

Arizona Project WET - City of Tucson IGA Annual Report 2015-16

Arizona Project WET (APW) shares the City of Tucson's goal to promote responsible water stewardship through excellent and effective education.

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Summary Table

2015-16 School Year Summary				
All Arizona Project WET Programs				
Teachers 547	Adults 3,471	Students 29,542	Instruction Facehours 2,110	
Professional Development				
Workshop	Workshop Hours	Teachers	Students Reached By Teachers	Instruction Facehours
STEMAZing July 2015	7.5	12	1,250	30.0
Tucson Water Festival Workshop	6.0	14	437	12.0
Living River Workshop	14.0	19	1,502	28.0
Water We Singing About?	6.5	8	662	13.0
2015 STEM Academy Follow Up	6.0	19	1,759	12.0
Marana Water Festival Workshop	6.0	25	797	12.0
2016 STEM Academy	41.5	25	2,032	290.5
2016 STEMAZing Water Energy World	22.5	22	2,923	45.0
Other 1-day workshops	13.5	38	1,745	13.5
Totals	123.5	182	13,107	456.0
Direct Student Outreach Programs				
Sweetwater Wetlands				
Schools	Classes	Teachers (481 Adults)	Students	Instruction Facehours
49	135	135	2,996	404.0
Groundwater Model Presentation - 3rd Grade Classrooms				
Schools	Classes	Teachers (131 presentations)	Students	Instruction Facehours
52	146	136	3,220	340.0
Groundwater Model Presentation - 6th Grade Classrooms				
Schools	Classes	Teachers (82 presentations)	Students	Instruction Facehours
25	82	33	2,054	184.0
Groundwater Model Presentation - Other Classrooms				
Schools	Classes	Teachers (9 Presentations)	Students	Instruction Facehours
3	9	3	221	26.0
School Water Audit Program & Water Scene Investigation				
Schools	Classes	Teachers	Students	Instruction Facehours
7	17	11	429	98.2
Water Festival - Tucson				
Schools	Classes	Teachers (88 Adults)	Students	Instruction Facehours
10	32	32	878	44
Discovery Program - Sweetwater Wetlands				
Schools	Classes	Teachers (12 Adults)	Students	Instruction Facehours
8	13	15	254	95.8
Total Schools	Total Classes	Total Teachers	Total Students	Total Facehours
154	434	365	10,052	1192.0
Community Outreach Events				
Number of Events	Hours	Adults	Students	Instruction Facehours
36	141	2,890	5,772	462.0

Table 1

2015-16 School Year Summary			
Arizona Project WET Programs			
School Water Audit Program - Irrigation			
School	# Students Participated	# Sprinklers	Calculated DU
Magee Middle School	60	11	29%
Amphi High School	72	18	56%
Canyon del Oro High School	82	30	44%
Hollinger	35	10	27%
Totals	249	69	39%
Water Scene Investigation			
School	# Students Participated	# Students Reporting Data	Projected Water Savings (gals/yr)
Dietz K-8	76	0	N/A
Canyon del Oro High School	79	29	377,138
Mission View Elementary	25	4	55,383
Totals	180	33	432,521
Projected Water Savings are reported data only - Actual Projected Water Savings would be much higher			
Drinking Water Quality Testing			
School	Grade Level	# Classes	# Students Participated
Desert View High School	10, 11, 12	5	110
Flowing Wells High School	10, 11	2	60
Flowing Wells Junior High School	7,8	4	100
Dodge Middle School	8	5	130
CDO High School	11, 12	3	85
Paulo Freire Freedom School	8	1	23
Walter Douglas Elementary School	6	3	78
Sky Island School	9, 10, 11,12	2	25
Totals		25	611

