to determine quantity.
- Uses the number name of the last object counted to represent the number of objects in the set.

▶ NUMBER RELATIONSHIPS & OPERATIONS

The use of numbers to describe relationships and solve problems.

- Uses a range of strategies, such as counting, subitizing, or matching, to compare quantity in two sets of objects and describes the comparison with terms, such as more, less, greater than, fewer, or equal to.
- Recognizes that numbers (or sets of objects) can be combined or separated to make another number through the grouping of objects.
- Identifies the new number created when numbers are combined or separated.

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△MATHEMATICS KNOWLEDGE & SKILLS

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▶ GEOMETRY & SPATIAL SENSE

The understanding of shapes, their properties, and how objects are related to one another.

- Recognizes and names common shapes, their parts, and attributes.
- Combines and separates shapes to make other shapes.
- Compares objects in size and shape.
- Understands directionality, order, and position of objects, such as up, down, in front, behind.

▶ PATTERNS

The recognition of patterns, sequencing, and critical thinking skills necessary to predict and classify objects in a pattern.

- Sorts, classifies, and serializes (puts in a pattern) objects using attributes, such as color, shape, or size.
- Recognizes, duplicates, and extends simple patterns.
- Creates patterns through the repetition of a unit.

▶ MEASUREMENT & COMPARISON

The understanding of attributes and relative properties of objects as related to size, capacity, and area.

- Compares objects using attributes of length, weight and size (bigger, longer, taller, heavier).
- Orders objects by size or length.
- Uses nonstandard and standard techniques and tools to measure and compare.

△SCIENCE KNOWLEDGE & SKILLS

Science Knowledge & Skills refers to the emerging ability to gather information about the natural and physical world and organize that information into knowledge and theories. Young children are often called natural scientists. Their inclination to be curious, explore, ask questions, and develop their own theories about how the world works makes science an important domain for enhancing learning and school readiness. Science learning during the early childhood years encourages children to discover the world around them and refine their understanding of it. It provides opportunities for rich vocabulary learning and collaboration with peers. It fosters a sense of curiosity and motivation to learn. In the domain of Science Knowledge & Skills, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Science Knowledge & Skills for 3 to 5 year olds are:

▶ SCIENTIFIC SKILLS & METHOD

The skills to observe and collect information and use it to ask questions, predict, explain, and draw conclusions.

- Uses senses and tools, including technology, to gather information, investigate materials, and observe processes and relationships.
- Observes and discusses common properties, differences, and comparisons among objects.
- Participates in simple investigations to form hypotheses, gather observations, draw conclusions, and form generalizations.
- Collects, describes, and records information through discussions, drawings, maps, and charts.
- Describes and discusses predictions, explanations, and generalizations based on past experience.

▶ CONCEPTUAL KNOWLEDGE OF THE NATURAL & PHYSICAL WORLD

The acquisition of concepts and facts related to the natural and physical world and the understanding of naturally-occurring relationships.

- Observes, describes, and discusses living things and natural processes.
- Observes, describes, and discusses properties of materials and transformation of substances.

△CREATIVE ARTS EXPRESSION

Creative Arts Expression refers to participation in a range of activities that allow for creative and imaginative expression, such as music, art, creative movement, and drama. The creative arts engage children's minds, bodies, and senses. The arts invite children to listen, observe, discuss, move, solve problems, and imagine using multiple modes of thought and self-expression. The creative arts provide ways for young children to learn and use skills in other domains. In the domain of Creative Arts Expression, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements of Creative Arts Expression for 3 to 5 year olds are:

▶ MUSIC

The use of voice and instruments to create sounds.

- Participates in music activities, such as listening, singing, or performing.
- Experiments with musical instruments.

▶ CREATIVE MOVEMENT & DANCE

The use of the body to move to music and express oneself.

- Expresses what is felt and heard in various musical tempos and styles.
- Moves to different patterns of beat and rhythm in music.
- Uses creative movement to express concepts, ideas, or feelings.

▶ ART

The use of a range of media and materials to create drawings, pictures, or other objects.

- Uses different materials and techniques to make art creations.
- Creates artistic works that reflect thoughts, feelings, experiences, or knowledge.
- Discusses one's own artistic creations and those of others.

▶ DRAMA

The portrayal of events, characters, or stories through acting and using props and language.

- Uses dialogue, actions, and objects to tell a story or express thoughts and feelings about one's self or a character.
- Uses creativity and imagination to manipulate materials and assume roles in dramatic play situations.

△SOCIAL STUDIES KNOWLEDGE & SKILLS

Social Studies Knowledge & Skills refers to understanding people and how they relate to others and the world around them. Social studies helps children to understand themselves, their families, and communities. Through learning experiences related to history, culture, and the environment, children enhance their self-identity and expand their experiences beyond the walls of their home and early childhood setting. In the domain of Social Studies Knowledge & Skills, programs need to ensure that children who are dual language learners can demonstrate their abilities, skills, and knowledge in any language, including their home language.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for Social Studies Knowledge & Skills for 3 to 5 year olds are:

▶ SELF, FAMILY & COMMUNITY

The understanding of one's relationship to the family and community, roles in the family and community, and respect for diversity.

- Identifies personal and family structure.
- Understands similarities and respects differences among people.
- Recognizes a variety of jobs and the work associated with them.
- Understands the reasons for rules in the home and classroom and for laws in the community.
- Describes or draws aspects of the geography of the classroom, home, and community.

▶ PEOPLE & THE ENVIRONMENT

The understanding of the relationship between people and the environment in which they live.

- Recognizes aspects of the environment, such as roads, buildings, trees, gardens, bodies of water, or land formations.
- Recognizes that people share the environment with other people, animals, and plants.
- Understands that people can take care of the environment through activities, such as recycling.

▶ HISTORY & EVENTS

The understanding that events happened in the past and how these events relate to one's self, family, and community.

- Differentiates between past, present, and future.
- Recognizes events that happened in the past, such as family or personal history.
- Understands how people live and what they do changes over time.

△ENGLISH LANGUAGE DEVELOPMENT

English Language Development is the development of receptive and expressive English language skills for children who speak a home language other than English. This domain only applies to these children, often referred to as dual language learners (DLLs). Learning English lays the foundation for a successful start as children transition to public school. When children are able to understand and speak some English, they are better prepared to learn from teachers and engage with peers in English-speaking environments. Because the home language serves as a foundation for learning English, ongoing development of the home language also is essential.

Children who are DLLs typically go through several stages of English language development prior to becoming proficient. The receptive skills usually emerge before the expressive skills. There may be an extended period of time when the child understands some English but relies on the home language as well as gestures and nonverbal means to communicate. During this time, the child is attending to and listening to the English language used in the learning environment and beginning to grasp the fundamentals of the language. Gradually, the child begins to use more English words and phrases, often interspersed with the home language. Over time, the child develops more complex vocabulary and grammar, moving toward English language proficiency.

How much time this process takes will vary. It may take several months or several years, depending on the individual child, the home and school language environments, motivation, and other factors. Children will be at different stages in the process when they enter a program, and therefore, the developing path of their receptive and expressive abilities will not be the same.

The examples represent behaviors individual children may demonstrate in the process of learning English.

KEY △ = **Domain** ▶ = **Domain Element** • = **Example**

The domain elements for English Language Development for 3 to 5 year olds are:

▶ RECEPTIVE ENGLISH LANGUAGE SKILLS

The ability to comprehend or understand the English language.

- Participates with movement and gestures while other children and the teachers dance and sing in English.
- Acknowledges or responds nonverbally to common words or phrases, such as "hello" "good bye" "snack time" "bathroom", when accompanied by adult gestures.
- Points to body parts when asked, "Where is your nose, hand, leg…?"

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△ENGLISH LANGUAGE DEVELOPMENT

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- Comprehends and responds to increasingly complex and varied English vocabulary, such as “Which stick is the longest?” “Why do you think the caterpillar is hungry?”
- Follows multi-step directions in English with minimal cues or assistance.

▶ EXPRESSIVE ENGLISH LANGUAGE SKILLS

The ability to speak or use English.

- Repeats word or phrase to self, such as “bus” while group sings the “Wheels on the Bus” or “brush teeth” after lunch.
- Requests items in English, such as “car,” “milk,” “book,” “ball.”
- Uses one or two English words, sometimes joined to represent a bigger idea, such as “throwball.”
- Uses increasingly complex and varied English vocabulary.
- Constructs sentences, such as “The apple is round.” or “I see a fire truck with lights on.”

▶ ENGAGEMENT IN ENGLISH LITERACY ACTIVITIES

Understanding and responding to books, storytelling, and songs presented in English.

- Demonstrates eagerness to participate in songs, rhymes and stories in English.
- Points to pictures and says the word in English, such as “frog,” “baby,” “run.”
- Learns part of a song or poem in English and repeats it.
- Talks with peers or adults about a story read in English.
- Tells a story in English with a beginning, middle, and end from a book or about a personal experience.

The Head Start Child Development and Early Learning Framework

Promoting Positive Outcomes in Early Childhood Programs Serving Children 3-5 Years Old

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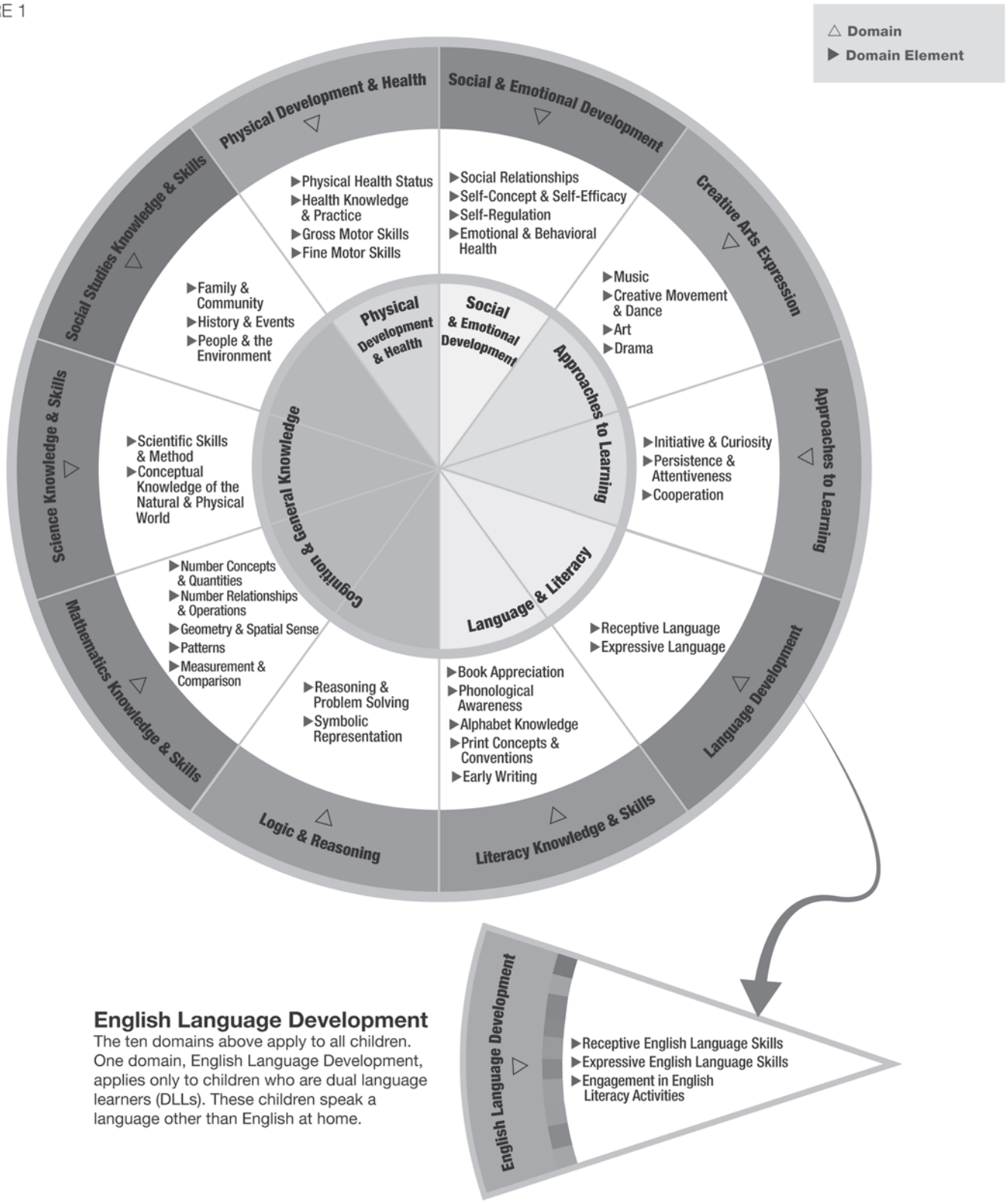
FIGURE 1



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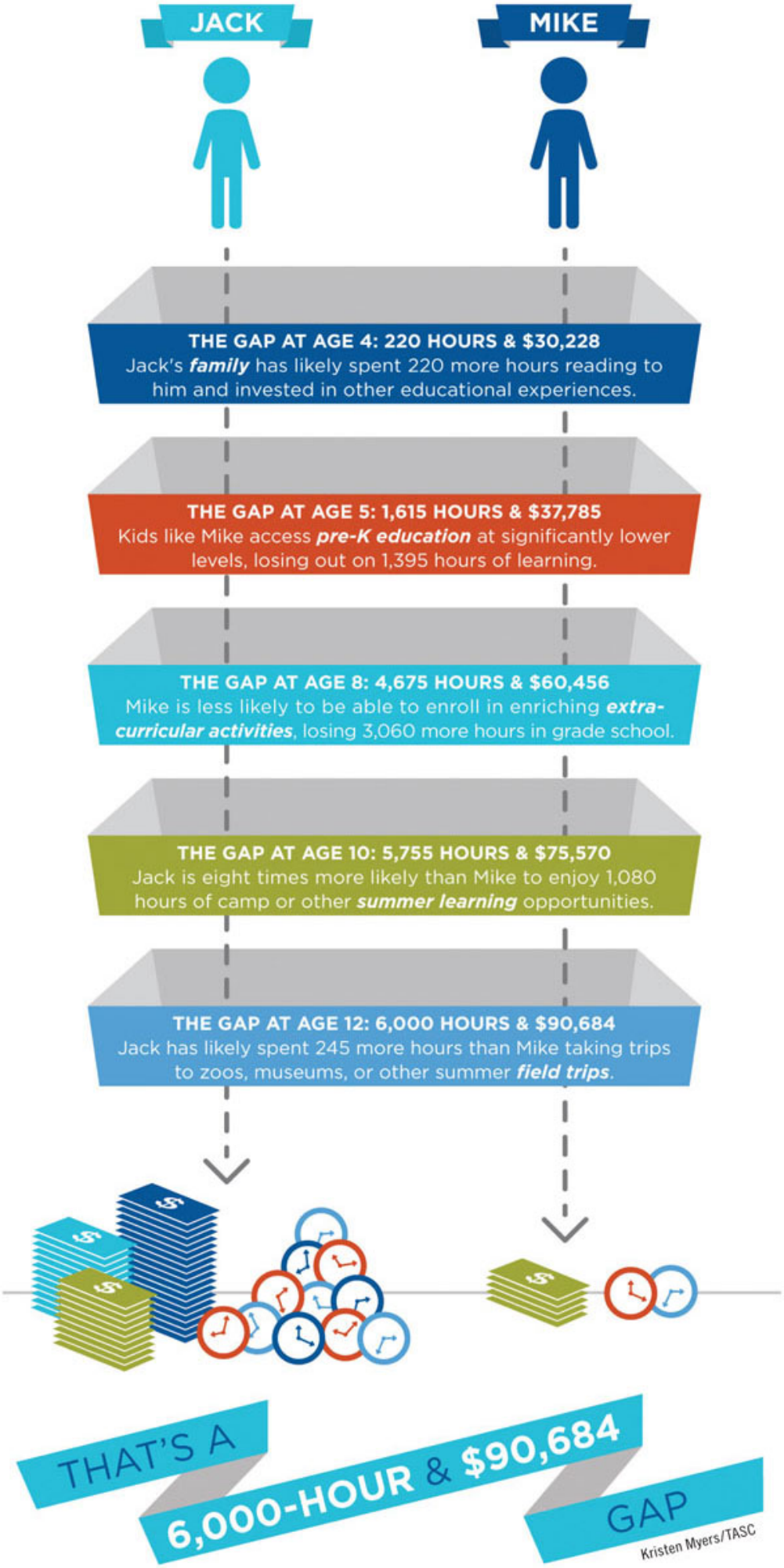
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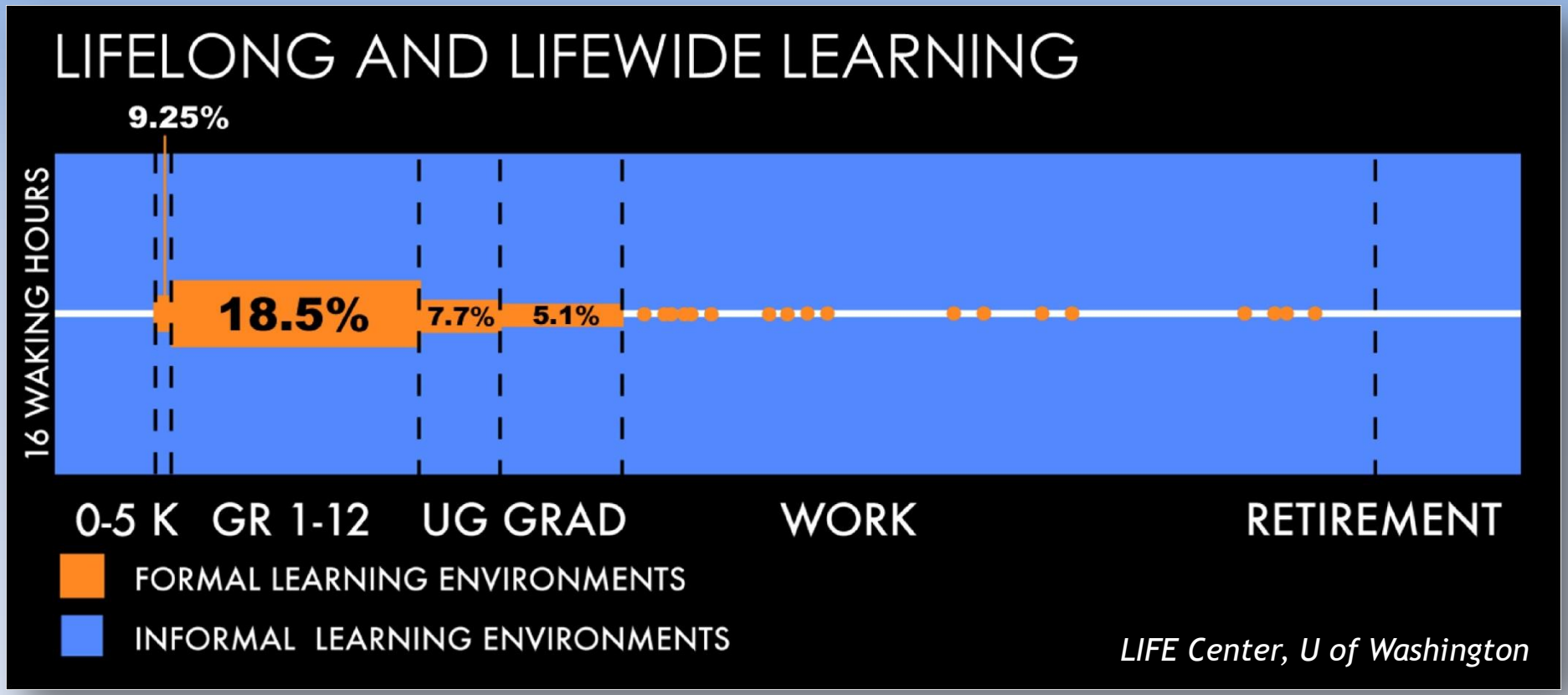
MIKE
THE GAP AT AGE 4: 220 HOURS & $30,228
Jack's family has likely spent 220 more hours reading to him and invested in other educational experiences.
THE GAP AT AGE 5: 1,615 HOURS & $37,785
Kids like Mike access pre-K education at significantly lower levels, losing out on 1,395 hours of learning.
THE GAP AT AGE 8: 4,675 HOURS & $60,456
Mike is less likely to be able to enroll in enriching extra-curricular activities, losing 3,060 more hours in grade school.
THE GAP AT AGE 10: 5,755 HOURS & $75,570
Jack is eight times more likely than Mike to enjoy 1,080 hours of camp or other summer learning opportunities.
THE GAP AT AGE 12: 6,000 HOURS & $90,684
Jack has likely spent 245 more hours than Mike taking trips to zoos, museums, or other summer field trips.
THAT'S A
6,000-HOUR & $90,684
GAP
Kristen Myers/TASC

Out-of-School STEM Learning Experiences: What the Research Says

Scott Pattison

OMSI, OSU, Institute for Learning Innovation

Out-of-school experiences dominate our lives.



