This presentation premiered at WaterSmart Innovations

watersmartinnovations.com
Teachers Work with Professionals to Understand Tucson’s Water Distribution System:
The Tucson STEM Academy

Water Smart Innovations Conference
Las Vegas, NV
October 9, 2014
Curriculum & Lesson Guides: Content & Method

• Developed in group writing events with teachers and specialists working together
• Use research-based pedagogy
• Address multiple intelligences and learning styles
• Develop critical thinking and problem solving skills
Tucson STEM Academy

- Water Professionals
- Site Visits
- Resources

- Education Experts
- Applied Lessons
- Curriculum Guides
Teacher Academies

Offer multiday professional development that evolves teachers' instructional practice and water-related content mastery through STEM integration, interdisciplinary standards inclusion, project based learning, real-world and relevant application, and collaborative work with teachers.

94% agree or strongly agree that the information, strategies, and instructional methods presented during the academy were helpful.

arizonawet.arizona.edu/programs/teacher_academies
Teachers explore Tucson Water’s Reliability

**Mission:**

1. Water Supply
2. Operations & Systems
3. Water Quality
4. Water Conservation & Efficiency

water.tucsonaz.gov/water/conservation
Working STEM Definition

STEM education is an interdisciplinary approach to learning which removes the traditional barriers separating the four disciplines of science, technology, engineering and mathematics, and integrates them into real world, rigorous and relevant learning experiences for students.

from Helios Foundation
Workshop Objectives
Critical Thinking – Problem Solving

- Integrate real-world content into instruction
- Explore STEM careers
- Use APW lessons to bring local relevancy into the classroom
- Engage in engineering projects/lessons in relation to water topics
- Implement water conservation projects that save water
- Utilize a wide variety of Technology Tools
STEM Academy Overview

1. Water Supply
2. Operations & Systems
3. Water Quality
4. Water Conservation & Efficiency
Water Supply

Future

- Hydrology
- History
- Sources

Future
Hydrology – Groundwater Movement
Hydrology – Groundwater Movement

Sweetwater Recharge Facilities

<table>
<thead>
<tr>
<th>Well Name</th>
<th>Lat</th>
<th>Long</th>
<th>Well Elevation (ft AML)</th>
<th>Measurement Date</th>
<th>Depth to Groundwater (ft BLS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WR-092B</td>
<td>-111° 1' 26.46&quot;</td>
<td>32° 16' 30.46&quot;</td>
<td>2282</td>
<td>2-Apr-2013</td>
<td>152</td>
</tr>
<tr>
<td>WR-200A</td>
<td>-111° 1' 58.04&quot;</td>
<td>32° 17' 43.21&quot;</td>
<td>2243</td>
<td>3-Apr-2013</td>
<td>159</td>
</tr>
<tr>
<td>WR-201A</td>
<td>-111° 1' 17.11&quot;</td>
<td>32° 18' 51.44&quot;</td>
<td>2201</td>
<td>2-Apr-2013</td>
<td>153</td>
</tr>
</tbody>
</table>
Hydrology - Watersheds

Conceptual understanding with Project WET lesson

Expands into understanding Tucson’s watersheds

[Map of Tucson's watersheds]
Colorado River Watershed

*One River Many Voices*

Plumbing the Colorado

*(DAW-TC, p. 277)*
Central Avra Valley Storage and Recovery Project
Water Sources

Water Production (1940-2013)

- Total Potable Water Use at 1989 Level
- Groundwater Use at 1944 Level

Water Production for TW Service Area (Acre-Feet)

- Potable Production
- CAP Production
- TARP Production
- Reclaimed Production

Year:
- 1940
- 1950
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010
- 2013
Operations & Systems

SCADA Control Center
Water Distribution System
Engineering
STEM Careers
Urban Water Cycle
Tucson’s Urban Water Cycle
Lessons

Operating Recharge Basins

Focus Question:
How do water managers calculate the amount of reclaimed water being intentionally recharged through a basin?

