The targeted outcomes are (1) elementary and middle school teachers of math and science build skills to develop and implement standards-aligned curricula with integration of content and connections to real-world practice; (2) shared lesson guides—curricula—for implementing projects with rich sets of resources (i.e., “Superlessons”); (3) students increasingly engage in authentic, standards-aligned projects and meet or exceed grade-level benchmarks in math and science. The project is entering its second of three years; the project aims to include 70 teachers representing all 16 districts in Lane County in order to support wide dissemination of the STEM project-based learning approach.

Program Model

Program staff includes University of Oregon math and science faculty also affiliated with STEM CORE (STEM Careers through Outreach, Research, and Education, a university STEM education center), a science and math education specialist from the educational service district, and school district teacher leaders in STEM and technology. Community partners include representatives of a public utility, an educational game developer, a nanotechnology research and development company, a health science laboratory, a recycling center, a school garden program, and the city parks and open space division.

In teacher workshops, including 56 hours in summer and 30 hours during the school year, participants are introduced to a project-based learning (PBL) approach. Activities are structured such that teachers build expertise in math and science standards (Common Core State Standards for Mathematics and Next Generation Science Standards). Community partners who use STEM skills in their careers host workplace visits and consult with teachers to inspire and guide the development of curriculum that draws on their expertise. Following the PBL approach, teams identify a driving question designed to engage students with a real-world problem and, in the process, meet the performance expectations described by targeted math and science standards.

Throughout the development and implementation of curriculum, project staff provide support for content, technology integration, and classroom pedagogy. Teachers learn to evaluate curricula to assure standards alignment. Embedded classroom professional development by project staff—personalized classroom support in the form of planning, co-facilitation, and observation—helps teachers successfully pilot their lessons. Instructional rounds, in which participants observe peer teachers’ classrooms, are used to foster constructive conversations about teaching practices and reflection on teachers’ own instructional practices (Marzano, 2011).

Involving STEM Professionals in Education

STEM professionals include industry professionals, government employees, and researchers. Examples partners from these projects include a city parks and open space management, a civil engineer, an educational video games designer, a health sciences lab technician, a researcher in a nanotechnology lab, and a biochemistry graduate student. Roles are defined based on partners’ interests, availability, and skills. Partners participate in teacher workshop sessions that involve facilitated time to explore connections between STEM workplace skills and practices and lessons. For example, to initiate conversations between partners and teachers, conversations were organized centered on 21st Century Skills and how they are represented in the workplace and the classroom. As teachers continue to consult with partners in the development of their lessons, they may take additional roles, including various roles as visitors to the classroom, field trip hosts, and resource providers.

Evaluation Design and Findings

The first-year external evaluation focused on the quality of recruitment and professional development and the ability of the project to adapt to participant needs using participant surveys, workshop observations, and participant demographics. Cohort 1 teachers also responded to a pre/post teacher efficacy belief instrument, T-STEM (Friday Institute, 2012) designed to capture evidence related to (1) teacher attitude toward math and science teaching, (2) 21st Century Skills, (3) educational technology, (4) teacher leadership, and (4) teaching about careers. A subset of teachers were observed teaching using a rubric based on the NGSS Science and Engineering Practices (SEPs).

The most consistent feedback from teachers across the numerous professional development meetings was the preference for activities that related directly to planning lessons. After ten months, cohort 2 teachers reported significantly higher mean frequencies of addressing NGSS Practices, Student Technology Use, and STEM instruction. Two of the attitude items showed significant change, Science Teaching Efficacy and Beliefs, and Career Awareness. All other variables showed some positive change (i.e., reduced need or increased confidence) but the changes in means were not significant. All survey sections showed high internal consistency, with coefficients alpha above .80 and individual item-test correlations above .40. The medians reported in Table 1 are useful for qualitative understanding of changes. Values close to 3 indicate that half of teachers are engaging in a practice weekly. Classroom observations provided evidence of SEPs implementation.

Example SuperLessons

• It’s Rainy, It’s Pouring, the Water We Are Storing—Design & test runoff rainwater collectors and rice paddy irrigation equipment to control nutrient runoff
• How to Fall 35,000 Feet and Survive—Study gravity, design protection for egg drop devices
• How Slow Can You Go?—Design and test a manufacturing machine to move materials slowly
• KeyLimeCity!—Understand and create a limestone city
• Tsunami Survival!—Create and test a vertical evacuation structure
• Flooding, Oh My!—Design and test a barrier to reduce flooding at the school
• Tsunami Surfco!—Create and test a vertical evacuation structure
• Faithfully Feeding Fish—Making an automated fish feeder dispenser with Arduino
• Tidbit from Tyler: Apply knowledge of electricity & magnetism to design a magnetic recycling sorter

Table 1: Cohort 1 Pre/Post Teacher Efficacy Survey Professional Development Needs

<table>
<thead>
<tr>
<th>Professional Development Needs</th>
<th>Premean</th>
<th>Postmean</th>
<th>Median</th>
<th>sd</th>
<th>Premean</th>
<th>Postmean</th>
<th>Median</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evidence-Based Instruction</td>
<td>1.43</td>
<td>3.31</td>
<td>2.35</td>
<td>3.11</td>
<td>3.80</td>
<td>3.78</td>
<td>4.00</td>
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<td>0.74</td>
<td>1.09</td>
<td>0.71</td>
<td>0.67</td>
<td>0.48</td>
<td>0.58</td>
<td>0.45</td>
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<td>3.63</td>
<td>2.50</td>
<td>3.21</td>
<td>4.00</td>
<td>3.78</td>
<td>4.30</td>
<td>3.75</td>
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<td>0.91</td>
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<td>0.46</td>
<td>0.59</td>
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<tr>
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<td>2.85</td>
<td>3.30</td>
<td>3.95</td>
<td>3.62</td>
<td>4.17</td>
<td>3.71</td>
</tr>
</tbody>
</table>

Lessons Learned

• Introduce partners and teachers at the beginning of the lesson plan development process
• Use time in real world for teachers and students to identify roles and potential contributions
• Focus on standards and development of a driving question as the starting point for projects— and include partners and teachers in this conversation
• Provide opportunities for partner-hosted workplace visits by teachers in the early phases of lessons
• Emphasize meaningful integration of math

Dissemination

Participant teachers’ project-based units, or Superlessons, are publicly shared via the OER Commons, or Oregon Educational Resources, website on the Content in Context Superlessons page: https://www.oercommons.org/groups/content-in-context-superlessons/533/

News and resources organized and developed by project staff and teachers that may be helpful to other teachers are shared on the project website: http://www.stem.lane.educ/2-superlessons/

Integrating Math and Science with Project-Based Learning and Community Partners

Bryan Rebar, Tricia Bevans, Talbot Bielefeldt, Dana Brennaar, Bob Curtin, Ronda Fryer, Dean Livelybrooks, Kory Plakos, Dev Sinha

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