Children and adults engage in rich STEM learning outside of the classroom.

peace

SPACE

Out-of-school experiences impact academic success, STEM interest and literacy, and STEM careers.

OMSI and other regional education leaders are developing programs to support out-of-school STEM learning.

Rosa Park Tech Challenge

Salmon Camp Research Team

Libraries of Eastern Oregon

Questions and Challenges

- *How do we make the case? How do we ensure that stakeholders representing all aspects of the educational ecosystem are part of the conversation?*
- *How do we align efforts and measure results across sectors and organizations?*
- *How do we promote broad and equitable access to out-of-school experiences?*

Key References

- Falk, J., & Dierking, L. (2010). The 95 percent solution: School is not where most Americans learn most of their science. *American Scientist, 98*(6), 486–493.
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- National Research Council and Institute of Medicine. (2000). *From neurons to neighborhoods: The science of early childhood development*. Washington DC: The National Academies Press.
- National Research Council. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. Washington, DC: The National Academies Press.
- Institute of Medicine and National Research Council. (2012). *From neurons to neighborhoods: An update*. Washington DC: The National Academies Press.

Jeri Janowsky, Ph.D.
Executive Director
www.saturdayacademy.org

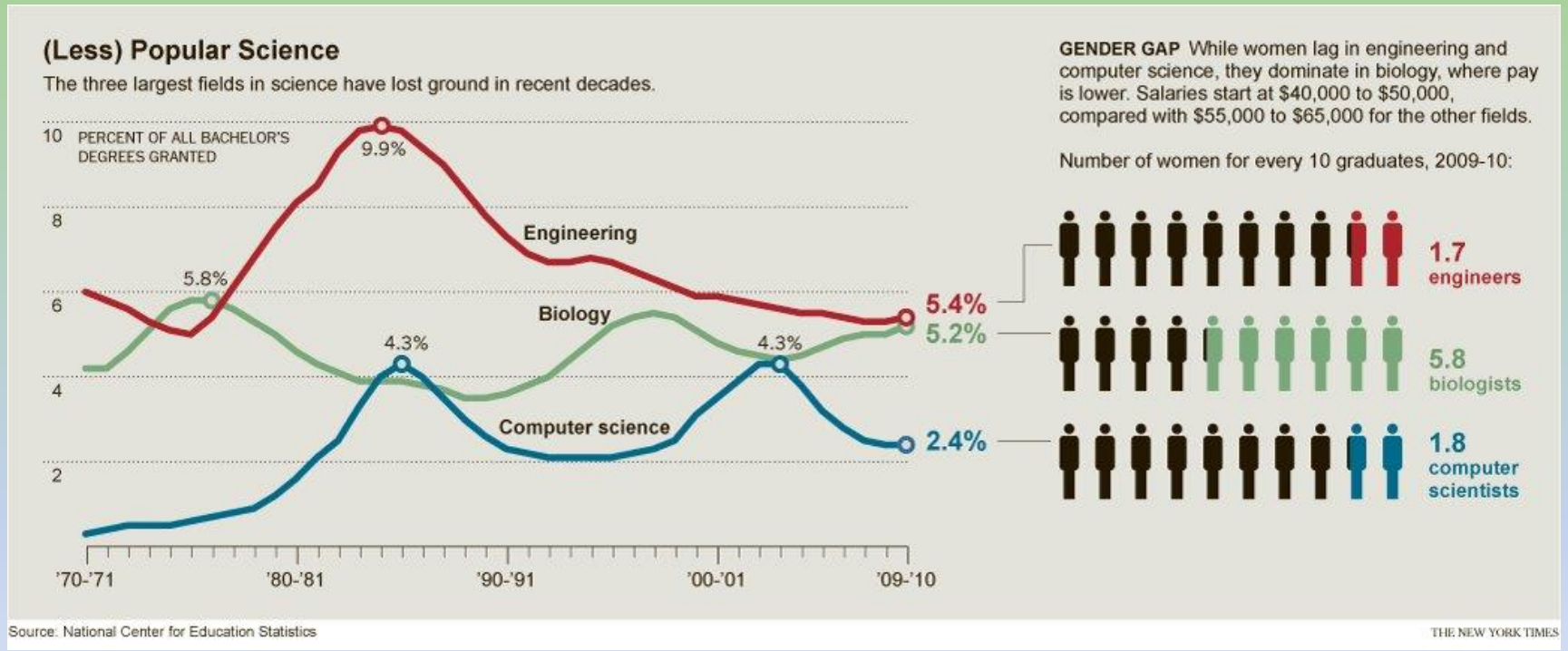
- **Born 1983**
- **Nonprofit status 2006**
- **Mission: To engage young people in hands-on, in-depth learning and problem solving by connecting them with community experts as instructors and mentors.**
- **Currently serve ~6000 students/year**

STEM Council's Goals

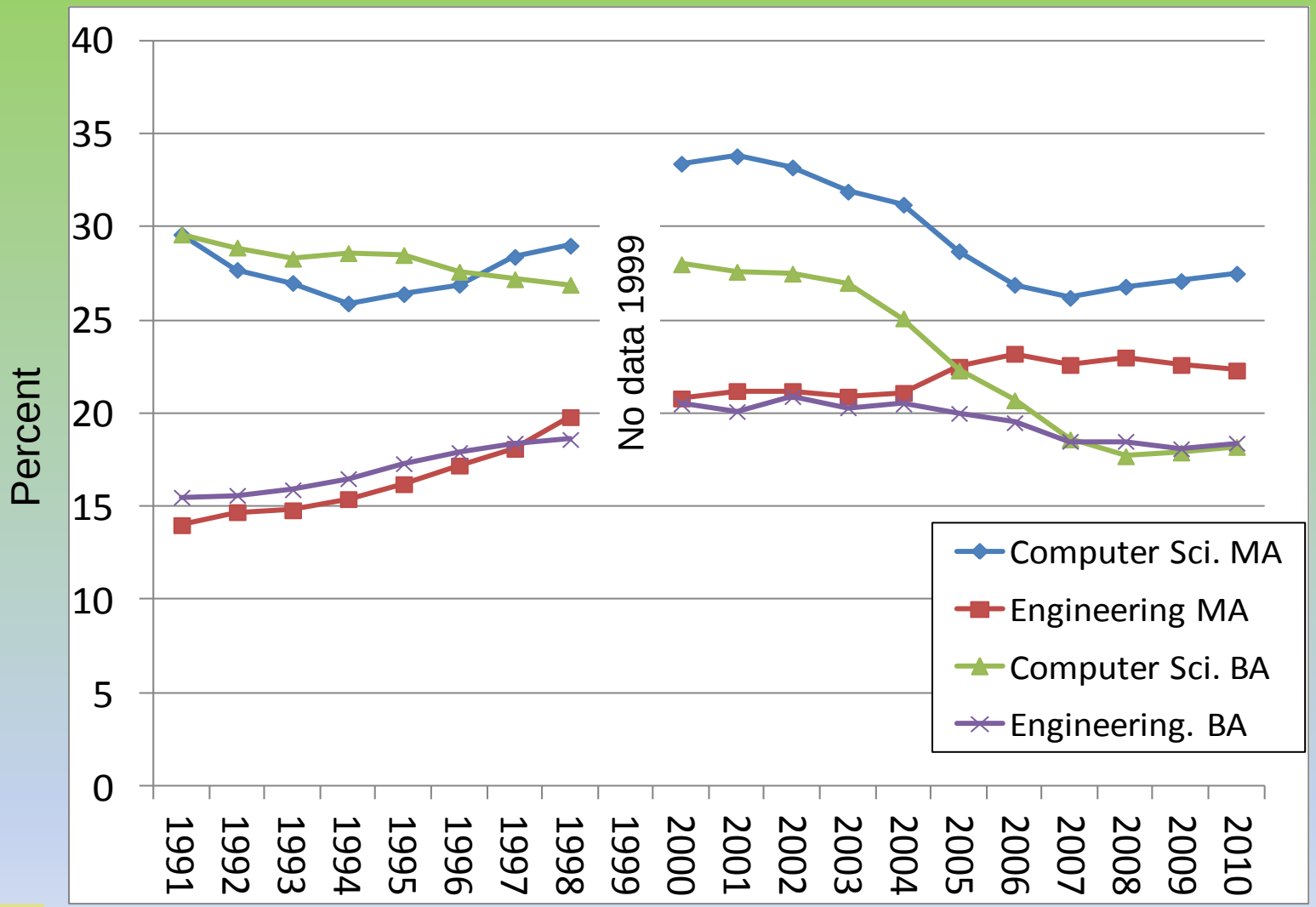
- Double STEM degrees
- Double STEM achievement
- Address Oregon workforce needs
  - Thinkers
  - Life-long learners

STEM Council's Pain Points

- Double STEM degrees
- Double STEM achievement
- Address Oregon workforce needs
  - Thinkers
  - Life-long learners



Low participation fields for women: Computer sciences and engineering, 1991–2010



www.nsf.gov/statistics/wmpd/

Obstacles and Opportunities

- Major sectors of the population are not participating
- Those that would benefit the most are the least served: Very bright, Underserved
- Critical thinking skills require integration across STEM
- STEM moves fast
- Career exploration is a prime motivator but not available to vast majority of students

Difficult to fully address in schools because of time, training, equipment.

Education in out-of-school time provides solutions

Aquatic Microbiology

Investigate the invisible world of aquatic microbes and learn how these tiny organisms impact the ecology of the oceans.

Main Programs:

Portland Metro:

- 550 Classes and Day Camps; mostly STEM
- >100 Afterschool classes
- NSF college internship program

State-wide

- 126 full time, 8wk summer high school STEM internships (state-wide)

Classes and School Based Programs:
Inspiring Curiosity

- Small class size ~10-12
- Hands on learning
- **Taught by community professionals**
- 2nd – 12th grade

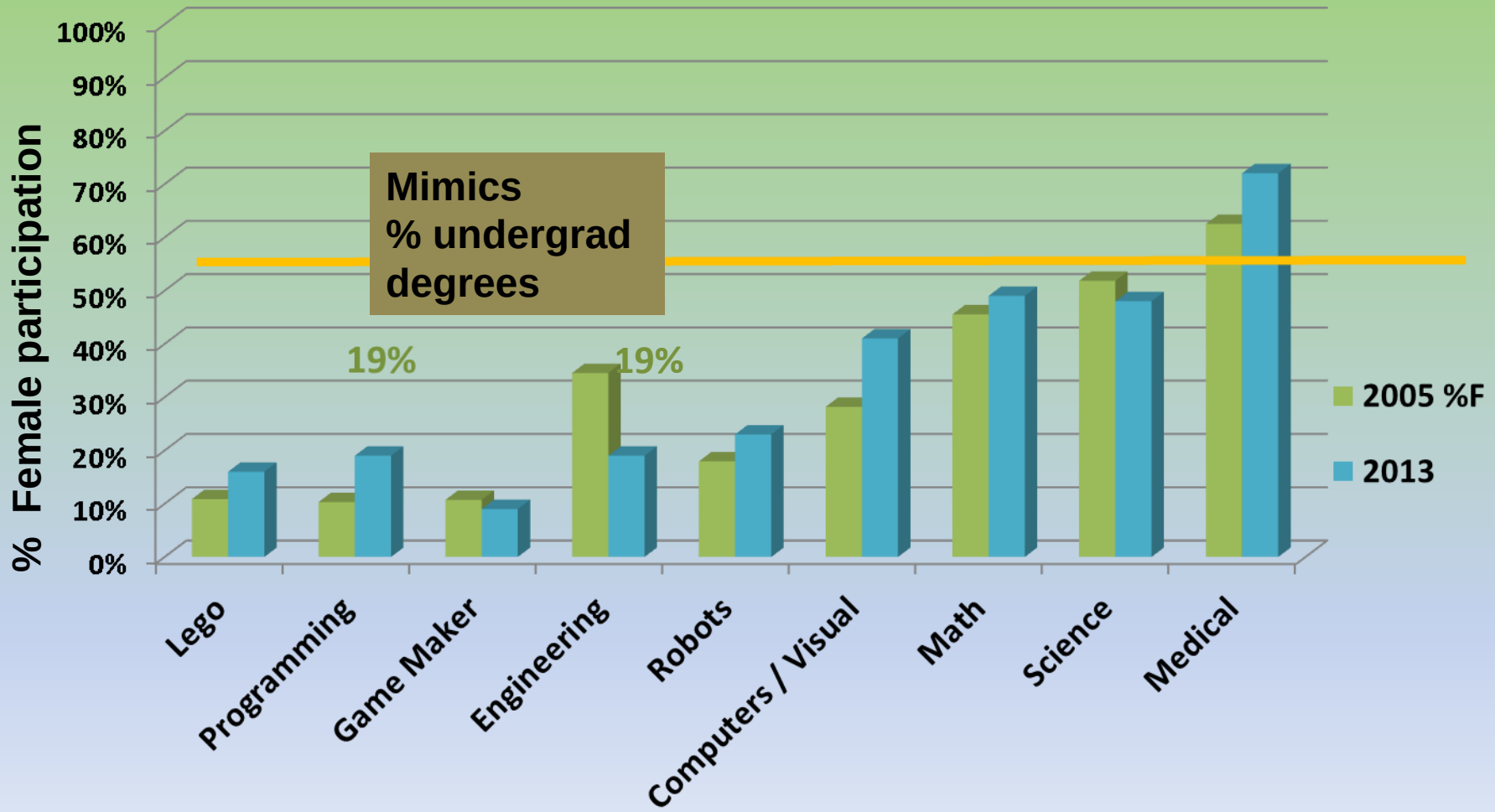
Examples of Classes

Microbiology
Programming in C, Java, Python, Scratch, Blender
Cancer Research & Genetics
Chemistry
Medical Camp
Architecture Workshop
Engineering Camp
Engineering Solar Car Challenge
Engineering Rube Goldberg
Forensic Science: CSI
Herpetology
Lego Physics
Math: Logic & Problem-Solving
Chemistry of Natural Dyes
Science of Firefighting
Physics of Rock Climbing

Write for Success
SAT Prep
Study Skills
Interviewing Skills

saturday academy
In affiliation with University of Portland

Girls participation in STEM classes varies systematically



Apprenticeships for Science and Engineering (ASE) Mentor Organizations 2012-2013

Bend Research, Inc.
Bonneville Power Administration
Columbia River Inter-Tribal Fish Commission
Design Science, Inc.
Digimarc Corporation
Food Innovation Center
Freshwaters Illustrated
Hewlett Packard Company
Huron Consulting Group
IBM
Institute for Applied Ecology
Johnson Creek Watershed Council
Kryptiq Corporation
Lewis & Clark College
Mead & Hunt, Inc.
Mentor Graphics Corporation
Multnomah County Facilities and Property Management
National Weather Service
Nike, Inc.
Oregon Department of Transportation
Oregon Health & Science University
Oregon National Primate Research Center, OHSU
Oregon State University
Oregon State University Cascades Campus
Oregon Translational Res. & Drug Development Inst.
Oregon Zoo
Portland State University
Portland VA Medical Center
Reed College
Rockwell Collins
Saltire Software
Tripwire, Inc.
University of Oregon
University of Portland
USDA Agriculture Research Service
USDA Natural Resources Conservation Service - Tangent
Vernier Software & Technology
Watershed Sciences, Inc – Portland
Welch Allyn, Inc.
Xerox Corporation

Example Apprenticeships

- PSU - The Center for Life in Extreme Environments - Extreme Virus Structure Research
- OSU – Engineering - Electroceramic Thin Film Microelectromechanical Systems (MEMS) Development
- VA Medical Ctr - Exploring Nurses Response to Critical Alarms and Designing Strategies to Reduce Alarm Fatigue
- OHSU - Postural Motor Learning in People with Multiple Sclerosis
- USDA – Corvallis - Marker-Assisted Breeding of Black Raspberry
- Mentor Graphics - System Engineering: Software Tool Development
- Johnson Creek Watershed - Coho Spawning Beds & Geomorphology
- Beeminder - Build a Quantified Self Tool
- ATI Wah Chang - Cutting-Edge Material and Process Development
- Saltire Software - Engineering Mechanics iBook
- Bonneville Power Administration-Distributed Generation

Solutions through Out-of-School Opportunities

- Inspiration
- Deep STEM learning, critical thinking, integration
- Scalable with instructors and mentors from industry
- Career exploration
- Nimble – changes with the science and engineering
- Ability to focus on specific fields/populations
- Relatively low cost

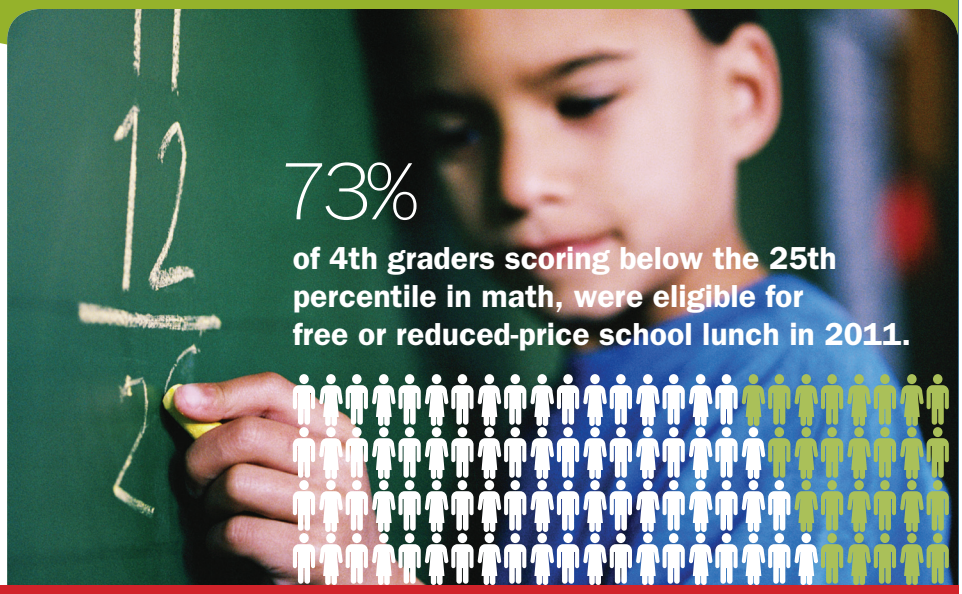
Thank
You

The **Achievement Gap** Is Real

"We can no longer afford to deny any child, let alone entire communities, the opportunity to learn, achieve and compete."