<table>
<thead>
<tr>
<th>Recharge Basin</th>
<th>Area (ft²)</th>
<th>Depth (ft)</th>
<th>Volume (ft³)</th>
<th>Volume x 7.48 (gal)</th>
<th>Volume Recharged (gal)</th>
<th>Volume x 0.98</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total

*Total Volume of water recharged through all basins for each filling event.*

Areas

- **Triangle**: \( \frac{1}{2} \times b \times h \) (\( h \)=vertical height)
- **Rectangle**: \( w \times h \) (\( w \)=width)
- **Circle**: \( \pi r^2 \) (\( r \)=radius)
- **Trapezoid**: \( \frac{1}{2} (a + b) \times h \) (\( h \)=vertical height)
- **Ellipse**: \( \pi ab \) (\( a \times \frac{3}{5} \) width \( \times \frac{3}{5} \) length)
Engineering Design Challenge

Calculating Pressure Loss - Equivalent Pipe Length Method

<table>
<thead>
<tr>
<th>Section</th>
<th>Pipe Size (inches)</th>
<th>Flow (gall/min)</th>
<th>Pressure Loss (ft/100ft)</th>
<th>System Components</th>
<th>Equivalent Length of Component (ft)</th>
<th>Number of Components</th>
<th>Equivalent Length (ft)</th>
<th>Total Pressure Loss (ft/100ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path A</td>
<td>10</td>
<td>750.0</td>
<td>0.26</td>
<td>90 deg Elbows</td>
<td>18.0</td>
<td>2.0</td>
<td>36.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>45 deg Elbows</td>
<td>9.0</td>
<td>8.0</td>
<td>72.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gate Valves</td>
<td>3.2</td>
<td>2.0</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Globe Valve</td>
<td>310.0</td>
<td>2.0</td>
<td>620.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Straight Pipe</td>
<td>1.0</td>
<td></td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>1.9</td>
<td></td>
<td>744.0</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Elevation Delivery Point (ft)=
Elevation Starting Point (ft)=
Total Elevation Change (ft)=

Total Pressure Loss Path A = 1.9
Water quality

Water Sample Areas:
- Site 1: Mesa Water, Mesa and E. Ina Road
- Site 2: One Valley Water, Tempe and E. 48th St.
- Site 3: Phoenix Water, South Mountain Water (Sandario and Old Naglee Pk)
- Site 4: Phoenix Water, Westward Ho and E. 27th Ave.

Interesting Findings at the Home Water Tests:

3
Data Analysis with Google Maps Engine Lite

Chlorine Map

Drinking Water Chemistry Analysis
6/18/13 performed by teachers in Tucson STEM Academy

6-18-13 Drinking Water Chem Data S... ✔

- Style
- Data
- Labels

Stylished by Chlorine (mg/L):

- 0 - 0.25 (6)
- 0.5 - 0.5 (4)
- 0.75 - 0.75 (1)
- 1 - 1 (9)
- 1.25 - 1.25 (1)
- 1.5 - 1.5 (1)

Untitled layer
Empty

Base map
Water efficiency

School Water Audit Program

1 - Getting Their Feet Wet: A Home Water Audit
2 - Plunging In: The School Inventory

Indoor Audit
3.1 - Structured Inquiry: Bathroom Faucet Audit
3.2 - Guided Inquiry: Classroom Faucet Audit
3.3 - Guided Inquiry: Cafeteria Audit
3.4 - Student-driven Inquiry: Student-led Audit

Outdoor Audit
3.5 - Structured Inquiry: Athletic Field Audit
3.6 - Guided Inquiry: Non-athletic Field Audit
3.7 - Student-driven Inquiry: Student-led Audit

4 - Resurfacing: Communicating Data & Recommendations
Distribution Uniformity

Sprinkler Locations on a Rectangular Athletic Field

<table>
<thead>
<tr>
<th>360</th>
<th>340</th>
<th>320</th>
<th>300</th>
<th>280</th>
<th>260</th>
<th>240</th>
<th>220</th>
<th>200</th>
<th>180</th>
<th>160</th>
<th>140</th>
<th>120</th>
<th>100</th>
<th>80</th>
<th>60</th>
<th>40</th>
<th>20</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>16</td>
<td>13</td>
<td>11</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Catch Can Placement
- Blue square in center is one sprinkler head
- Yellow squares are catch cans, placed at 10 and 20-foot intervals

1 square = 0.8 feet
Appendix 3.1.D: Measure Bathroom Faucet Flow Rate Data Sheet

<table>
<thead>
<tr>
<th>Location</th>
<th>Location 1</th>
<th>Location 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>B</td>
<td>F</td>
</tr>
</tbody>
</table>
| D | A | \_

Baseline flow rate (existing condition i.e. with or without aerator) (How many ml in 5 seconds?):

<table>
<thead>
<tr>
<th>Location 1</th>
<th>Location 2</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Notes and Comments (Leak level / GPH):
Excelets

• “Excelets are interactive Excel spreadsheets or simulations of mathematical models.”