Congressman Chaka Fattah, Pennsylvania

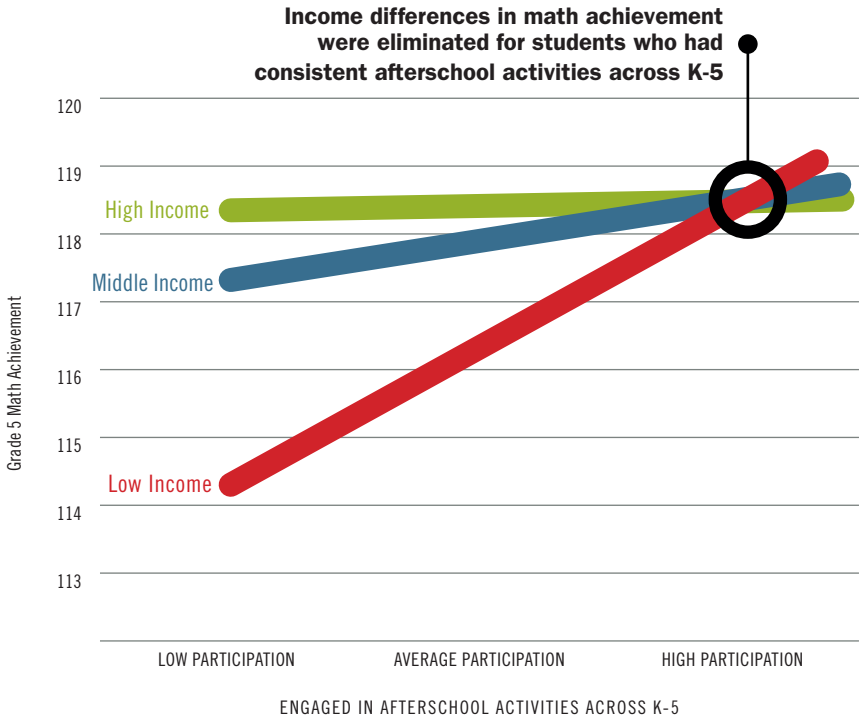
For Each and Every Child, Report to the Secretary of Education from the Equity and Excellence Commission, February 2013



NEW RESEARCH SHOWS

Afterschool Is a **Real Solution** Linked to **Closing the Gap**

Afterschool Participation Narrows the Math Achievement Gap[1]



1. Pierce, K. M., Auger, A. and Vandell, D. L. (April, 2013). *Narrowing the Achievement Gap: Consistency and Intensity of Structured Activities During Elementary School.* Unpublished paper presented at the Society for Research in Child Development Biennial Meeting, Seattle, WA.

New research demonstrates that more consistent time spent in afterschool activities during the elementary school years is linked to narrowing the gap in math achievement at grade 5.

What the data indicate:

- When afterschool participation is highly consistent, there is no gap in low-income and high-income children's math achievement at grade 5
- The more consistent the afterschool participation, the narrower the gap in math achievement
- The more rarely students participate in afterschool activities, the wider the achievement gap

Expanding Learning Through Afterschool: Three Key

1 More time spent expanding learning in afterschool = greater benefits for youth.[2]

Consistent participation in afterschool activities yields positive results.

- **Narrowed gap in math achievement**
- **Greater gains in academic and behavioral outcomes**
- **Reduced school absences**

More time spent in afterschool is associated with:

- Better work habits
- Improved academic performance
- Gains in self-efficacy
- Improved GPA
- Increased attendance, fewer school absences

Unstructured time with peers in the after school hours is associated with:

- Lower GPA
- More school absences
- Greater misconduct
- Reduction in work habits and self-efficacy

2. Auger, A., Pierce, K. M. and Vandell, D. L. (April, 2013). *Participation in Out-of-School Settings and Student Academic and Behavioral Outcomes.* Unpublished paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Factors Linked to Positive Outcomes

2 When youth like their afterschool program, they show improvement in the classroom.[3]

When youth report positive afterschool experiences, teachers report gains in the classroom.

- **Better work habits**
- **Stronger task persistence**
- **Pro-social behavior with peers**

3 Youth appreciate and need support from afterschool staff.

When youth report on their afterschool experience, emotional support from adult staff is the most significant factor leading to their positive assessment.

3. Kataoka, Sabrina and Deborah L. Vandell. "Quality of Afterschool Activities and Relative Change in Adolescent Functioning Over Two Years." *Journal of Applied Developmental Science.* VOL 17, ISS 3 (2013): 1-12. Print.

Embrace Expanded Learning & Afterschool for the Future of Our Youth

Young people need—and deserve—more from their education. High-quality afterschool and summer learning programs powered by school-community partnerships offer young people a variety of hands-on, engaging learning activities that build on the school day. The Expanded Learning & Afterschool Project is a 50-state initiative harnessing the power of networks and leaders to help schools and communities leverage the time beyond school to accelerate student achievement. The initiative connects you with research, resources and best practices for building affordable and sustainable approaches to expanding learning in your community.

Only 8.4 million K-12 children
participate in after school programs. 18.5 million would participate if a quality program were available in their community. (Afterschool Alliance, 2009)

Over 15 million school-age children
are on their own after school. Among them, more than 1 million are in grades K-5. (Afterschool Alliance, 2009)

Join the growing community of people committed to ensuring that all children have access to afterschool and expanded learning opportunities they need to succeed.

Sign on **as a supporter of the Expanded Learning & Afterschool Project and our principles**

Stay informed **about expanded learning events and opportunities**

Sign up **for our newsletter**

For more information visit the Expanded Learning & Afterschool Project at www.ExpandingLearning.org

ABOUT THE RESEARCHER

Deborah Lowe Vandell is the founding dean of the School of Education at the University of California, Irvine. An internationally recognized scholar on the effects of early child care, K-12 education, afterschool programs and families on children's social, behavioral and academic functioning, Vandell has examined the effects of afterschool programs on academic and social outcomes. This work underscored the importance of out-of-school time as a factor in classroom success. In addition, Vandell developed an online assessment tool in use by the state of California to measure quality and student performance in afterschool and summer learning programs. Learn more about Vandell's research and how to put it to use at www.afterschooloutcomes.org

OregonASK
STATEWIDE AFTERSCHOOL NETWORK

Non-competitive STEM Program and Professional Development Grantees, 2011-2013
21st Century Community Learning Centers
Summary and Findings

Adrien Schless-Meier
Mary Masla
October 2012

Introduction: STEM Education and 21st Century Community Learning Centers

As the pace of scientific and technological advancement continues to speed up, it is crucial that we provide children and youth with STEM education. While STEM learning is a cornerstone of most elementary, middle, and high school curricula, students' limited classroom time[1] can stifle their success in these fields. Developing a comprehensive plan to promote STEM education within Oregon and across the U.S. does not entail a one-size-fits-all approach. By supporting multiple options, governments, school districts, teachers, and communities ensure that more students gain access to well-rounded, high-quality STEM programming.

Afterschool programs such as 21st Century Community Learning Centers (21st CCLC) encourage children and youth to extend the learning process beyond the classroom by providing access to a rich and varied array of STEM activities. For many students who struggle with STEM during the regular school day, the afterschool setting can provide a low-pressure atmosphere in which these students can become more proficient in science and mathematics. This is especially important for low-income students, students of color, and young women, who often underperform in STEM topics despite their potential. Because 21st CCLC programs target students in high poverty, low-performing schools, they can be a meaningful way to boost students' confidence and help them see the real world applications of STEM, particularly as potential career paths.

In addition to promoting student success, confidence, and proficiency in STEM, 21st CCLC afterschool programming can contribute to staff and teacher professional development.[2] Funding for afterschool programs is often used to host conferences and workshops where afterschool staff and school day teachers can share best practices, as well as develop skills to teach scientific inquiry and engage students in STEM learning both inside and outside the classroom. Enhancing teachers' STEM instruction through professional development is another key way in which 21st CCLC programs can have a broad impact in schools striving to meet state standards.

Recent research[3] underscores the role that state governments can play in supporting STEM education through afterschool programs, particularly in conjunction with 21st CCLC. In 2011, the Oregon Department of Education (ODE) awarded 25 non-competitive STEM program grants to all grantees currently receiving 21st CCLC funds. These grants, each totaling $25,000,[4] provide support for 21st CCLC programs to develop STEM curricula and activities for the 2011-2012 and 2012-2013 school years. In addition, five grantees were award non-competitive STEM $50,000 professional development grants in order to promote high-quality instruction among afterschool staff and school day teachers.

STEM program grants primarily serve elementary and middle school students, although

several programs also provide STEM education for high school students. Based on available student attendance data, current STEM program grantees offer afterschool education in a range of science- and math-based curricula to 137 students per year on average.[5] Programs have been able to implement STEM activities afterschool for an average of 17.8 weeks, which covers approximately half of the regular school year.[6] Grant funds were not distributed to grantees until November 2011, leaving a little more than half the school year for programs to implement grant activities.

The following sections highlight some of the accomplishments these 21st CCLC STEM programs have achieved in a range of areas, including curriculum development and professional development. Their successes underscore the importance of connecting 21st CCLC programs with high-quality STEM education, as well as the role the ODE can continue to play in fostering these connections.

Science Outside the Classroom: STEM Activities in Afterschool

Current STEM program grant funds provide afterschool staff and school day teachers with an exciting opportunity to develop new curricula and enhance existing curricula across a range of subjects in science and mathematics. Program activities cover a broad array of topics, from engineering to soil science to code development. Below is a list of common subject matter in science and mathematics highlighted through current 21st CCLC STEM programming:

- Environmental sciences
- Astronomy
- Plant and soil science; photosynthesis
- Forest ecology
- Physics and engineering
- Lego robotics
- Computer programming
- Science fairs/Odyssey of the Mind competitions
- Forensics science
- Ocean and watersheds
- Wind and weather
- Algebra/geometry
- Animal physiology

Several grantees stand out in regard to the complexity and success of their programs. A cohort of 7th and 8th grade students in the Falls City F.A.C.E.S. program learned difficult concepts in physics and engineering, such as velocity, acceleration, potential and kinetic energy, and g-force, through the use of K-NEX toolkits to build model roller coasters. Students then measured these values on their personal roller coasters using Vernier computing software and LabQuest mini-computers. Amy Houghtaling, coordinator for F.A.C.E.S., highlighted the multiple components of Vernier software, including motion detectors, force sensors, and accelerometers, which allowed students to engage in complex calculations. Overall, Falls City School District is well on track to complete all of the activities outlined in its original grant proposal, and has been very successful in providing stimulating, challenging curricula to middle-school program attendees.

In Mapleton School District's LEAF program, students in 4th and 5th grade have the opportunity to learn about watersheds through an innovative curriculum developed in partnership with the Siuslaw Watershed Council. In addition to gaining comprehensive knowledge of watershed science through hands-on learning, including site visits, students are taught the basic fundamentals of the scientific method and inquiry by participating in collaborative group work. The partnership between the LEAF program and the Siuslaw Watershed Council has led to the training of several afterschool staff in LabQuest and Vernier software in addition to watershed curricula. This has allowed staff to adapt the curricula to meet the needs of early elementary students, as well as middle and high school students. While these cohorts do not have the opportunity to go on field trips to visit different areas of the Siuslaw Watershed, their participation in the watershed programming has been a tremendous success.

Program coordinators at Springfield High School partnered with a professional video game developer to provide high school students with the opportunity to design their own games. At the beginning of the program, students coded simple depictions of a bouncing ball in order to explore fundamental principles of physics and motion. Moving beyond this introduction to computer syntax and program development, several students went on to create more complex, personalized games. One game centered on the evolution of the life cycle, underscoring how this pedagogical tool can be used to develop more in-depth curricula regarding the biological sciences.

The above examples highlight how 21st CCLC STEM programming can give children and youth the opportunity to learn principles in science and mathematics and apply them to the world around them. Such programming can help bolster students' confidence in STEM subject areas inside of the classroom, as well as expose them to potential career opportunities in STEM fields. Overall, pairing STEM education with 21st CCLC programs is a critical component to developing a comprehensive, multi-faceted STEM agenda for Oregon.

Standards Alignment

Aligning 21st CCLC STEM curricula with standards in science and mathematics can fill in a crucial gap for students who struggle in these areas, providing low-stakes programming that engages students in applying STEM principles to real world scenarios. Standards alignment also offers a means for afterschool staff and teachers in Title I schools to work together to create comprehensive, in-depth curricula in a sustained, directed fashion. Program directors across the state can share resources and best practices to complement school day learning with afterschool STEM activities.

Several of the current grantees surveyed have made significant efforts to align afterschool STEM curricula to local and state standards in science and mathematics. For example,

program coordinators in Eugene have worked with both the city's Parks and Recreation department and the School Garden Project of Lane County in order to design an innovative outdoor curriculum that aligns with Oregon state science standards. In the Three Rivers school district, one aspect of professional development for afterschool staff involves training in common core math and ELA standards, which allows staff to provide culturally relevant STEM education while aligning their curricula to core standards.

In addition to providing tangible benefits to students inside the classroom by promoting their understanding of key concepts in science and mathematics, aligning afterschool curricula with state standards also allows for collaboration between program staff and school day teachers.

Partnerships with School Day Teachers

By working together, school day teachers and afterschool staff can develop streamlined programming that helps students succeed both inside and outside of the classroom. Indeed, school day teachers often contribute their time and energy to coordinate and staff 21st CCLC programs, so engaging them in the development and implementation of STEM curricula is a crucial aspect of successful programming.

Partnerships with school day teachers can provide meaningful opportunities for students to develop mentoring relationships outside of the classroom. In the Gresham-Barlow School District, STEM program grants funded participation for over 300 students in a science fair at Gresham High School. Thirty students went on to enter the Northwest Science Expo System's At-Large Regional Science Fair. Teachers then mentored groups of 1-3 students as they developed projects for the fair, which offered students the opportunity to select from a wide range of scientific topics to suit their personal interests. One project ultimately advanced to state expo at Portland State University, sponsored by Intel, highlighting the importance of the program in supporting student achievement.

In McMinnville, roughly 40% of the school day staff participates in afterschool programming, in partnership with the district's 21st CCLC program. Using STEM program grant funds McMinnville has infused STEM activities like Lego Robotics into the school day. Introducing students to Lego Robotics during their regular school day hours has sparked student interest, which has lead to a significant increase in the number of students participating in Lego Robotics afterschool. Due to increased student interest and STEM program grant funds McMinnville is providing Lego Robotics afterschool programming to 73 students (an almost 50% increase from last year), with hopes to expand the program to 120-150 students in the future.

School day teachers not only contribute significant knowledge and expertise to 21st CCLC STEM programming, particularly in guiding the development of curricula to align with state standards, but their involvement can also serve to enhance student experience by providing additional mentorship and guidance.

Community Involvement

An important avenue to encourage youth to pursue careers in STEM fields is to establish connections with partners within the community. These relationships can help students understand the real world applications of STEM principles, as well as provide preliminary opportunities to connect with potential future employers. Furthermore, by engaging with stakeholders in the business, education, and museum communities, 21st CCLC programs gain access to a wealth of potential resources ranging from funding opportunities to curriculum development.

In the Siuslaw School District, high school students will participate in a Forensics Science program. While primarily Siuslaw School District staff designed the program, many community partners will work to enhance students' experiences via the exploration of real-world applications of forensic sciences. Before jumping into forensic sciences students will learn from a panel of crime-related professionals including police offices, fire fighters, EMT's and the Pacific Northwest Donor Program. Students will also travel to Eugene to visit the Life Technologies Corporation, where they will learn about the biotechnologies they will be using for DNA testing in their afterschool activities. This exposure to real-world applications of afterschool STEM activities exemplifies the opportunities afterschool can provide.

In Neah-Kah-Nie students have the opportunity to participate in the Odyssey of the Mind competition. While the STEM program grant funds one Odyssey of the Mind team (with roughly six students on each team), a local community group called Mudd Nicks funds five other teams. This partnership between local community groups and the School District, has allowed for a significant increase in student participation in exciting STEM-related activities.

Community involvement is one mechanism through which afterschool 21st CCLC STEM programs can strive to sustain themselves as well as offer relevant and diverse activities to students.

Professional Development

As mentioned previously, ODE awarded five professional development grants to 21st CCLC grantees in 2012. While this is a significant boon to those districts in particular, it is important to note that several other STEM program grant recipients also undertook

professional development activities in order to bolster the quality of their programs. These activities often included both school day teachers as well as 21st CCLC staff, further underscoring the importance of collaboration between these two groups.

The Woodburn School District 21st CCLC program used their STEM program grant not only to build curriculum and implement STEM activities, but also to provide front-line staff with professional development. Woodburn School District teachers in partnership with Pacific University designed STEM curricula for elementary-aged students. Following curriculum development, front-line staff members received training on best practices for implementation. Curriculum developers (WSD teachers and Pacific staff) also conducted site visits during afterschool program hours, in order to provide front-line staff with additional support in implementing STEM activities. This example showcases the multi-faceted use of a STEM program grant.

The STEM professional development grant provided opportunity for large-scale STEM professional development. In addition to grant recipients' afterschool staff, these funds served other 21st CCLC grantees and district school day staff. This summer the Salem-Keizer Education Foundation hosted a one-day STEM professional development conference called STEM and Beyond. At the conference Salem-Keizer School District teachers, Salem-Keizer Education Foundation staff and staff from Sheridan, Falls City and Gervais 21st CCLC programs were introduced to innovative STEM curricula by industry experts. The keynote speaker was Ed Sobey, PhD President of the Northwest Invention Center, and the creator of Kids Invent! Attendees received complete curricula, and an opportunity for peer-to-peer sharing via email following the conference.

Woodburn and Salem-Keizer Education Foundation's multi-faceted approaches showcase how afterschool programs can support widespread professional development in STEM education. Programs like 21st CCLC can also provide opportunities for teachers and afterschool staff to sharpen their quality of instruction through hands-on lessons and diverse curriculum activities.

Conclusion

The collaboration between ODE and current 21st CCLC grant recipients to bolster STEM education in afterschool programs has led to significant successes across the state. Several school districts have used their non-competitive STEM grant funds to develop engaging activities for hundreds of students who would not otherwise have had access to them. These efforts are a step in the right direction to ensure that more children have the opportunity to pursue in-depth learning in STEM fields and to continue the work of closing the achievement gap. Because of partnerships like the one between ODE and 21st CCLC grantees, districts, schools, and teachers are able to galvanize more resources to support and sustain quality STEM programming.[7, 8]

Looking ahead, it is important that ODE and 21st CCLC partners continue to work together to provide high-quality STEM education to students most in need of improvement, particularly those students in high-poverty schools. One significant step the ODE and 21st CCLC programs can take together is to develop a standard by which STEM activities can be evaluated and assessed. This is crucial in helping schools and districts identify best practices in afterschool education and will allow the ODE to ensure that grant funds are being utilized to strengthen alignment with state standards in science and mathematics. Collaboration in this area will minimize potential confusion among grantees and will guide the development of high-quality programming.

Furthermore, by tracking attendance in afterschool programs, ODE can identify those programs with high rates of participation and attendance versus those that struggle in these areas. This would allow the Department to share additional resources with struggling programs, as well as make recommendations for how such programs might improve attendance and retention based on successful participatory models.

Overall, the key to ensuring that high-quality STEM education becomes integrated into all children's learning experiences is to provide a diverse array of activities in multiple settings to address differences in learning styles, community resources, and areas of interest. Supporting such activities occurs best through collaboration between principal stakeholders, including local governments, school districts, teachers, parents, and community organizations. With strong, consistent, and mutually agreed upon methods of data collection and reporting, all partners invested in high-quality STEM education will be able to track their progress and continue to refine and develop curricula as necessary.

[1] "STEM Learning in Afterschool: Analysis of Impact and Outcomes." 2011. Afterschool Alliance.
[2] Thomasian, John. 2012. "The Role of Informal Science In the State Education Agenda." Issue Brief. National Governors Association.
[3] Ibid. See also "Afterschool Programs as Partners in Stem Education: Policy Recommendations." 2012. Afterschool Alliance.
[4] STEM program grants were $20,000 per grantee. Applicants also received a $5,000 stipend in order to support the planning phase of their STEM program implementation (Oregon Department of Education).
[4] OregonASK obtained data on student attendance from 15 grant recipients, and the average attendance was calculated based on these figures. The actual average across all STEM programs may be higher or lower than what has been reported.
[5, 6] OregonASK obtained data on the duration of programming from 7 grant recipients, and average length of the program was calculated based on these figures. The actual average across all STEM programs may be higher or lower than what has been reported.
[7] Harvard Family Research Project, "Partnerships for Learning: Promising Practices in Integrating School and Out-of-School Time Program Supports," March 2010.
[8] Center for Advancement of Informal Science Education, "Making Science Matter: Collaboration Between Informal Science Education Organizations and Schools," March 2010.

Leveraging the Power of Afterschool and Summer Learning for Student Success

This article is an excerpt from the groundbreaking book, ***Expanding Minds and Opportunities: Leveraging the Power of Afterschool and Summer Learning for Student Success.*** This landmark compendium, edited by Terry K. Peterson, PhD, is composed of nearly 70 research studies, reports, essays, and commentaries by more than 100 researchers, educators, community leaders, policy makers, and practitioners.

Collectively, these writings boldly state that there is now a solid base of research and best practices clearly showing that quality afterschool and summer learning programs—including 21st Century Community Learning Centers—make a positive difference for students, families, schools, and communities.

Together, the collection of articles demonstrates the power of quality expanded learning opportunities to:

- **promote student success and college and career readiness;**
- **build youth assets such as character, resilience, and wellness;**
- **foster partnerships that maximize resources and build community ties; and**
- **engage families in their children's learning in meaningful ways.**

For information on how to order the full book, download sections and individual articles, or explore the topic areas, visit **www.expandinglearning.org/expandingminds.**

About the Expanded Learning and Afterschool Project

The Expanded Learning and Afterschool Project is a 50-state initiative harnessing the power of networks and leaders to help schools and communities leverage the time beyond school to accelerate student achievement. A partnership of funders led by the C.S. Mott Foundation support the Expanded Learning and Afterschool Project. More information about the book and the project, as well as additional resources, can be found at www.expandinglearning.org.

Anita Krishnamurthi
Director of STEM Policy, Afterschool Alliance

Ron Ottinger
Executive Director, Noyce Foundation

Tessie Topol
Senior Director for Strategic Philanthropy & Community Affairs, Time Warner Cable

STEM Learning in Afterschool and Summer Programming: An Essential Strategy for STEM Education Reform

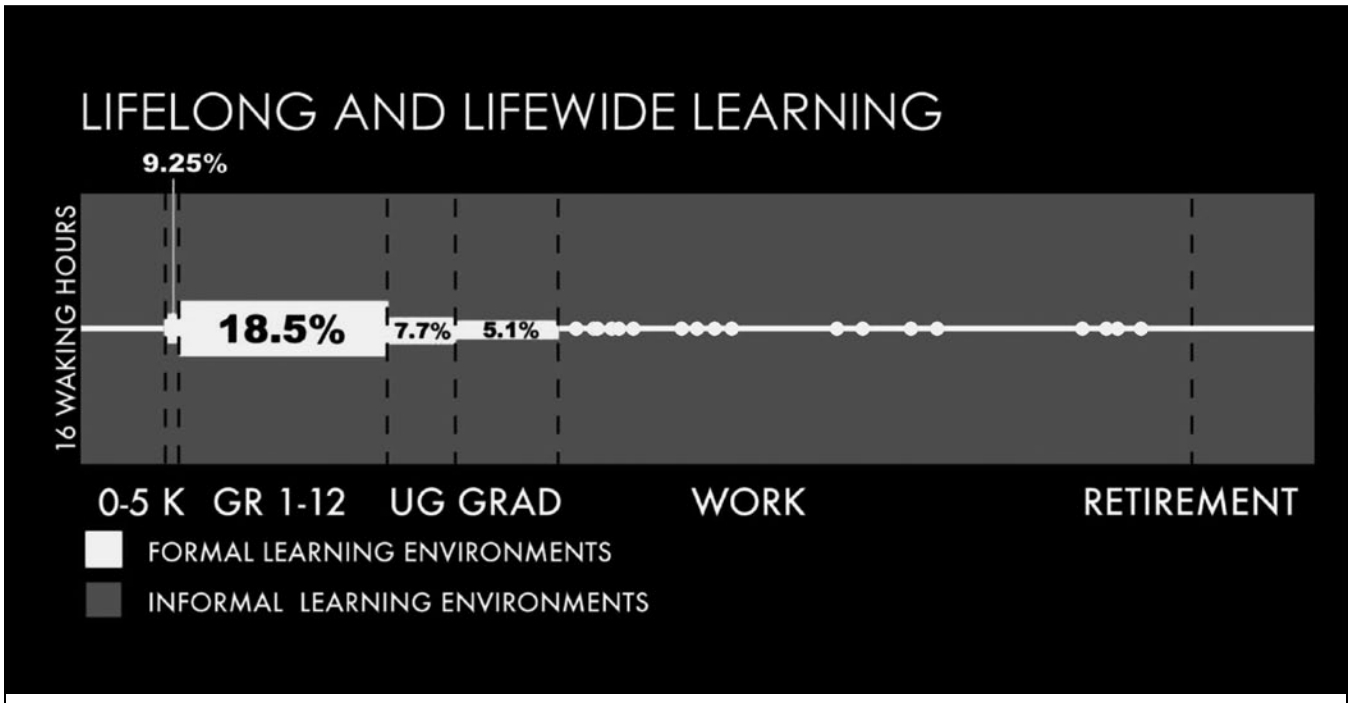
Science, technology, engineering, and math (STEM) skills are increasingly necessary to navigate an ever-more complex world and a globalized economy. There is tremendous energy and momentum to improve these skills among our citizens and students so they can participate fully in contemporary society and the modern economy.

Afterschool and summer programs all over the United States are offering engaging, hands-on STEM learning programs that are not only getting children excited about these topics, but also are helping them build some real-life skills and proficiencies.

Yet most strategies and policies for reforming STEM education focus on what happens during the school day. While schools are absolutely essential for learning, we must acknowledge that children spend less than 20% of their waking hours in schools each year, and some persuasively argue that school is not where most Americans learn most of their science anyway (Falk & Dierkling, 2010).

Hence, efforts to improve and increase STEM education opportunities must include programs that take place during the afterschool hours and the summer. Despite the need for many more quality afterschool and summer programs, more than 8 million young people already attend afterschool programs (Afterschool Alliance, 2009).

In addition, there is a sizeable infrastructure of programming and support (for example, the 21st Century Community Learning Centers initiative and the California Afterschool and Safety Program) focused especially on serving young people from groups that are typically



under-represented in the STEM fields. This is a large and growing field that local, state, and national education and business leaders and policy makers interested in STEM and K–12 education reform should pay attention to.

Afterschool and summer programs all over the United States are offering engaging, hands-on STEM learning programs that are not only getting children excited about these topics, but are also helping them build some real-life skills and proficiencies. There is mounting evidence that demonstrates the impact of these settings. A recent analysis of evaluation studies of several afterschool STEM programs showed that high quality programs can lead to increased interest and improved attitudes toward STEM fields and careers, increased STEM knowledge and skills, and increased likelihood of pursuing STEM majors and careers (Afterschool Alliance, 2011b).

Evidence of STEM Benefits from Afterschool

- **4-H** (nationwide) – 71% of 4-H science participants say science is now one of their favorite subjects, and 59% say they would like to have a job in a science field.
- **ACE Mentor Program** (nationwide) – 66% of program alumni (mostly from minority communities) are studying Architecture, Construction, or Engineering or working in one of these fields.
- ***FIRST*** (nationwide) – Participants learn a wide variety of skills, ranging from technical to teamwork and presentation skills, in this program focused on robotics. 89% of alumni go on to college.
- **TechBridge** (Oakland, CA) – This girls-only program enjoys great success, with more than 80% of participants reporting improved problem-solving, computer, and technical skills.

The impact of these types of expanded learning programs and extracurricular activities is also reflected in improvements in academic performance, as noted in the research cited by many other authors in this compendium. Other recent research also reveals the importance of out-of-school-time settings for STEM education. Tai, Liu, Maltese, and Fan (2006) found, for example, that early engagement with STEM fields was crucial and that a professed interest in STEM careers by eighth grade was a more accurate predictor of getting a science-related college degree than were the math or science test scores for average students. Thus, early encouragement of elementary and middle school students in STEM fields can be very effective in influencing their choice of college majors. Additionally, Wai, Lubinski, Benbow, and Steiger (2010) found that students who had more opportunities to participate in STEM learning (including beyond the classroom) were more likely to follow STEM career pathways and excel in them.

Afterschool programs are well placed to deliver on these needs by not only providing additional time to engage in STEM topics but also by doing so in a manner that is different from school and that engages different types of learners. These programs can also be very effective in improving access to STEM fields and careers among populations that are currently greatly underrepresented – women, African Americans, and Hispanics (Beede et al., 2011a; Beede et al., 2011b)—helped in part by the fact that African American and Hispanic children participate in afterschool programs in greater numbers (Afterschool Alliance, 2009).

Promising Trends in Afterschool STEM Learning

Afterschool programs are no strangers to STEM programming. STEM-rich institutions, such as museums and universities, as well as youth groups such as 4-H, Girls Inc., Girl Scouts, etc., that have deep roots in their communities, have been offering afterschool STEM programs for many decades. What has changed in the past decade is that they have renewed and deepened their commitment and that the average afterschool provider has also become interested in offering such opportunities to the children they serve. The only federal funding source exclusively dedicated to afterschool and summer learning programming, the 21st Century Community Learning Centers initiative, is now emphasizing STEM as a priority area for its grantees. Indeed, the importance of this key funding source cannot be overstated, as it is essential for providing the basic programs and infrastructure that many other STEM-focused partners can tap into to expand learning opportunities for students.

Funding from this federal initiative has significantly leveraged additional resources for STEM programming. For example, the Noyce Foundation is a private philanthropic foundation that invests heavily in afterschool STEM learning through innovative partnerships. A C. S. Mott Foundation-Noyce Foundation collaboration currently is active in 16 states and will continue to expand among the nation's growing number of state afterschool networks, which are supported by the Mott Foundation. Also Noyce is investing in "Project LIFTOFF," an initiative to develop and nurture afterschool STEM systems in 10 Midwestern states. This initiative has led many school districts to combine their foundation funding with their 21st Century Community Learning Centers funding to offer exceptionally high quality afterschool STEM opportunities.

In 2011, the Nebraska 21st Century Community Learning Centers program received a NASA Summer of Innovation grant to launch Nebraska BLAST! This is a 4-year collaborative initiative that brings together STEM content specialists with teachers and

afterschool staff from schools that receive funding through the 21st Century Community Learning Centers initiative. This effort will provide high quality STEM training to staff of all of Nebraska's 21st Century Community Learning Centers programs and will give thousands of Nebraska youth the opportunity to engage in exciting, hands-on STEM experiences through their local program.

As schools, communities, and parents negotiate how to provide additional learning opportunities for their children and youth, afterschool and summer programs that work closely with schools provide a model to meet this need. Research shows that afterschool programs that are well aligned with the school day and have strong community ties have optimal benefits for kids (Afteschool Alliance, 2011a).

The corporate sector is also getting deeply involved in afterschool STEM education. Change the Equation is a nonprofit organization that was formed to help companies with their STEM education-related philanthropy. Most of the philanthropic investments of these companies focus on the "informal education" arena, which includes afterschool.

Nebraska BLAST! will provide high quality STEM training to staff of all of Nebraska's 21st Century Community Learning Centers programs and will give thousands of Nebraska youth the opportunity to engage in exciting, hands-on STEM experiences.

For example, in 2009, Time Warner Cable (TWC) decided to focus the majority of its philanthropic resources on a single cause. The result was Connect a Million Minds (CAMM)—a 5-year, $100 million cash and in-kind commitment to inspire students to engage in math and science learning. To bring this commitment to life, TWC supports *FIRST* (For Inspiration and Recognition of Science and Technology), a robotics organization with a model proven to engage young people in STEM learning also funded by 21st Century Community Learning Centers programs in areas across the country. On a national level, TWC also partners with the Coalition for Science After School to provide the "Connectory," a free, online resource that makes it easy for parents and teachers to find informal STEM learning opportunities. In addition, TWC brings the impact of CAMM to its local markets by supporting *FIRST* teams and competitions, science museums, and other nonprofit organizations that are engaging kids in STEM.

Several *FIRST* teams have also utilized 21st Century Community Learning Centers funding with great success. The Camdenton R-III Afterschool Science, Engineering and Robotics program in rural Missouri receives funding from the 21st Century Community Learning Centers initiative and has leveraged that to great effect. Their team has won several awards, including the regional competition that has allowed them to go to the finals for 2 years in a row. The Safe Harbor Before and After School Program in Michigan City, Indiana, which has received 21st Century Community Learning Centers funds for many years, worked with the Indiana Afterschool Network and the Indiana Department of Education to develop a *FIRST* Robotics team in 2012. The team won the All Star Rookie award in the Midwest and went to the national championship.

Recommendations

It is becoming clear that there is a great need—and a prime opportunity—to tap the potential of afterschool and summer learning programs to serve an urgent national priority to enhance STEM education. Deliberate action by all key stakeholders is required, however, to help afterschool and summer programs fully realize this potential and become strategic—and integral—partners in STEM education.

Federal and state education policies must ensure, in particular, that afterschool and summer programs are included in STEM education policy initiatives if this to become a sustainable, long-term practice (Krishnamurthi, 2012; Afterschool Alliance, 2012).

In addition, the afterschool field must also adopt several strategies to become effective partners in STEM education:

- *Afterschool programs must deliberately commit to offering STEM learning opportunities and then prioritize and allocate resources to provide professional development in STEM programming areas to staff.*
- *Afterschool intermediary organizations and large networks must widely promote existing high quality curricula to avoid wasting scarce resources on developing new programs and curricula.*
- *The field must reach consensus around youth outcome indicators and adopt them widely so that programs have a clear vision of their goals and role within the STEM education ecosystem. A local- or state-level hub is often a necessity for disseminating information and coordinating professional development efforts and other STEM programming needs for afterschool. This may include seeking partnerships with STEM-rich institutions, such as science museums and universities, as well as other science and math hubs in many states.*
- *Meaningful STEM learning that extends beyond one-shot experiences are necessary. Afterschool and summer programs must pay close attention to offering regular, consistent programming in STEM topics. Furthermore, wherever possible, programs must offer a continuum of STEM learning experiences that extend into middle and high school in order to derive maximum impact from their STEM programming.*

Employers and professionals in STEM fields who would like to engage in afterschool programs might find it helpful to familiarize themselves with the landscape of afterschool STEM in their region before getting started. As with any new community, the afterschool field has its own culture and philosophy, and it is important to be aware of the issues before delving into it.

- *A good place to start is to seek out the Mott-funded statewide afterschool network in the state, the national Afterschool Alliance, the local afterschool consortium, or the National Girls Collaborative Project and other similar networks to find out about existing efforts and partnership needs.*

- *Large afterschool providers, such as local and state 21st Community Learning Centers programs, 4-H, Boys and Girls Clubs, Girls Inc., the YMCA, as well as afterschool coordinators within school districts, are all good places to get started at a local level.*
- *Additionally, businesses wishing to get involved in supporting afterschool and summer STEM programming might find the guidelines suggested by Change the Equation in their "Design Principles for Effective Philanthropy" (n.d.) useful. Public-private partnerships could also greatly advance the systems-building effort required to support STEM learning in afterschool by focusing on content-related professional development, evaluation studies, and other technical assistance. An example of such a public-private partnership is that between the Mott Foundation and the Department of Education around the 21st Century Community Learning Centers. Recently, the Noyce Foundation has partnered with the Mott Foundation to support some of the Statewide Afterschool Networks in their STEM efforts, further leveraging the investments. Many other partnership opportunities are available with the state afterschool networks and local and state 21st Century Community Learning Centers programs.*

Afterschool and summers programs have emerged as essential partners in improving and increasing STEM education opportunities for our children and youth. They are often overlooked but have a big and growing infrastructure and interest in STEM. Your involvement and leadership is needed to capitalize on it.

For More Information

- **Afterschool Alliance** – http://www.afterschoolalliance.org/STEM - This website provides information on resources for programs as well as ways for STEM professionals to get involved in afterschool.
- **Coalition for Science After School** – http://afterschoolscience.org/ - This organization has several resources, including a guide to science activities and curricula (look under the Program Resources tab).
- **Connect a Million Minds Connectory** – http://connectamillionminds.com/connectory.php - This resource allows you to search by zip code for activities and resources for afterschool programs.
- **Statewide Afterschool Networks** – http://www.statewideafterschoolnetworks.net/ - The Statewide Afterschool Networks work with a broad range of partners to foster partnerships and policies to develop, support and sustain high quality afterschool and expanded learning opportunities for children and youth.

ABOUT THE AUTHORS

Anita Krishnamurthi is director of STEM policy at the Afterschool Alliance. She leads the Alliance's efforts to advance policies, research, and partnerships so children and youth can have rich STEM education experiences in their afterschool programs. She worked at the National Aeronautics and Space Administration (NASA) for 6 years. Before joining NASA, Anita was a program officer at the National Academy of Sciences. Anita's formal training is as an astrophysicist,

Ron Ottinger is the executive director of the Noyce Foundation and is leading the foundation's initiatives in informal and out-of-school-time science, focusing on field-building efforts that are marrying afterschool and science. These efforts include strategies to scale quality out-of-school science programming nationally within the Mott State Afterschool Networks, the urban Collaborative for Building After School Systems, 4-H, the Afterschool Alliance, National Afterschool Association, and National Summer Learning Association.

Tessie Topol is senior director for strategic philanthropy & community affairs at Time Warner Cable. In this role, she is responsible for the company's community giving and engagement strategy and leads its signature philanthropy program, Connect a Million Minds™, a 5-year, $100 million cash and in-kind initiative to inspire the next generation of STEM innovators.

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STEM Investment Council
March 2014

COMMON CORE STATE STANDARDS OREGON

NEXT GENERATION SCIENCE STANDARDS For States, By States

CCSS-M and NGSS Connections and Implications

Cheryl Kleckner
Education Specialist
Oregon Department of Education

OREGON DEPARTMENT OF EDUCATION

Discussion Topics

- Current State of Practice
  - Teacher Preparedness
  - Instruction Time and Resources
  - Professional Development
- Barriers
- Major Shifts
- Connections
- Recommendations

Current State of Practice Teacher Preparedness*

- Lack of Strong Content Background
- Beliefs Inconsistent with Learning Research
- Unprepared to Teach Diverse Learners
- Less Prepared to Identify Previous Knowledge, Misconceptions, Difficult Areas
- Well-prepared Teachers not Equitably Distributed

**Report of The 2012 National Survey of Science and Mathematics Education*, Horizon Research, Inc., February 2013

OREGON DEPARTMENT OF EDUCATION

Current State of Practice Instruction Time and Resources*

- Lack of Elementary Science Instruction
  - 20% every day in K-3; 30% every day in 4-6
  - Oregon NAEP Grade 4 = 1.9 hours/week**
  - Increased time = higher achievement**
- Inadequate Resources
- Resources Not Equitably Available
- Lack of Science PD at Elementary
- PD not Aligned with Standards or Research

**Report of The 2012 National Survey of Science and Mathematics Education*, Horizon Research, Inc., February 2013

***Science Instructional Time is Declining in Elementary Schools: What are the Implications for the Student Achievement and Closing the Gap?,* Science Education, Vol. 97, No. 6, 2013

Current State of Practice Barriers*

From Educator Surveys:

- Science
  - Inadequate funds for equipment and materials
  - Lack of facilities
  - Insufficient time to teach (elementary)
  - Lack of PD
- Math
  - Low student interest
  - Low student reading abilities

**Report of The 2012 National Survey of Science and Mathematics Education*, Horizon Research, Inc., February 2013

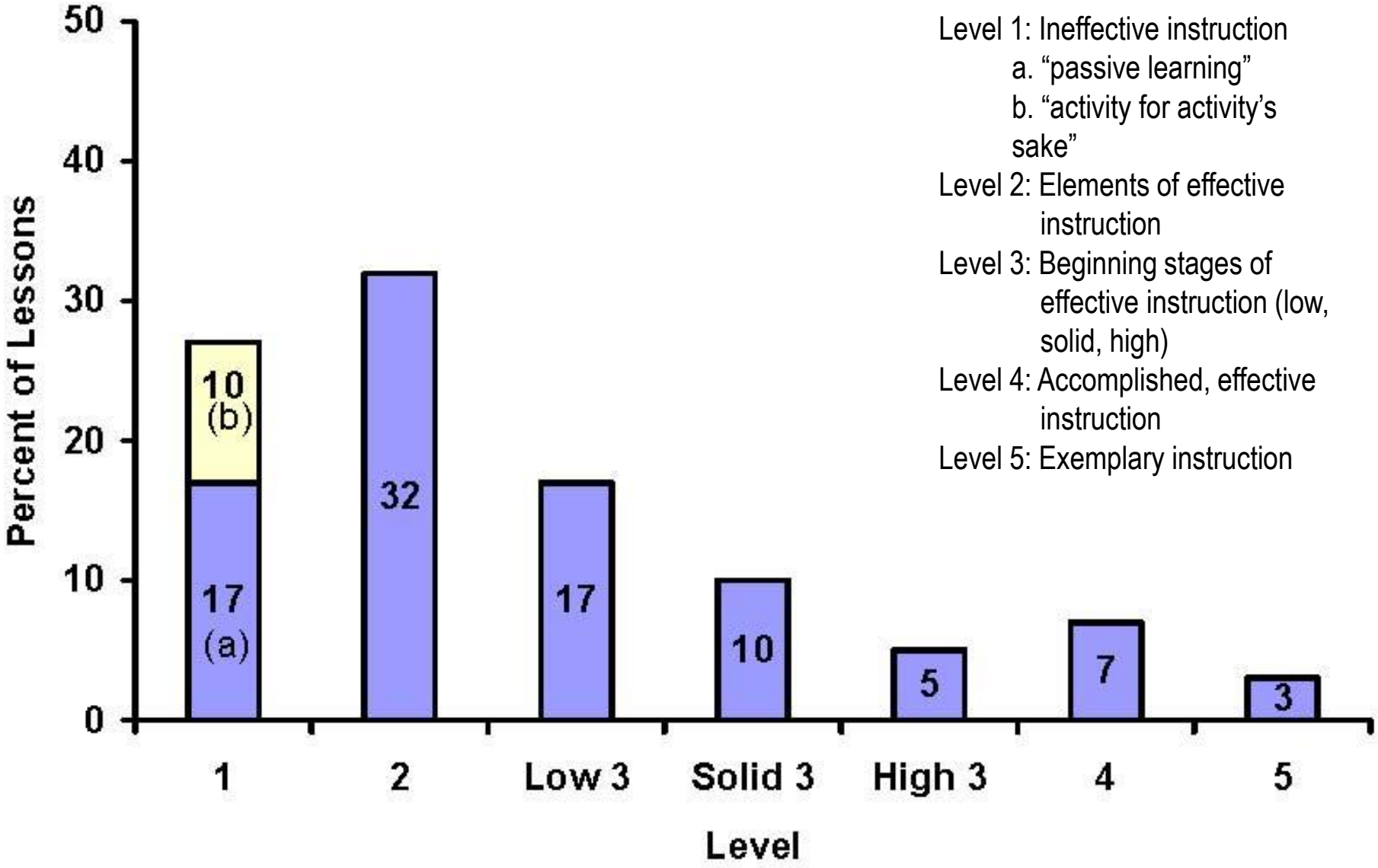
Current State of Practice Barriers*

From Classroom Observations, High Quality Lessons Must:

- Engage students with rigorous content;
- Create an environment conducive to learning;
- Ensure access for all students;
- Use questioning to monitor and promote understanding; and
- Help students make sense of the content.