![Excelets example](chart.png)
Technology

Technology Questions Tucson STEM Academy 2014

<table>
<thead>
<tr>
<th>Activity</th>
<th>Pre-Workshop Average</th>
<th>Post-Workshop Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorporating Google Earth into my lessons</td>
<td>3.12</td>
<td>7.60</td>
</tr>
<tr>
<td>Using Excel with my students for data recording and analysis</td>
<td>3.58</td>
<td>7.48</td>
</tr>
<tr>
<td>Creating Excel for computational modeling</td>
<td>1.54</td>
<td>5.96</td>
</tr>
<tr>
<td>Producing a Prezi presentation incorporating audio and video</td>
<td>3.08</td>
<td>7.36</td>
</tr>
<tr>
<td>Online collaboration in a Professional Learning Community (PLC)</td>
<td>5.08</td>
<td>8.04</td>
</tr>
<tr>
<td>Using Google Drive to create and distribute surveys, and analyze data</td>
<td>2.81</td>
<td>7.44</td>
</tr>
<tr>
<td>from surveys</td>
<td></td>
<td>7.96</td>
</tr>
<tr>
<td>Using Google Maps Engine to visualize data geographically</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Day 1 Tucson STEM Academy 2014
Urban Water Cycle

<table>
<thead>
<tr>
<th>Level of Understanding - Familiarity</th>
<th>The Urban Water Cycle and Tucson Water's Mission</th>
<th>The Colorado River Compact</th>
<th>A day in the life of a civil engineer in Tucson Water</th>
<th>Engineering design of piping system for delivering water</th>
<th>The allocation of Colorado River Water</th>
<th>The watershed we live in and depend upon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Workshop Average</td>
<td>4.19</td>
<td>3.62</td>
<td>2.12</td>
<td>2.00</td>
<td>4.31</td>
<td>4.46</td>
</tr>
<tr>
<td>Post-Workshop Average</td>
<td>7.64</td>
<td>7.52</td>
<td>7.28</td>
<td>7.24</td>
<td>7.80</td>
<td>7.96</td>
</tr>
</tbody>
</table>
Content Knowledge

Day 3 Tucson STEM Academy 2014

Water Quality

<table>
<thead>
<tr>
<th>Level of Understanding - Familiarity</th>
<th>Water quality indicators and monitoring performed by Tucson Water</th>
<th>STEM careers of water professionals that work at Hayden-Udall</th>
<th>Water quality testing and analysis</th>
<th>The interrelationship of some water quality indicators</th>
<th>Presenting scientific data in a concise meaningful manner</th>
<th>Water sampling protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - Low</td>
<td>2.70</td>
<td>2.07</td>
<td>3.56</td>
<td>2.63</td>
<td>5.15</td>
<td>3.37</td>
</tr>
<tr>
<td>10 - High</td>
<td>7.76</td>
<td>7.31</td>
<td>7.83</td>
<td>7.45</td>
<td>7.69</td>
<td>7.97</td>
</tr>
</tbody>
</table>
Summary

- Teachers’ mastery/knowledge of water content increased an average 50.3%
- We have educated 48 teachers in Real World, Rigorous and Relevant learning that translates into quality STEM teaching for the 5,815 students they teach
Tucson STEM Academy

- Water Professionals
- Site Visits
- Resources

- Education Experts
- Applied Lessons
- Curriculum Guides
Contact Information

Kerry Schwartz  
Director, Arizona Project WET  
Associate Specialist, Extension  
kschwart@cals.arizona.edu  
520-621-1092

Betsy Wilkening  
Education Coordinator  
ewilkening1@email.arizona.edu  
520-621-8673

The University of Arizona  
Water Resources Research Center  
350 N. Campbell Ave.  
Tucson, AZ  85719  
(520) 621-9591

arizonawet.arizona.edu