**Looking Inside the Classroom,* Horizon Research, Inc., 2003

Capsule Ratings:
K-12 Mathematics and Science Lessons



Level 1: Ineffective instruction
a. “passive learning”
b. “activity for activity’s sake”
Level 2: Elements of effective instruction
Level 3: Beginning stages of effective instruction (low, solid, high)
Level 4: Accomplished, effective instruction
Level 5: Exemplary instruction

Discussion

What is the level of awareness of these issues in your district/school/community?

How does the current status of practice affect students learning STEM?

NGSS Vision

- Learning as a **developmental progression**
- **Engaging students** in scientific investigations and argumentation to achieve deeper understanding of core science ideas
- **Integrating the knowledge of scientific explanations and the practices** needed to engage in scientific inquiry and engineering design

KNOWLEDGE AND PRACTICE MUST BE INTERTWINED IN LEARNING EXPERIENCES

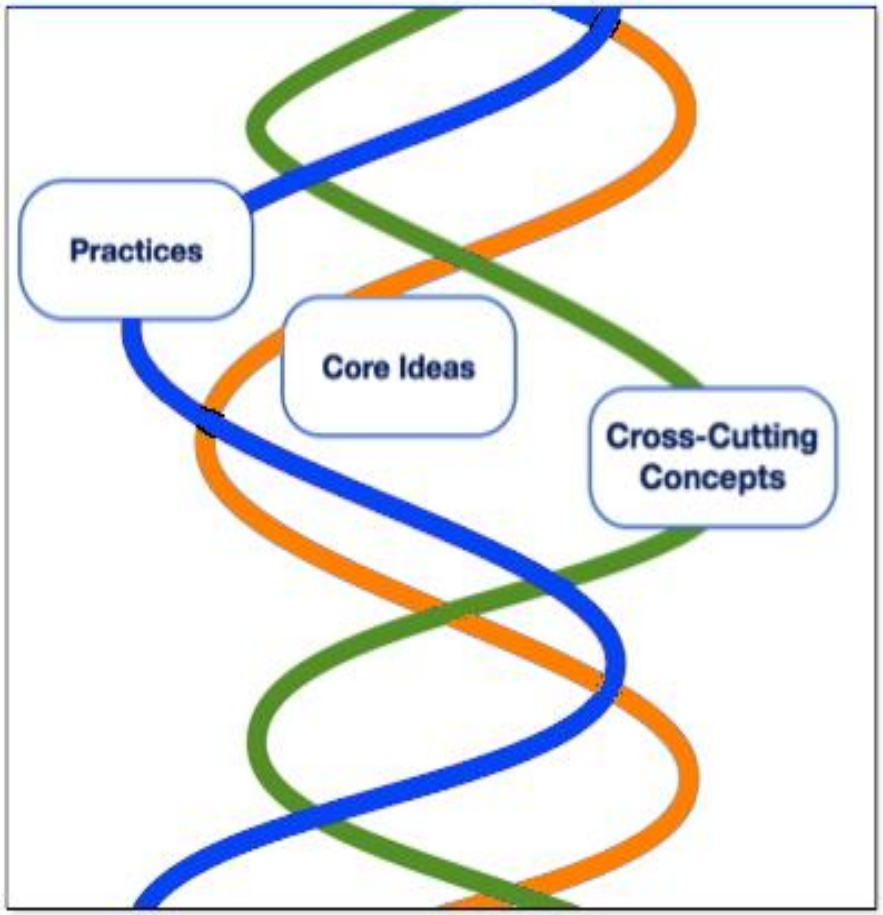
Scientific and Engineering Practices

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Developing explanations and designing solutions
- Engaging in argument
- Obtaining, evaluating, and communicating information

Crosscutting Concepts

- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change

NGSS Architecture



- The NGSS are written as Performance Expectations
- NGSS require contextual application of the three dimensions by students.
- Focus is on how and why as well as what

Shift to Science Practices

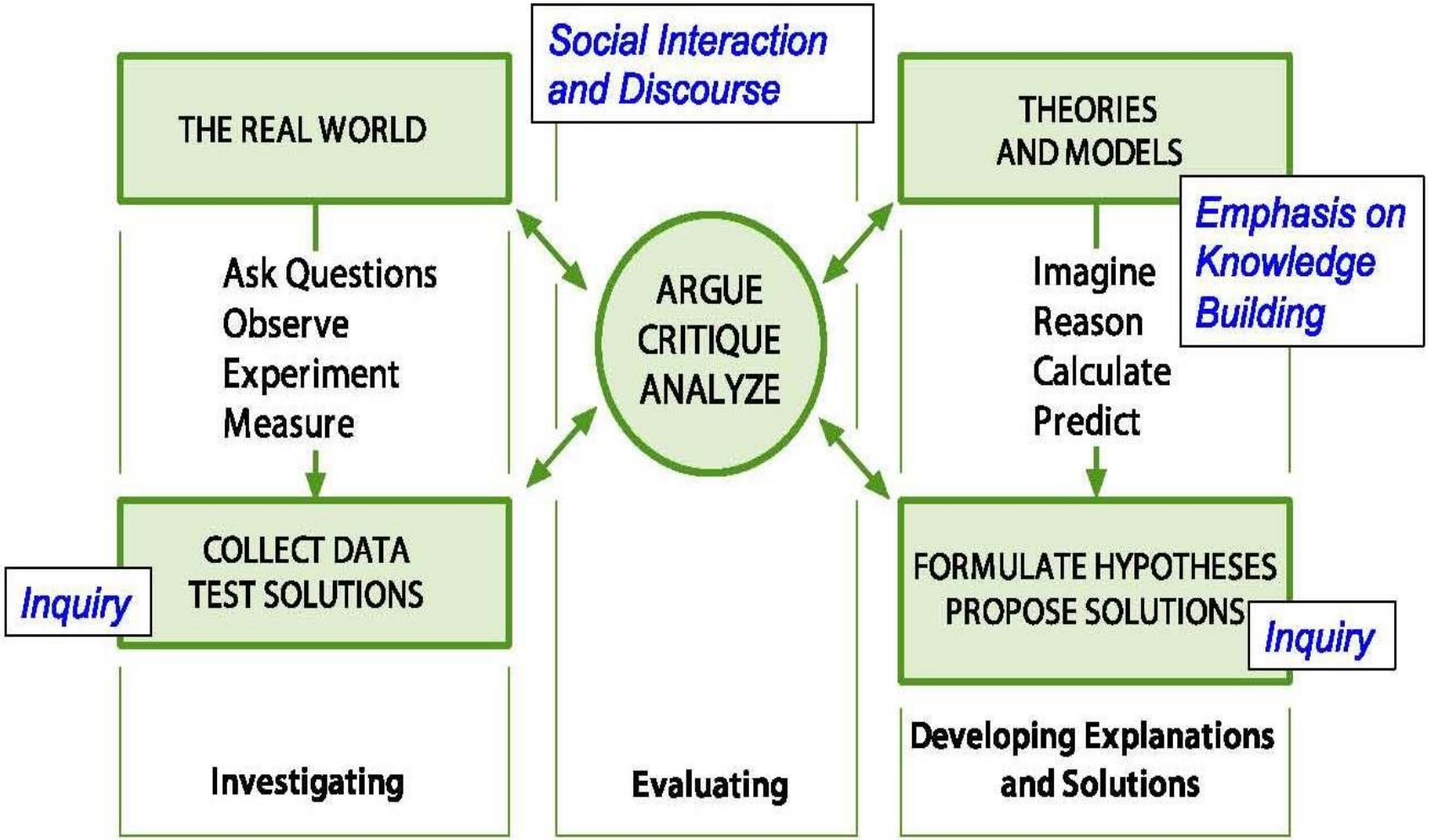


Figure 1. The shift from inquiry to science and engineering practices.
Adapted from A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, *by the National Research Council, 2012, Figure 3-1, Washington, DC: National Academies Press.*

NGSS, CCSS, Equity, STEM

NGSS Alignment with CCSS is Critical

- nstahosted.org/pdfs/ngss/PracticesVennDiagram.pdf

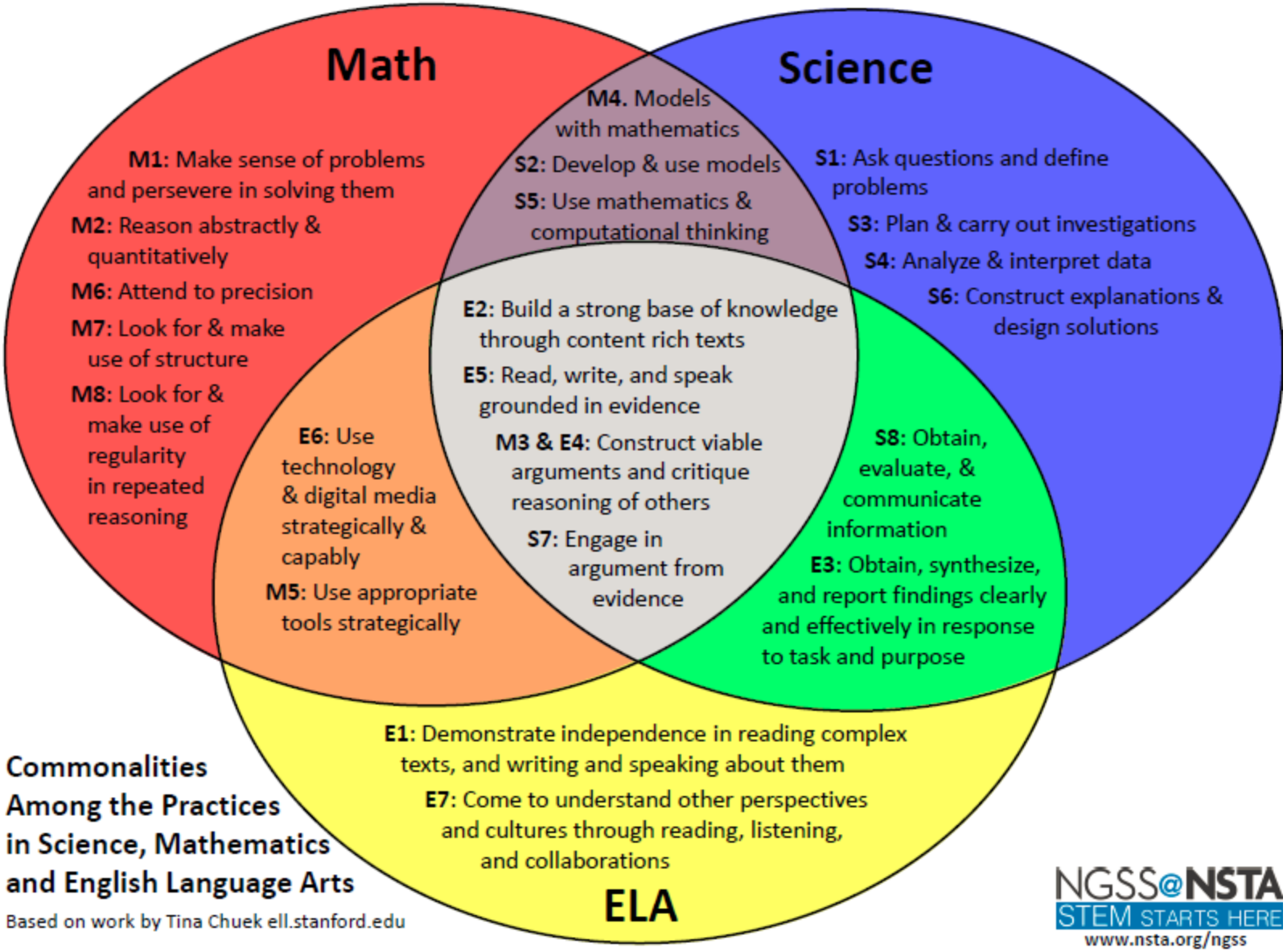
Focus on Equity

- NGSS Appendix D and Case Studies

STEM Education

- STEM is Interconnected
- Incorporates Standards
- Prepares Students for College, Careers, and Citizenship

Connections



Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Chuek ell.stanford.edu

NGSS@NSTA
STEM STARTS HERE
www.nsta.org/ngss

Practices

Practices in Mathematics, Science, and English Language Arts*		
Math	**Science**	**English Language Arts**
M1. Make sense of problems and persevere in solving them.	**S1.** Asking questions (for science) and defining problems (for engineering).	**E1.** They demonstrate independence.
M2. Reason abstractly and quantitatively.	**S2.** Developing and using models.	**E2.** They build strong content knowledge.
M3. Construct viable arguments and critique the reasoning of others.	**S3.** Planning and carrying out investigations.	**E3.** They respond to the varying demands of audience, task, purpose, and discipline.
M4. Model with mathematics.	**S4.** Analyzing and interpreting data.	**E4.** They comprehend as well as critique.
M5. Use appropriate tools strategically.	**S5.** Using mathematics, information and computer technology, and computational thinking.	**E5.** They value evidence.
M6. Attend to precision.	**S6.** Constructing explanations (for science) and designing solutions (for engineering).	**E6.** They use technology and digital media strategically and capably.
M7. Look for and make use of structure.	**S7.** Engaging in argument from evidence.	**E7.** They come to understanding other perspectives and cultures.
M8. Look for and express regularity in repeated reasoning.	**S8.** Obtaining, evaluating, and communicating information.	

* The Common Core English Language Arts uses the term "student capacities" rather than the term "practices" used in Common Core Mathematics and the Next Generation Science Standards.

NGSS@NSTA
STEM STARTS HERE

Professional Development

- Work with Colleagues
- Engage with Content and Practice
- Develop High Quality Instruction
- Use Formative Assessment to Gauge Student Thinking
- Examine Student Work for Evidence
- Apply Instructional Strategies that Support Student Learning in their Classroom
- Discuss and Refine

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What Professional Development Strategies are Needed for Successful Implementation of the Next Generation Science Standards? Brian J. Reiser, K-12 Center at ETS, 2013.

Oregon "Points of Light"

- MSP High Quality PD and Partnerships
  - www.ode.state.or.us/search/page/?id=1739
  - http://orcostemed.webs.com/apps/blog/
  - klcc.org/post/lincoln-county-schools-bring-ocean-1
- Regional STEM Hubs
- Funding for STEM Education
- Pockets of Excellence
  - How do we identify and share/spread these?

Recommendations

- Time for Science Instruction at Every Grade
- High Quality Effective Professional Development for Teachers and Administrators
- Time for Teachers to Collaborate in Professional Learning Teams
- High Quality Facilities, Equipment, Instructional Materials for All Students
- Engage STEM Professionals and Local Community with PK-12
- Identify “Points of Light” and Spread Statewide
- Align Policies to Support the Vision of High Quality STEM Teaching and Learning

Discussion

What are we doing to support the recommendations identified in these research reports?

What is needed to fully address the recommendations?

Questions?

Thank you!

OREGON DEPARTMENT OF EDUCATION

Highlights Report

A Study of K–12 Mathematics and Science Education in the United States

May 2003

Horizon Research, Inc.
326 Cloister Court
Chapel Hill, NC 27514

www.horizon-research.com

Iris R. Weiss
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Highlights Report, Looking Inside the Classroom: A Study of K–12 Mathematics and Science Education in the United States was prepared with support from the National Science Foundation under grant number REC-9910967. These writings do not necessarily reflect the views of the National Science Foundation.

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- Ensuring Access for All Students 6
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- Helping Student Make Sense of the Mathematics/Science Content 8

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Acknowledgements

The *Inside the Classroom* project was coordinated by Horizon Research, Inc. (HRI) of Chapel Hill, North Carolina with support from the National Science Foundation (NSF). Mark St. John and his colleagues at Inverness Research Associates contributed to the early conceptualization of the project. In addition, Conrad Katzenmeyer of NSF's Division of Research, Evaluation, and Communication provided valuable advice as Program Officer for this study. Iris R. Weiss, President of HRI, served as Principal Investigator, assisted by Eric R. Banilower, Daniel J. Heck, Joan D. Pasley and P. Sean Smith. Alison Bowes, Anita Bowman, Lacey Dean, Brent Ford, Sherri Fulp, Alison Gerry, Susan Hudson, Kelly McMahon, Christina Overstreet, Alyson Paszek, Sheila Richmond, Shireline Scoggins, Dawayne Whittington, and Kimberley Wood also contributed to this report.

Classroom visits were conducted by Eric Banilower, Anita Bowman, Diane Burnett, Beatriz D'Ambrosio, Rebecca Dotterer, Nancy Drickey, Judith Edgington, John Flaherty, Sherri Fulp, Susan Gracia, Daniel Heck, David Holdzkom, Elizabeth Horsch, Michael Howard, Thomas Hughes, Mary Ann Huntley, Loretta Kelly, Julie Klasen, Arlene Mitchel, Heather Mitchell, Edward Mooney, Patricia Moyer-Packenham, Michael Oliver, Joan Pasley, Claire Passantino, Ben Saylor, Sean Smith, Claudia Templeton, Ruth Von Blum, Dawayne Whittington, and Kimberley Wood.

Special thanks to the on-site coordinators and to the many teachers throughout the United States who allowed us to observe their classrooms and took time from their busy schedules to be interviewed.

Introduction

The need for information on the nature and quality of K–12 mathematics and science lessons is particularly acute given the current emphasis on reform. The *Inside the Classroom* study was designed to provide snapshots of what transpires inside the nation's mathematics and science classrooms and the factors that shape that instruction. A more detailed description of the study design and results is included in the full report at www.horizon-research.com/public.htm

Lesson Ratings

Horizon Research, Inc. staff and consultants observed a total of 364 mathematics and science lessons using a structured observation protocol. Each lesson was rated on four components: the lesson design, lesson implementation, mathematics/science content addressed, and classroom culture. Observers rated several indicators within each component area, and then provided an overall "capsule" rating of the lesson, along with a detailed rationale for that rating. The scale observers used to provide an overall assessment of the quality and likely impact of the lessons is divided into the following categories:

Level 1: Ineffective instruction
- a. "passive learning"
- b. "activity for activity's sake"

Level 2: Elements of effective instruction
Level 3: Beginning stages of effective instruction (low, solid, high)
Level 4: Accomplished, effective instruction
Level 5: Exemplary instruction

Detailed descriptions of these levels can be found in the *Inside the Classroom* Observation and Analytic Protocol in Appendix A of the full report. Lessons are broadly categorized in this report as low in quality (1a, 1b, 2); medium in quality (low 3, solid 3), and high in quality (high 3, 4, 5). Based on observers' judgments, only 15 percent of K–12 mathematics and science lessons in the United States would be considered high in quality, 27 percent medium in quality, and 59 percent low in quality. (See Figure 1.) Descriptions of lessons at each of these levels can be found in the appendix to the full report.

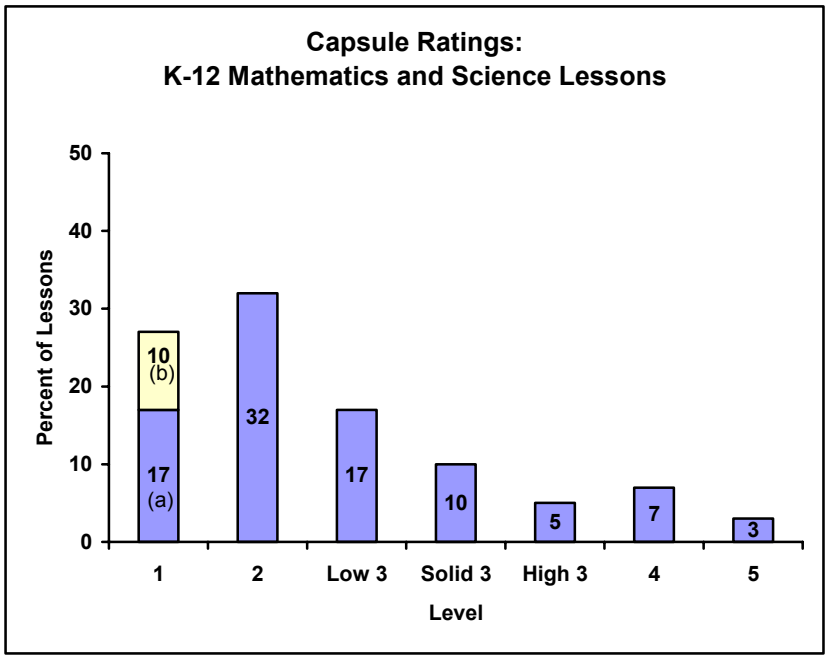

Figure 1

Lessons judged to be low in quality are unlikely to enhance students' understanding of important mathematics/science content or the ability to engage successfully in the processes of science or mathematics. At the other end of the scale, high quality lessons are structured and implemented in a manner which engages students with important mathematics/science concepts; these lessons are very likely to enhance student understanding of these concepts and to develop their capacity to do mathematics/science successfully.

Inside the Classroom observations suggest that mathematics and science lessons in the United States are relatively strong in a number of areas. For instance, a majority of lessons:

- Incorporate content that is both significant and worthwhile;
- Have teachers who appear confident in their ability to teach mathematics and science; and
- Have teachers who provide accurate content information.

At the other end of the spectrum, fewer than 1 in 5 mathematics and science lessons:

- Are strong in intellectual rigor;
- Include teacher questioning that is likely to enhance student conceptual understanding; and
- Provide sense-making appropriate for the needs of the students and the purposes of the lesson.

Strengths and Weaknesses of Mathematics and Science Lessons

Researchers saw some terrific lessons—classrooms where the students were fully and purposefully engaged in deepening their understanding of important mathematics and science concepts. Some of these lessons were "traditional" in nature, including lectures and worksheets; others were "reform" in nature, involving students in more open inquiries. Observers saw other lessons, some traditional and some reform-oriented, that were far lower in quality, where learning mathematics/science would have been difficult, if not impossible. In an effort to determine which characteristics were most important in determining quality, the authors did an in-depth analysis of lesson descriptions for lessons judged very effective and decidedly ineffective. The factors that seem to distinguish effective lessons from ineffective ones are their ability to:

- Engage students with the mathematics/science content;
- Create an environment conducive to learning;
- Ensure access for all students;
- Use questioning to monitor and promote understanding; and
- Help students make sense of the mathematics/science content.

➢ Engaging Students with the Mathematics/Science Content

One of the most important aspects of effective mathematics and science lessons is content that is both significant and worthwhile, and the majority of lessons do, in fact, include such content. However important content is not enough; high quality lessons invite students to interact purposefully with the content, and represent science and mathematics as dynamic bodies of knowledge generated and enriched by investigation. The following descriptions illustrate how lessons either effectively address, or fail to address, the need to engage students intellectually with the mathematics/science content.

Intellectual Engagement
20 Percent of Lessons

The teacher began an elementary mathematics lesson with a review of the terms for solid geometric shapes. She then asked the class to find a number of shapes. For example: "I spy a shape that has six faces, eight corners, and twelve edges. What solid is it? Can you find an example in the room?" Said the observer: "The children eagerly participated in the game, and had surprisingly little trouble recognizing a rectangular prism, just from the teacher's verbal description."

As a lesson on the skeletal system started, a life size skeleton, named Mr. Bones, was introduced to the 5th grade class. The teacher talked about specific bones of the body, frequently capturing students' attention by telling stories and personal experiences: her husband's broken collar bone, actor Christopher Reeves' spinal cord injury, and her father's arthritis; students shared similar stories about the mailman with carpal tunnel syndrome and a mom with TMJ.

The teacher in a human anatomy and physiology class began a lecture by drawing a diagram of a nerve receptor, connected by a nerve fiber to (eventually) the brain. He explained the concept of a threshold for a receptor, noting that stimuli could be either sub-threshold, threshold, or super-threshold, stressing that only after the threshold is reached does the receptor respond to the stimulus and send a signal to the brain. Using the hand as the point of reference, the teacher differentiated among different stimuli—touch, pressure, poke, punch, hammer, excruciating pain. He gave the example of an instance where if "punch" receptors were stimulated, the brain would not register "touch", only "punch." The students were intrigued with the notion, asking if it worked that way with taste, hearing, and sight.

Lack of Intellectual Engagement
55 Percent of Lessons

For 30 minutes the teacher directed the students in a 1st grade class to complete a test preparation worksheet. The class then went over the answers. The observer noted that "the pace was monotonous and seemed to lose students' attention."

An 8th grade science lesson was designed to give the students a great deal of factual information on Newton's Third Law of Motion. The students copied notes from the blackboard for half of the lesson, and the next half of the lesson was spent with the teacher asking them to recall information from the notes. The observer wrote: "The lesson was designed in a way that allowed the students to be very passive, interacting little with each other or the content. The students spent a great deal of time hurriedly copying the notes; only those students who were called on by the teacher during the review time were required to think about the content, and even that was at the basic level of recalling facts they had just written down."

In a 9th grade teacher's efforts to help his students better understand how to solve equations and inequalities, he asked them to remember and repeat the procedures he had demonstrated in the beginning of the class. The teacher's presentation of the content included questions and comments such as, "There's the variable, what's the opposite?" and "Tell me the steps to do." He did very little to engage students with the content; two students slept through the teacher's entire presentation, and one read a magazine. Other students contributed very little, spending most of the time asking about the particulars of the upcoming assignment.

➢ Creating an Environment Conducive to Learning

A classroom that is both respectful and rigorous is essential in order for students to have an opportunity to learn. In many classrooms, a climate of respect for students' ideas, questions, and contributions prevails, with 45 percent of lessons nationally receiving high ratings on this indicator. Ratings for rigor are much lower, with only 14 percent of lessons nationally having a climate of intellectual rigor, including constructive criticism and the challenging of ideas.

In only 13 percent of lessons is the classroom culture rated as highly respectful and at the same time highly rigorous, encouraging the students to engage in serious learning. The following examples illustrate highly respectful and highly rigorous lessons, as well as lessons that are lacking in respect, in some cases even hostile and demeaning to students; nearly all of these are also very low in rigor. Many other lessons are "cordial" and "pleasant", but lack intellectual rigor.

High Respect, High Rigor
13 Percent of Lessons

An observer described the classroom culture in a 3rd grade mathematics class as "phenomenal," noting that "at any given point there was an extraordinary amount of excitement, and the content was new and rigorously-taught for this bunch of students." During the introductory discussion, the teacher allowed students the opportunity to challenge one another's answers by asking questions such as "Is this correct?" and "Does anyone have a different idea?" After the discussion, the students worked in pairs on plotting. When they had completed the assignment, students came up and placed pictures on the overhead version of the grid and the teacher encouraged other pairs to comment on the correctness of the placement. The observer noted that, "The teacher and students were respectful of each other's thoughts. Discussions were lively and included multiple students' perspectives."

The researcher reported that all of the students in a high school biology class were involved throughout the lesson, and it was clear that all of them were expected to contribute. "The students worked together in groups, discussing and challenging each other's ideas. The teacher also challenged students to back up their ideas with evidence from the lab (e.g., 'How do you know?' and 'What happened [when you tested it]?'). The classroom atmosphere was rigorous, but friendly."

Low Respect, Low Rigor
26 Percent of Lessons

The researcher reported that she had never seen a class with a poorer classroom culture than this 3rd grade class. "The teacher's main classroom management strategy was to chastise the class repeatedly, 'pockets on your seat, eyes up, lips zipped.' She allocated 'points' for each table behaving as she had requested, and recorded these table points on the board….To ensure that the students were able to follow the instructions, she called on individual students to repeat each instruction as it was given. For example, 'While I am handing out the construction paper, please finish writing. When you get the construction paper, write your name on one side; that will be the back… Where do you need to write your name?' She would then call on individual students, and each one would parrot, 'on the back.'

The observer of a 9th grade Pre-Algebra class reported that comments like "Stop talking," "Settle down," and "Am I disturbing you or something?" were used to interact with students throughout the lesson. "The teacher focused less on participation and more on control….There was no rigor and no opportunities for trying to talk about or make sense of any ideas. …The teacher did not seem to trust the students to do the computations in their heads—at four times during the lesson he told them to use the calculators and not to trust their own thinking."

➢ Ensuring Access for All Students

A critical aspect of the teacher's role is to ensure that students are in fact accessing the mathematics/science content, and that no students are slipping between the cracks. Researchers rated the extent to which observed lessons encouraged active participation of all students. They described cases where some students were "left out" of the lesson, as well as cases where the teacher was particularly successful at engaging learners with differing needs.

Across the nation, 29 percent of lessons would be rated low in terms of encouraging active participation of all students. The following are examples of lessons from both ends of the spectrum, where teachers adjusted, or failed to adjust, their instruction for the differing needs of the students.[1]

Access for All Students
47 Percent of Lessons

A researcher indicated that a student in a 2nd grade class was hearing-impaired and wore a special amplification device. The teacher had a microphone/transmitter around her neck, which beamed her voice to the hearing device. Said the observer, "the student participated in the lesson to the same extent as all the others, including being asked the same level of questions by the teacher."

A 3rd grade teacher altered her lesson plan to accommodate the varying levels of her students. She required that all students depict what they had observed in the experiment that they had conducted during the class. The more able students could do this in a six part step-by-step description, with pictures, of the experiment. Other children, who had more difficulty with writing, were allowed to express their understanding through a cartoon or other drawing.

An observer reported that "two non-English speaking students were included fully [in a middle school science lesson], using specially translated notes, translation tools, and lots of contact with the teacher and other members of their group. These students contributed to the making of observations, recording of information, and identification of the rock samples."

Lack of Access for Some Students
29 Percent of Lessons

An observer reported that this 7th grade science teacher "had students she liked and students she didn't like…One boy and one girl were particular favorites. The sole African American boy was treated differently and badly. Any answers he suggested were dismissed with a strong 'No.' even when they were much closer to the correct answer than the suggestions of white students in the class."

A teacher noted that the students in his 7th grade mathematics class varied widely in ability levels, with some students "who can retain information at jet speed" and other students who are "very low functioning." The observer noted that the teacher "made no adjustments in instruction to accommodate the diverse needs of his students. This lesson was designed as a 'one size fits all lesson' without attention to students' levels of mathematics development."

Another observer noted that although the teacher had identified a few students in a high school science class as special education students, "no effort could be observed during the class to engage them in any way different from the techniques used for the general group."

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[1] It is also important to note that lessons in rural schools and in "majority-minority" classes were rated lower than lessons in other classes on key indicators such as significant and developmentally appropriate content, respect, rigor, intellectual engagement, and sense-making. Lessons in classes where all students were considered by their teachers to be low or middle ability were also rated lower on key indicators than those in classes that included high ability students, whether in homogeneous or heterogeneous groups.

➢ Questioning to Develop Understanding

The kinds of questions teachers ask are key in determining the extent to which lessons are likely to help students learn important mathematics and science concepts. Teachers can use questioning to monitor student understanding of new ideas and to encourage students to think more deeply, however this kind of effective questioning is relatively rare in the nation's mathematics and science classes. More often, we saw questioning that was unlikely to deepen students' understanding, including teachers asking a series of questions too rapidly, and teachers asking questions focused only on a correct answer without checks for fuller understanding. Below are examples of lessons from both ends of the spectrum -- those that included effective questioning, and those that were lacking in this regard.

High-Level Questioning
16 Percent of Lessons

The observer reported that an 8th grade mathematics class was a very nice illustration of an interactive lecture, where the instructor asked for examples and justifications from the students as a means of assessing their understanding. "For example, when generating examples of tessellations around the room one student proposed the border of the bulletin board that was made of circles.

Student: 'How about the border?'
Students: 'No… that won't work.' (several students talk at once and reject this contribution)
Teacher: 'Why won't it work? Can the circle ever work?'

The discussion became focused on why the circle did not create a pattern that fit the definition of a tessellation. While the student who suggested the circle had been focusing more on patterns, the disagreement helped him redirect his analysis back to the definition of tessellations presented earlier."

As the students in a 10th grade science class were examining the results of their experiment, the teacher asked questions that pushed them to examine their results further and to provide evidence for their conclusions. Examples of questions asked by the teacher are: "How could we test if there is still sugar in the reservoir?" "Why didn't it [the iodine indicator] reach equilibrium?" and "How do you know?"

Inadequate Questioning
66 Percent of Lessons

Said the observer of a Kindergarten science lesson, "The teacher's questioning was fast-paced and primarily low level." For example:

Teacher: "Do leaves all look the same? What is different about them?"
Student: "Veins."
Teacher: "What else?"
Students: "Shape."
Teacher: "What do some trees have and others don't?"
After a few incorrect guesses, a student said, "Pine cones."
Teacher: "What else?"
Student: "Fruit."

The researcher reported that the teacher's questions in a 6th grade mathematics lesson were low-level, "micro-questions." "As she worked the long division problem 4,879,000 divided by 0.39 on the board, she called on students, by name, to give her each number to write down. When the 'brought down part' was 99 and a student had told her that 39 would go into 99 two times and another student had told her that 39 times 2 is 78 (which she wrote down), she asked a third student, 'What is 9 minus 8?' The student answered, '21' (i.e., she did the complete subtraction, 99 minus 78). The teacher responded, '9 minus 8 is 21? You know that's not right!' When the student said, 'I just did the whole thing,' the teacher responded, 'you should answer the question that I ask—what is 9 minus 8?'"

➢ Helping Students Make Sense of the Mathematics/Science Content

A teacher's effectiveness in providing explanations at appropriate junctures as the lesson unfolds often determines students' opportunities to learn. It is important that lessons engage students in doing the intellectual work, with the teacher helping to ensure that they are, in fact, making sense of the key concepts being addressed. Although researchers observed some lessons where students were helped to make sense of the content and see connections among mathematics/science ideas, overall, most lessons lack adequate sense-making. Only 16 percent of lessons in the nation would receive high ratings in this area. Below are examples of lessons that emphasized sense-making and those that were unlikely to help students make sense of the mathematics/science content.

Appropriate Sense-Making
16 Percent of Lessons

The purpose of a 2nd grade mathematics lesson was to allow students to demonstrate understanding of place value—ones, tens, and hundreds, and to practice with thousands place. The lesson emphasized numbers containing a zero, since this was something students found difficult. As the class worked on the various tasks, students would look at each group's response and indicate their agreement with thumbs up or down. The teacher encouraged students to question each other if there was an answer they didn't understand or didn't agree with. If a group did not represent the number correctly, the teacher would probe with questions to see if they could identify their error. She also asked students to respond to discrepancies that appeared among the groups' solutions. During wrap-up at the end of the lesson, the teacher emphasized, "When we write numbers, the digits have to be in the right spot. Remember that the zeros are important, too."

Students in a high school chemistry class had been working on properties of compounds and elements. The observed lesson built upon that knowledge, focusing on compound formation. There were three main components to the lesson: (1) a quick review of the previous lesson's concepts; (2) a lecture/discussion on the new material; and (3) a question/answer review of the new material. The lesson included time for sense-making during the lecture portion of the class (the teacher asked questions throughout to ensure comprehension), and a wrap up question/answer segment at the end.

Inadequate Sense-Making
66 Percent of Lessons

The teacher guided a 3rd grade class through the completion of a science worksheet by telling them to turn to specific pages in their textbook and look for the answers. She asked one student to read an answer from the book, then wrote it on an overhead transparency copy of their worksheet. The observer reported the following conversation as an example:

Teacher: "Let's look at lesson two. Turn to page E16. Fill in the blank. Look on the page. Matter is made of…what?"
Student 1: "Atoms."
Teacher: "Adding heat changes a solid to a what?"
Student 2: "Liquid."
Teacher: "Good. Now read number three."

At the completion of the worksheet, the teacher then went over the questions and answers to summarize the content in the lesson. The students were instructed to keep their worksheets for the next lesson.

The student in this Algebra class who put the equation $6x + 7 = -14y$ into standard form on the board explained that she first subtracted 6x from both sides getting $7 = -14y - 6x$, which in standard form is: $-6x - 14y = 7$. Some students seemed confused, and asked the teacher if that was right. The teacher said it was, then solved it a different way, by first moving the y-term, getting the answer $6x + 14y = -7$. As she began solving it this way, some students seemed fixed on first moving the 6x—they didn't understand that either way was correct. The teacher concluded "So you can have two different answers." The observer noted that the teacher never mentioned that these two answers are mathematically equivalent.

Major Influences on Content and Instruction

The previous section provided snapshots of lessons in K–12 mathematics and science classes throughout the United States. This chapter examines some of the reasons the lessons were designed as they were.

In planning mathematics and science lessons, teachers are influenced by a multitude of factors that work together to impact what content is taught, how it is taught, and the materials selected to engage students with the content. These factors may include curriculum standards/frameworks; accountability systems; teachers' familiarity with specific content and pedagogy; teacher perceptions of the needs of the students; and teacher perceptions of the views of the principal, parents, and other key stakeholders.

Following the *Inside the Classroom* observations, extended interviews were conducted with teachers to determine what led them to select the content in the lesson, and why they chose the pedagogy and the materials used in the lesson. The ultimate goal of the interviews was to determine which factors have the greatest influence on the design of the lessons students experience each day in mathematics and science instruction in the United States. The factors that were determined to be most important in selection of either content, instructional strategies, or both, are shown in Figure 2.

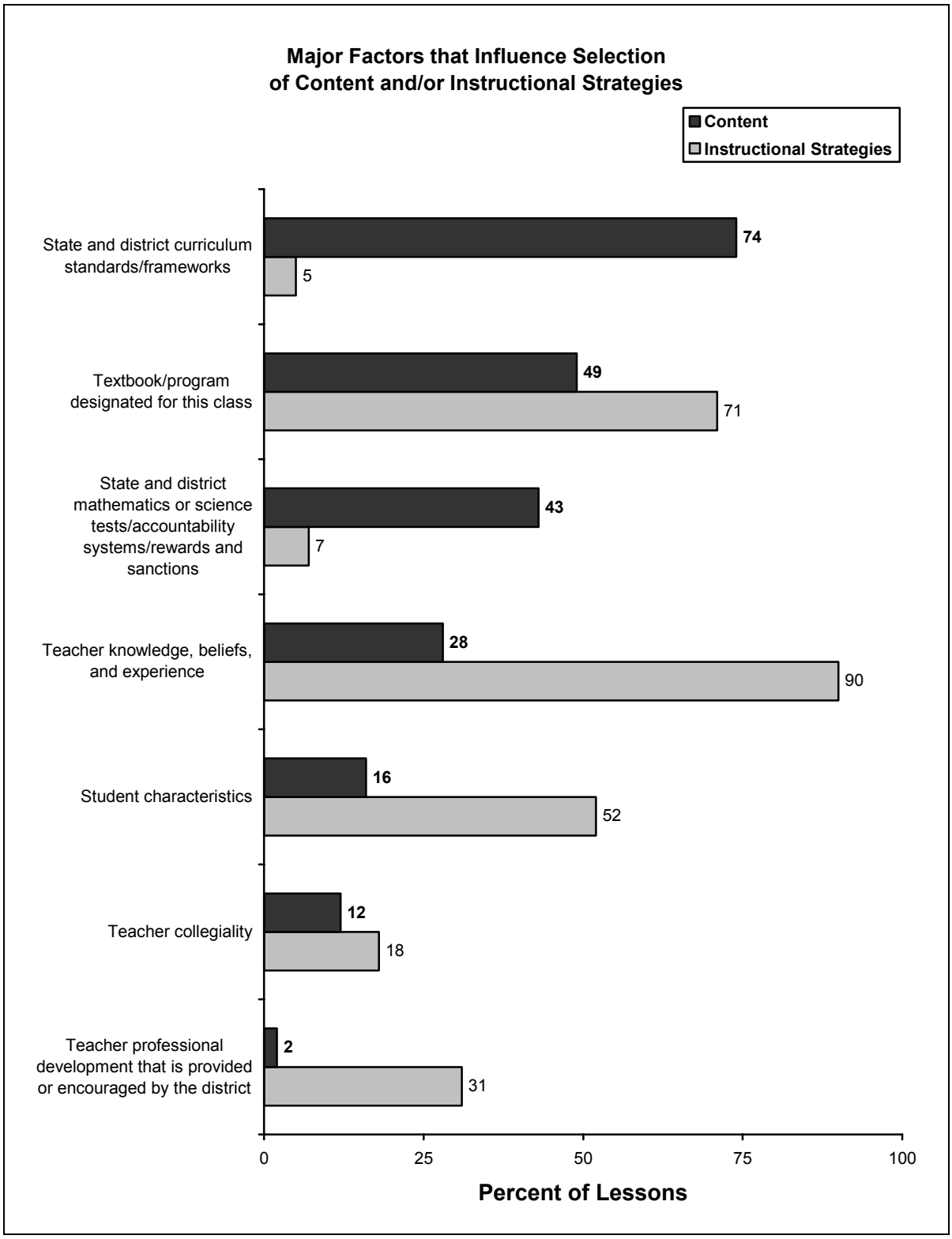

Major Factors that Influence Selection
of Content and/or Instructional Strategies
Content
Instructional Strategies
State and district curriculum standards/frameworks
74
5
Textbook/program designated for this class
49
71
State and district mathematics or science tests/accountability systems/rewards and sanctions
43
7
Teacher knowledge, beliefs, and experience
28
90
Student characteristics
16
52
Teacher collegiality
12
18
Teacher professional development that is provided or encouraged by the district
2
31
0
25
50
75
100
Percent of Lessons

Figure 2

- **Selection of Mathematics/Science Content**

The most frequently cited influences on lesson content are state/district curriculum standards, followed by the textbook/program designated for the class, and then state/district accountability systems.

Influence of Curriculum Standards
State and district curriculum standards have a substantial influence on the selection of content, providing teachers a road map for what to teach in roughly 3 out of 4 mathematics/science lessons nationally.

> *[The state's course of study is] very important because we align everything and, therefore, you're always conscious of the state requirements, and once you align everything, you know that you're going in the right direction and the children are getting everything that they pretty much need during the course of the year.* (3rd grade mathematics teacher)

> *As far as the state, we are teaching to the curriculum. If it says we have to teach it in the 7th grade, you teach it. There's a set of goals; there's a set of objectives, and you teach it…We are driven by the state objectives…You teach to the objectives.* (7th grade mathematics teacher)

> *In other words, the state standards will determine what chapters we teach and don't teach.* (High Schools Honors Chemistry teacher)

Influence of Textbook/Curriculum Programs
After state and district standards, the next most common influence on content appears to be textbook/curriculum programs, typically selected at the district level, with 1 in 2 teachers nationally reporting that the textbook has an influence on the content they select for their lessons.

> *That's exactly where we are…as far as chapter-wise…because I pretty much go in order, or in the sequence of the book, because it's pretty much a good order for the kids to learn the concepts.* (Kindergarten mathematics teacher)

> *[The fact that the topic was in the designated text] was an important factor. Sometimes I may pull a resource to enhance, to add to it, but I really do try to go with the topics in the book.* (8th grade science teacher)

I looked through the book, and I think the progression of the book is sound. So, quite frankly, I'm just following the progression of the book to an ultimate final exam. (High School Geometry teacher)

Influence of Accountability Systems

The content selection for nearly 1 in 2 lessons nationally is influenced by an accountability system related to student achievement.

We are teaching right to that [state assessment] and that's not how I prefer to do it, but it's the way we are geared right now. (4th grade science teacher)

I definitely wouldn't be doing that unit if it weren't for the benchmark test coming up. (8th grade Pre-Algebra teacher)

I don't like to be driven by a test, but it was important. I feel compelled to teach it if they're going to be tested on it, because I don't want them to get on the test and say "I don't know this; what in the world is this?" I think that would be the worst disservice I could do them. (8th grade science teacher)

- **Selection of Instructional Strategies**

A sense of autonomy in choosing how to implement lessons is reflected in teachers' identification of factors that have the greatest influence on their selection of pedagogy. The factors examined in this study that appear to have the greatest influence on instructional strategies are the teachers' background, knowledge, and experience, and their beliefs—about the subject, about effective pedagogy, and about their students.

Influence of Teacher Knowledge, Beliefs, and Experience

In marked contrast to the "external" influences on lesson content, teachers have a great deal of latitude in choosing the instructional strategies to use in helping students learn the mathematics/science content. Teachers' background, knowledge, and experience influence the selection of instructional strategies in 9 out of 10 mathematics/science lessons.

What I tell my students is the way that I'm teaching them is the way that someone taught me. The strategies that I use I picked up from teachers that [taught me]. I didn't get them from my college instructors. I didn't get them from observing or anything like that. The way that I teach is because a teacher that I had one time or another taught me that way. The way that they taught me; I learned that way. I'll teach them [that way] because I think they will learn it. I'm the type of person that I have to do something to learn it. You tell me something, you explain something to me, I'll ask you to explain it to me again several times. So I have to do it. I have to actually do it to learn it. (4th grade science teacher)

I went to the university and they had a constructivist model…We were given lessons and information on discovery and inquiry. So I'm real comfortable with it. It makes a lot of sense to me. (7th grade mathematics teacher)

I remember my math teacher when I was in school…I still remember the way she taught certain topics…I emulate what she did. (9th grade Pre-Algebra teacher)

Actually, just trial and error over the years. Trying to get a feel for what works and what does not work. Like I try to tell my students, you can't always be in the lab, you can't always look at the weather, you can't always be outside. I can do what I can in the room, but you have to have lecture. There is some degree of lecture. (10th grade Biology teacher)

Influence of Textbooks/Curriculum Programs

Textbooks are second only to teachers' knowledge, experiences, and beliefs in the frequency of influence on instruction. The majority of teachers (71 percent nationally) rely to some extent on the textbook/curriculum program designated for use in their class in making decisions on how to teach.

I used the book exactly as it is laid out, because it had everything I needed for this topic. (3rd grade science teacher)

I like just about everything about it [the mathematics program]. I follow the format of the book. (6th grade mathematics teacher)

I must admit I think that the class is very textbook-oriented. I trust the judgment of textbook writers and textbook selectors to pick out a curriculum within that textbook that's going to be okay…That book has been used for 5–6 years. I'm pretty happy with it. (High School Pre-Calculus teacher)

Influence of Student Characteristics

Teachers often consider the ability levels of the students and their behavior when deciding on instructional strategies. In addition, proficiency with the English language and student absenteeism influence teachers' selection of instructional strategies.

Behavior is not a strong point for most of the groups across the [City] School System at this time. So I try to find lessons that will keep them calm. Usually nothing that will harm anyone. So I try to come up with a safe lesson. (5th grade science teacher)

I think because I really like this class that I do more hands-on…My other classes weren't allowed out of their seats. (7th grade science teacher)

This group is a lot slower than others. They need to see everything. I have some kids in the other class who can write down what I say. Here, I make sure I have my overheads ready. [Instruction is] stretched out a little bit more and includes a lot more repetition. They need to see everything. (9th grade Physical Science teacher)

Most of them are very self-motivated and we just kind of cut to the chase. We present the material. And if they have a particular problem, we may try to change the approach just a little bit to better the understanding, but it is going to be mostly lecture and examples and question and answer-type stuff. (12th grade AP Calculus teacher)

Implications

Observations conducted for the *Inside the Classroom* study suggest that the nation is very far from the ideal of providing high quality mathematics and science education for all students. The study findings, both the lesson snapshots and teacher reports on what influenced their lesson designs, have implications for the preparation and continuing education of the mathematics/ science teaching force, and for other support provided to teachers.

Teachers need a vision of effective instruction to guide the design and implementation of their lessons. Findings from this study suggest that rather than advocating one type of pedagogy over another, the vision of high quality instruction should emphasize the need for important and developmentally-appropriate mathematics/science learning goals; instructional activities that engage students with the mathematics/science content; a learning environment that is simultaneously supportive of, and challenging to, students; and, vitally, attention to appropriate questioning and helping students make sense of the mathematics/science concepts they are studying.

A number of interventions would likely be helpful to teachers in understanding this overall vision, and in improving instructional practice in their particular contexts. First, teachers need opportunities to analyze a variety of lessons in relation to these key elements of high quality instruction, particularly teacher questioning and sense-making focused on conceptual understanding. For example, starting with group discussions of videos of other teachers' practice, and moving toward examining their own practice, lesson study conducted with skilled, knowledgeable facilitators would provide teachers with helpful learning opportunities in this area.

Second, the support materials accompanying textbooks and other student instructional materials need to provide more targeted assistance for teachers—clearly identifying the key learning goals

for each suggested activity; sharing the research on student thinking in each content area; suggesting questions/tasks that teachers can use to monitor student understanding; and outlining the key points to be emphasized in helping students make sense of the mathematics/science concepts.

Third, workshops and other teacher professional development activities need to themselves reflect the elements of high quality instruction, with clear, explicit learning goals; a supportive but challenging learning environment; and means to ensure that teachers are developing understanding. Without question, teachers need to have sufficient knowledge of the mathematics/science content they are responsible for teaching. However, teacher content knowledge is not sufficient preparation for high quality instruction. Based on the *Inside the Classroom* observations, teachers also need expertise in helping students develop an understanding of that content, including knowing how students typically think about particular concepts; how to determine what a particular student or group of students is thinking about those ideas; and how the available instructional materials (and possibly other examples, investigations, and explanations) can be used to help students deepen their understanding.

Fourth, the apparent inequities in quality of instruction need to be further explored, and if confirmed, steps need to be taken to resolve them. It is essential that all students receive high quality instruction, regardless of the location of their schools or the demographic composition of their classes.

Finally, administrators and policymakers need to ensure that teachers are getting a coherent set of messages. Tests that assess the most important knowledge and skills will have a positive influence on instruction, as will providing opportunities and incentives for teachers to deepen their understanding of the mathematics/science content they are expected to teach, and how to teach it. Only if pre-service preparation, K-12 curriculum, student assessment, professional development, and teacher evaluation policies at the state, district, and school levels are aligned with one another, and in support of the same vision of high quality instruction, can we expect to achieve the goal of excellence and equity for all students.

Appendix: Methodology

For the *Inside the Classroom* study, Horizon Research, Inc. (HRI) staff and consultants conducted observations and interviews during the period November 2000–April 2002. The classroom observation instrument originally developed and validated by HRI as part of the core evaluation of the National Science Foundation's Local Systemic Change initiative was adapted for use in this study. An interview protocol was developed to query observed teachers about influences on their instruction.

The study design involved selecting a sample of schools to be representative of all schools in the United States; gaining school cooperation; selecting the sample of classes to be observed; collecting observation and teacher interview data; and weighting and analyzing the data appropriately to provide estimates for mathematics and science lessons in the nation as a whole.

A subset of 40 middle schools was selected from the sample of schools participating in the 2000 National Survey of Science and Mathematics Education. Systematic sampling with implicit stratification was used to ensure that the 40 sites would be as representative of the nation as possible. When a middle school agreed to participate, the study coordinators identified the elementary schools and high schools in the same feeder pattern and randomly sampled one of each. For classroom observations, a simple random sample was drawn from among the mathematics and science teachers in the sampled school. One class each of two mathematics teachers and two science teachers was to be observed in each school.

HRI encountered some resistance in securing cooperation of the sampled sites. When roughly half of the project observations had been completed, the study coordinators inspected the demographic characteristics of the observed sites to confirm that they were representative of schools in the nation. Noting some gaps, HRI drew a new random sub-sample of middle schools from the national survey schools and hand-picked a sub-group of 14 sites that would round out the sample in terms of demographic characteristics.

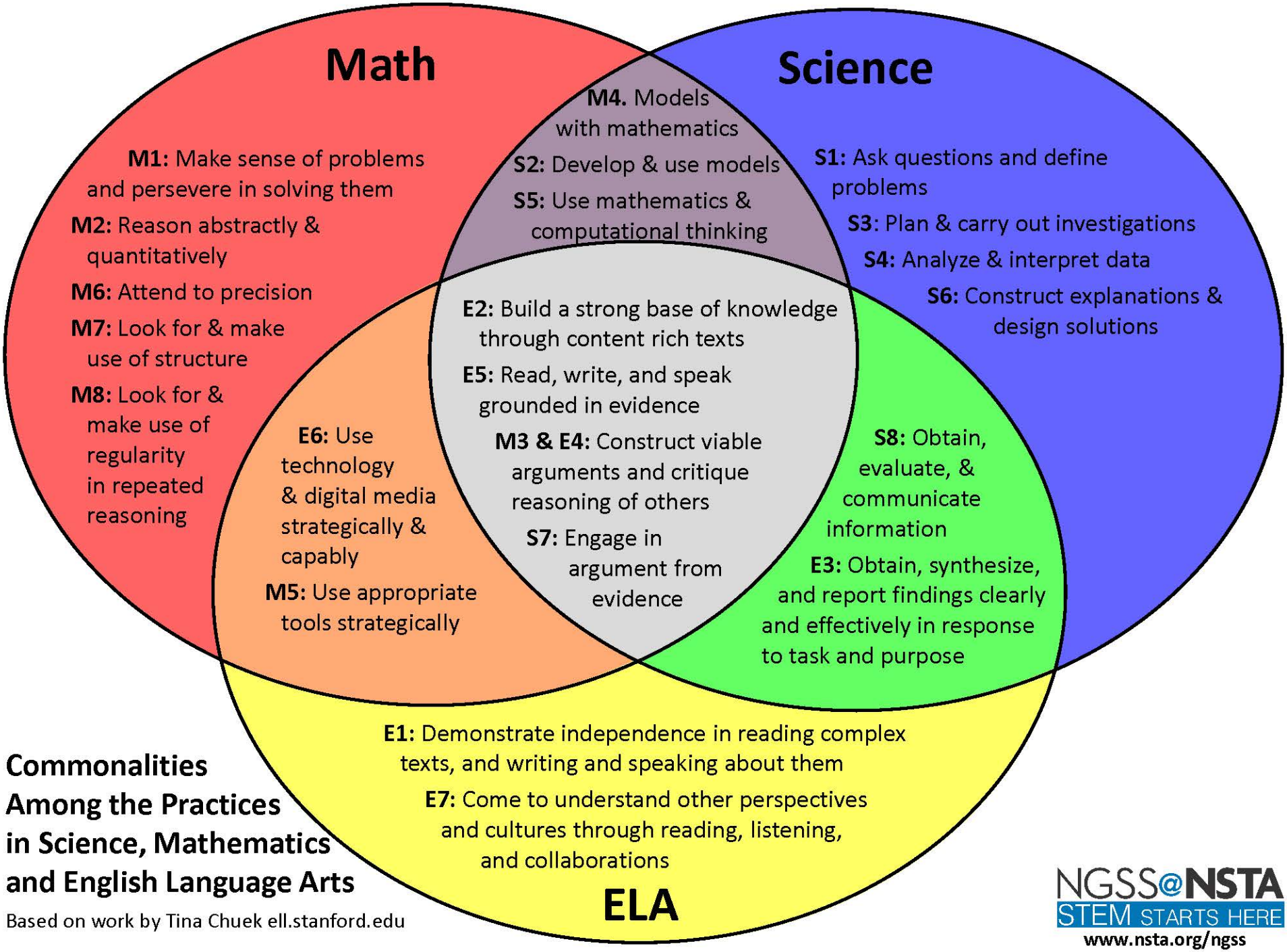
Due to time and resource constraints, HRI ended the observation phase of the study having visited 31 sites. The 31 sites and the sampled schools were representative of districts and schools in the nation. The observed teachers and classrooms were also representative of those in the nation in terms of teacher backgrounds, instructional objectives, and instructional activities.

For the analysis of the qualitative data, the research team read the observers' descriptions of the lesson designs to determine factors that distinguished designs judged to be effective from those judged to be ineffective. The same process was followed for each of the remaining component areas (implementation, mathematics/ science content, and classroom culture) and for the final capsule descriptions of entire lessons. In all cases, there was no predetermined coding scheme; themes were developed as they emerged from the data.

As part of completing the observation protocol, field researchers had analyzed the teacher interview data and noted the factors that teachers said had influenced their selection of content, pedagogy, and instructional materials. The research team analyzed the evidence provided by the

field researchers for each category, looking for themes in the nature of these influences. For example, teachers often talked about how the characteristics of the students in their classes influenced their instructional strategies. Themes within this category included addressing the needs of low ability, high ability, and heterogeneous groups as well as classes with high levels of absenteeism. It should be noted that it was difficult to separate pedagogy and instructional materials in these analyses. In interviews, teachers often discussed these lesson components as intertwined in their planning. Accordingly, pedagogy and instructional materials were combined into "instruction" in the analysis of these data.

Data from the classroom observations and teacher interviews were weighted in order to yield unbiased estimates of all mathematics and science lessons in the nation. Each sampled teacher was assigned to a cell determined by the subject observed (mathematics vs. science), school urbanicity (rural vs. urban vs. suburban), and sample grade range (K–5 vs. 6–8 vs. 9–12). All sampled teachers in a cell were then given the same weight such that the sum of weights of the sampled teachers equaled the number of teachers in the nation in that cell. These weights were multiplied by the average number of science or mathematics classes taught by teachers in the nation. To avoid underestimating the standard errors used in tests of statistical significance, the weights were normalized, effectively returning the weighted N to the actual sample size.



Commonalities Among the Practices in Science, Mathematics and English Language Arts

Based on work by Tina Chuek ell.stanford.edu

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Practices in Mathematics, Science, and English Language Arts*

Math	Science	English Language Arts
M1. Make sense of problems and persevere in solving them.	**S1.** Asking questions (for science) and defining problems (for engineering).	**E1.** They demonstrate independence.
M2. Reason abstractly and quantitatively.	**S2.** Developing and using models.	**E2.** They build strong content knowledge.
M3. Construct viable arguments and critique the reasoning of others.	**S3.** Planning and carrying out investigations.	**E3.** They respond to the varying demands of audience, task, purpose, and discipline.
M4. Model with mathematics.	**S4.** Analyzing and interpreting data.	**E4.** They comprehend as well as critique.
M5. Use appropriate tools strategically.	**S5.** Using mathematics, information and computer technology, and computational thinking.	**E5.** They value evidence.
M6. Attend to precision.	**S6.** Constructing explanations (for science) and designing solutions (for engineering).	**E6.** They use technology and digital media strategically and capably.
M7. Look for and make use of structure.	**S7.** Engaging in argument from evidence.	**E7.** They come to understanding other perspectives and cultures.
M8. Look for and express regularity in repeated reasoning.	**S8.** Obtaining, evaluating, and communicating information.	

* The Common Core English Language Arts uses the term "student capacities" rather than the term "practices" used in Common Core Mathematics and the Next Generation Science Standards.

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OregonASK
STATEWIDE AFTERSCHOOL NETWORK

Beth Unverzagt Director

National Network of Afterschool

- The national network brings together established statewide afterschool networks in a collective mission to build partnerships and policies that are committed to the development and sustainability of quality afterschool programs.
- Focused on actively engaging key decision makers to support afterschool and summer programs, in particularly high risk communities.
- 2014 – 47 states have afterschool networks.

National Afterschool Association

- Affiliate states provide professional development

CS Mott National Network

CS Mott National Network is centered around three goals:

- Goal 1 Create a sustainable structure of statewide, regional and local partnerships, particularly school/community partnerships, focused on supporting policy development at all levels.
- Goal 2 Support the development and growth of statewide policies that will secure the resources that are needed to sustain new and existing afterschool and summer programs.
- Goal 3 Support statewide systems to ensure programs are of high quality.

National Partnerships

Alliance for a Healthier Generation

- Health, Safety and Nutrition

National Summer Learning Association

- Summer Learning Initiative SL3

Afterschool Alliance

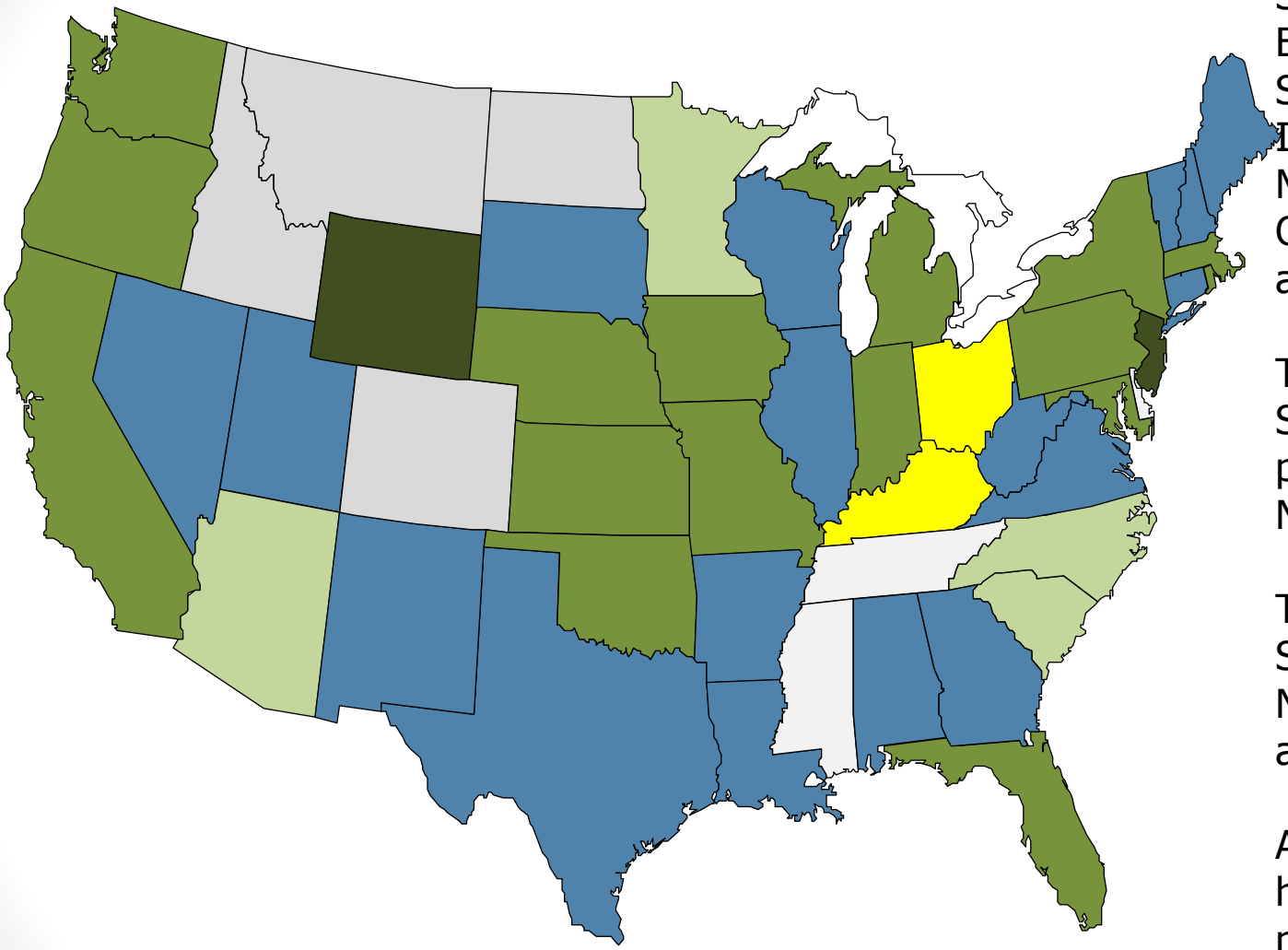
- Corporation for National Service - STEM VISTA project (14 states)
  - STEMx - formal partnership
  - Association of Science and Technology Centers – formal partnership

Oregon Girls Collaborative Project

- A sub-collaborative of the National Girls Collaborative Project
  31 collaborative serving 39 states

NOYCE Foundation

- 16 States funded – 2 more to be added



Networks involved in Afterschool and STEM System Building with Noyce Support (CA, FL, IA, IN, KS, MA, MD, MI, MO, NE, NY, OK, OR, PA, RI, NE, and WA)

Those finalizing STEM system proposals (AZ, MN, NC, and SC)

Those focused on STEM without Noyce support (NJ and WY)

And those who have gone through planning but not system building (KY, OH)

Oregon STEM OST

STEM Content Providers

- SMILE - Science Math Investigative Learning Experiences 34 schools
- LEGO Robotics - Jr. FLL FLL, FTC 560 sites
- MESA – 13 schools - 1 hour
- COSEY - 8 schools
- Girls, Inc.
- Saturday Academy

- OMSI & other science centers
- Environmental & discovery centers

Afterschool & Summer programs providing STEM

- 21stCCLC programs
- SUN
- Boys & Girls Clubs,
- Y's
- Community Based Child Care
- Park and Recreation

Afterschool in Oregon – 2010 /2011

- July 2010 – 18 month grant from National Governors Association, National Council of State Legislators and Chief State School Officers.

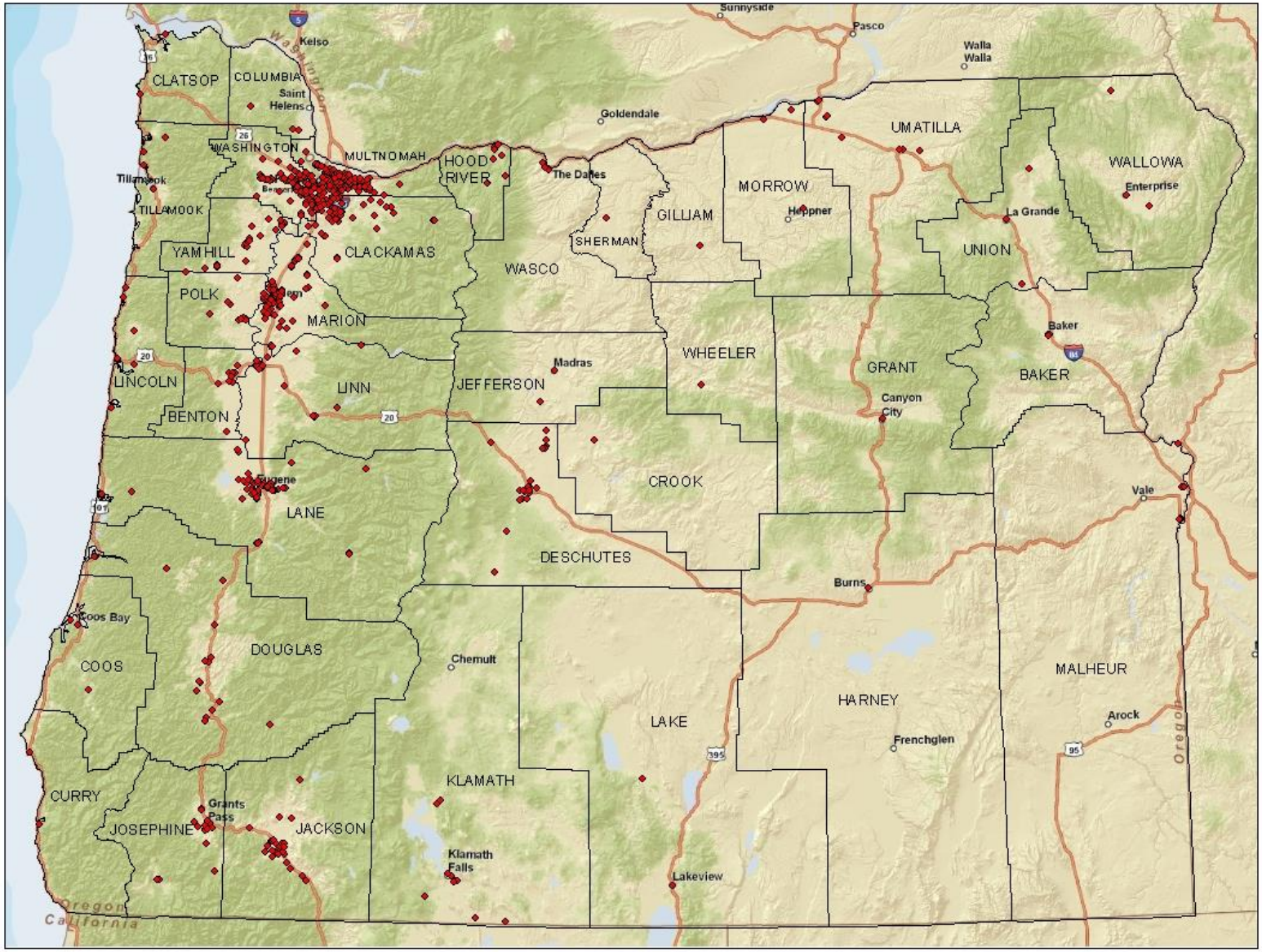
  Supporting Student Success (Oregon S-3)

Oregon Afterschool Report - November 2011

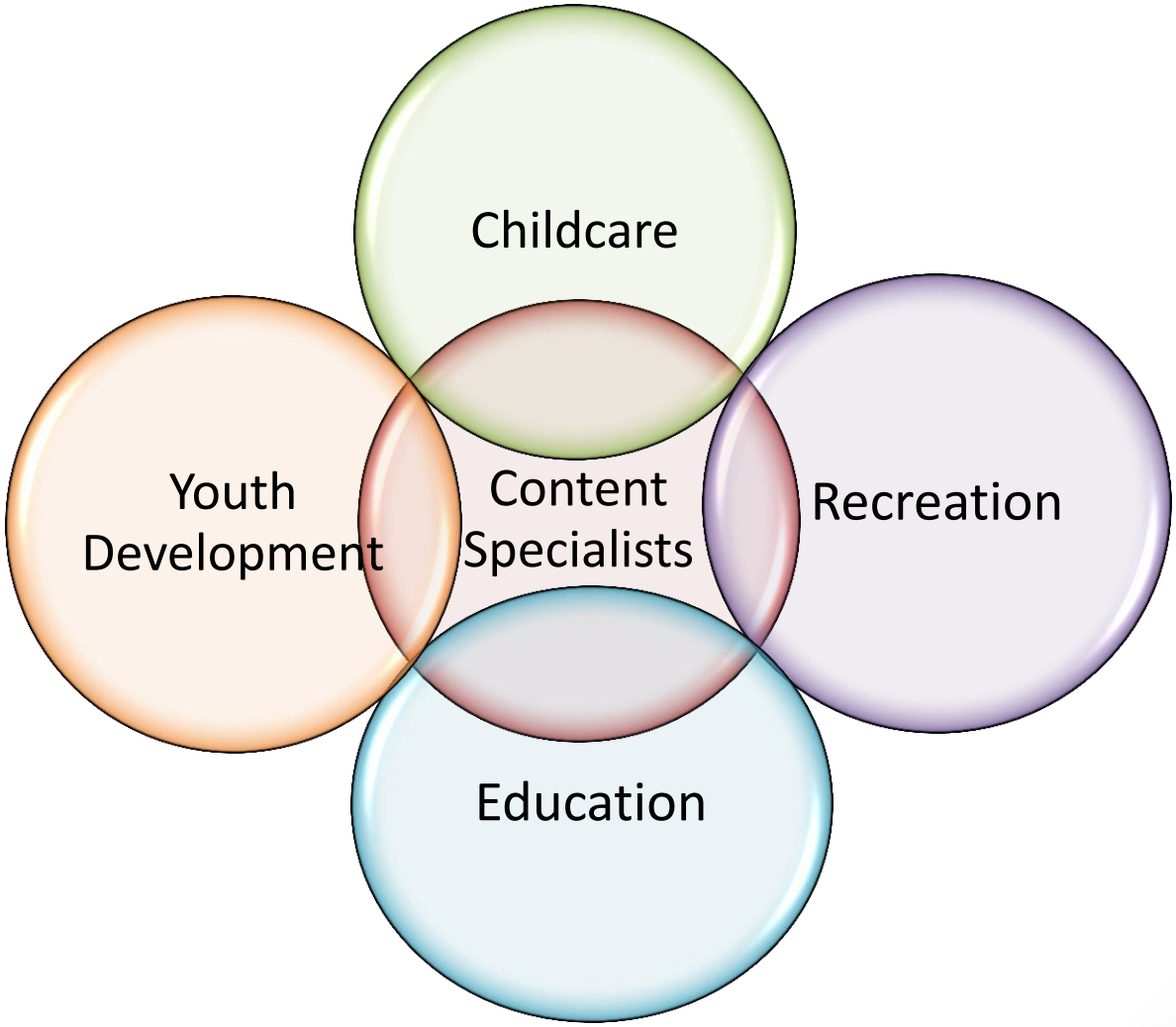
Key Findings

814 afterschool programs.
(3 days a week or 12 hours or more.)

- 79% or 640 of these programs serve school age children.
- 2010 - 135 of Oregon's 1,484 schools (9%) receive 21st Century Community Learning Center funds.
- 673 of the programs are co-located in public schools.


Sunnyside
Pasco
Walla Walla
Kelso
CLATSOP
COLUMBIA
Saint Helens
Goldendale
UMATILLA
WASHINGTON
MULTNOMAH
HOOD RIVER
The Dalles
WALLOWA
Enterprise
Tillamook
TILLAMOOK
MORROW
Heppner
GILLIAM
La Grande
SHERMAN
UNION
YAMHILL
CLACKAMAS
WASCO
POLK
MARION
Baker
WHEELER
Madras
GRANT
BAKER
LINCOLN
LINN
JEFFERSON
Canyon City
BENTON
Eugene
CROOK
Vale
LANE
DESCHUTES
Burns
Coos Bay
DOUGLAS
Chemult
COOS
MALHEUR
HARNEY
LAKE
Arock
Frenchglen
KLAMATH
CURRY
Grants Pass
JOSEPHINE
JACKSON
Klamath Falls
Lakeview
Oregon
California

The Five Circles of Afterschool & Summer



Oregon Afterschool Environment

- K-12 children in OR with working parent (s) 81% (507,449)
- K-12 responsible for taking care of self (3pm - 6pm) 31% (184,568)
  Average hours is 9.4 in self – care.
- K-12 children that participate in afterschool (3pm - 6pm) 15% (88,426)
- K-12 children likely to participate – if available (3pm – 6pm) 37% (186,865)
- Adults agree : "some type of organized activity for children and teens everyday that provide opportunities to learn." 87%
- Barriers – cost & transportation
- Afterschool In Oregon – primarily Public Schools house programs often operated by others or in partnership

School-year	(97.66 pr wk – average is $49)	$ 390
Summer		$ 463

Activity or Service	Percent of Programs
Academic Support or Tutoring	93.0 %
Educational Enrichment	89.2
Sports or Physical Fitness	88.5
Arts or Cultural Enrichment	84.1
Health and Wellness	64.3
Community Service	52.9
Technology	40.8
Mentoring	34.4
Spiritual/Character Development	32.5
Leadership Training and Development	29.3
Career Development or Employment Training	14.6
Activism or Organizing	10.2
Case Management / Credit Recovery	5.7 / 5.1

STEM - Oregon Network Three Pronged Approach

Oregon Girls Collaborative Project

- A sub-collaborative of the National Girls Collaborative Project
- Seek to increase the number of girls & under-represented populations involved in STEM by providing programs with:
  - Training Opportunities
  - Forums - Networking Opportunities
  - Program Mini-Grants
- **Implement the National survey of OST STEM In Oregon – 2014 / 2015**
- Systems building support for Oregon STEM programs

STEM Mentoring Project

- Partnerships with Oregon Mentors and new STEM hubs: Portland Metro & South Metro
- Build Mentoring Framework, Toolkit and Trainings to support best practices in utilizing STEM professionals in the in-school and afterschool spaces

STEM - Oregon Network Three Pronged Approach

STEM Bridges: School to Afterschool

- Year1: Facilitate, implement and evaluate co-planning process between in-school and out-of-school staff around STEM educational gaps and opportunities
  - STEM2 Power of Discovery Planning tools
    - Readiness & Needs Assessment
    - Program Planning Tool
  - Utilizing Next Gen Science Standards as a Lens/Framework
  - 4 communities/school districts
  - Survey and select STEM Curricula
  - Evaluation designed, managed and guided by Dr. Michael Coe
- Year 2: STEM Curricula Implementation - Support the implementation of previously identified STEM curricula, and conduct evaluation
  - Curricula
  - Digital Badges
  - Evaluation using Dimensions of Success (Dos) with support from Dr. Michael Coe and PEAR - Harvard

Question that have been posed…

- What is the extent of STEM initiatives in out-of-school programs in Oregon?
- How many children and youth do out-of-school programs in STEM serve?
- What level of coordination exists across out-of-school programs?
- How are out-of-school programs addressing the needs of underserved and underrepresented youth?
- Where are the challenges/limitations of relying on out-of-school programming to address STEM needs?
- How are out-of-school programs working to increase the quality of their programming and evaluation of outcomes?

We believe the following ….

- Afterschool intermediary organizations and large networks must widely promote existing high quality curricula to avoid wasting scarce resources on developing new programs and curricula.

- Afterschool programs must deliberately commit to offering STEM learning opportunities and then prioritize and allocate resources to provide professional development in STEM programming areas to staff.

- The field must reach consensus around youth outcome indicators and adopt them widely so that programs have a clear vision of their goals and role within the STEM education ecosystem. A local- or state-level hub is often a necessity for disseminating information and coordinating professional development efforts and other STEM programming needs for afterschool.

We believe in the following ….

- This includes seeking partnerships with STEM-rich institutions, such as science museums and universities, as well as other science and math hubs in many states.
- Meaningful STEM learning that extends beyond one-shot experiences are necessary.
- Afterschool and summer programs must pay close attention to offering regular, consistent programming in STEM topics.
- Furthermore, wherever possible, programs must offer a continuum of STEM learning experiences that extend into middle and high school in order to derive maximum impact from their STEM programming.

What Does It Take to Get Positive Outcomes?

- ✓ Access to and sustained participation in programs
- ✓ Quality …staff & training
- ✓ Programs that partner with families, other community organizations and schools
- ✓ Time and Duration: Students participate for at least 12 hours or 3 days a week

Harvard Family Research Project