Table 2

Infographic Summary

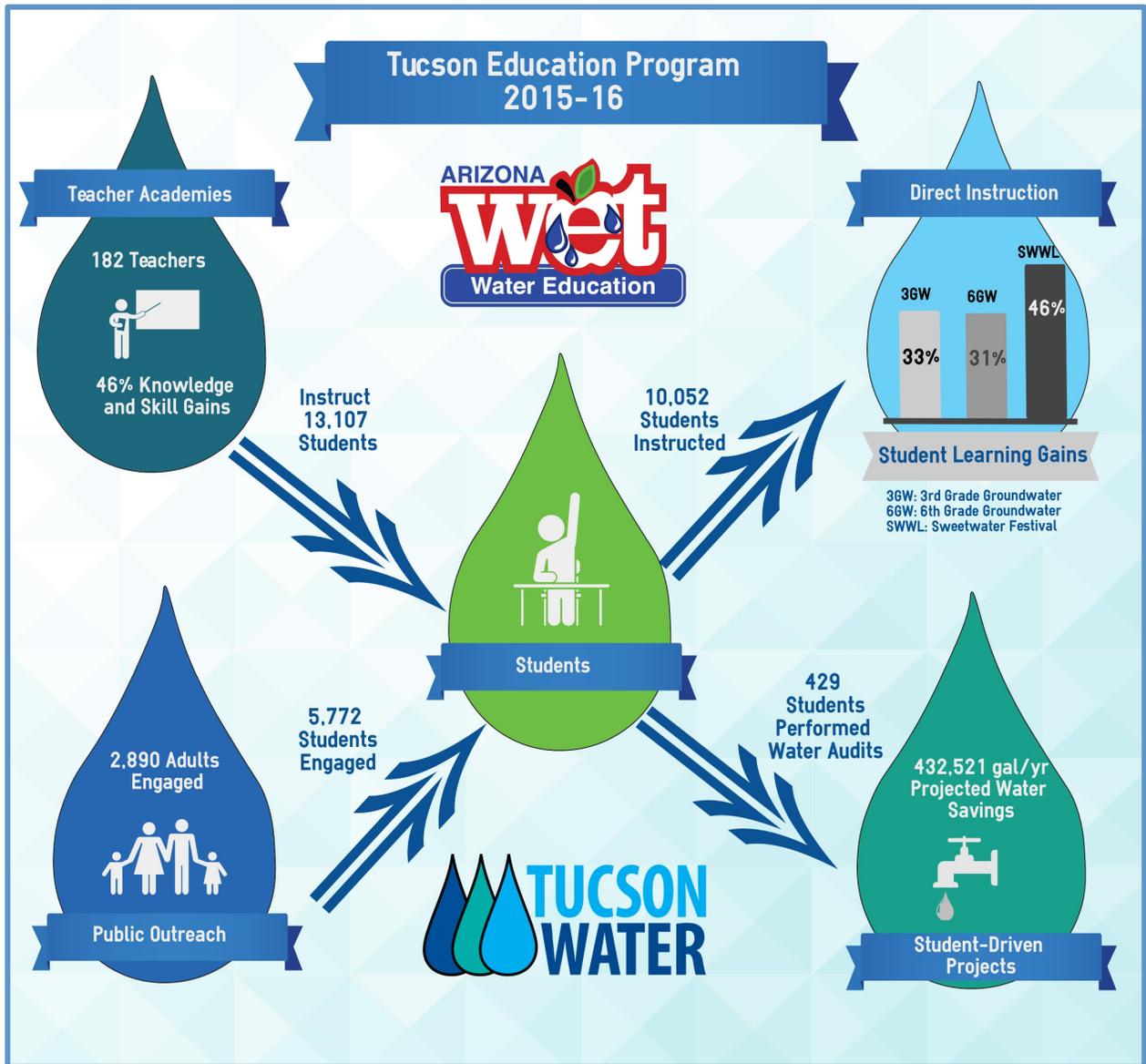


Figure 1

I. Summary

Arizona Project WET (APW) is a University of Arizona (UA) Cooperative Extension program that works statewide to accomplish two overarching goals through three pathways. APW develops water stewardship and STEM (Science, Technology, Engineering and Math) literacy by: 1) providing teacher professional development to evolve instructional practices and deepen content knowledge, 2) direct student outreach to deliver or extend classroom learning, and 3) community engagement to effectively involve adults in K-12 education.

Cooperative Extension programs, like APW, are developed based on needs assessments and are governed by clear and measurable outcomes. Assessment is built into these programs and used to improve lessons, programs and academies on a regular basis. APW programs target the specific needs of Arizona's students, teachers, and partners. It can be counted on that all APW programs are effectively achieving knowledge and skill gains. If they weren't, APW would stop doing them.

The APW team of ten professionals, dedicated to a targeted mission, stays abreast of the ever evolving needs of the Arizona education system as well as district partners. As part of the Water Resources Research Center (WRRC), Arizona's federally designated state water center, APW also brings relevant and research-based content in to instruction and programs.

APW is served by an advisory council represented by city water specialists and district education specialists from Tucson, Chandler, Gilbert, Scottsdale and Casa Grande, as well as specialists from Central Arizona Project, Salt River Project, U.S. Bureau of Reclamation and the Arizona Department of Education. These specialists advise and support the program, along with more than 40 other contributors across the state. The Tucson Education Program benefits from the thinking, creativity, and individual strengths of multiple teams of talented individuals (the statewide APW team, WRRC team, Cooperative Extension team and the APW Advisory Council).

The mission of Tucson Water (TW) parallels that of Arizona Project WET. Both organizations recognize that water stewardship begins when people know about, understand, and connect to their water resources. APW's Tucson programs teach about Tucson's interconnected water resources, water supplies and needs, regional and local water management, the effects of drought and uncertainty, water quality and chemistry, water efficiency, and wise water use. In Tucson, APW programs are adopted components of district curriculum for third, fourth and sixth grade students. Other APW programs delivered in Tucson target STEM education that reaches across the K-12 spectrum. For more than a decade, the TW/APW partnership has helped create a water literate citizenry invested in water stewardship for the future of our region.

In the 2015-16 fiscal year, Arizona Project WET programs reached 547 teachers, 29,542 students and 3,471 adults through 2,110 hours of instruction. This year 182 teachers improved their mastery of content knowledge and instructional practices by an average of 46% through participation in professional development academies and workshops. This positively affects the 13,107 students that they teach annually. Direct

student instruction engaged 10,052 students from 365 teachers' classes in learning about water resources, stewardship and efficiency. Student-driven school water audit projects resulted in a projected 432,521 gallons/year water savings. During public outreach events 5,772 students and 2,890 adults engaged in water education activities.

Over the course of the 3-year IGA period (2013-16), APW programs reached 1,889 teachers, 90,679 students and 12,602 adults.

II. History

Arizona Project WET's role at the University of Arizona is to work with partners across the state to address not only the need for water education and STEM literacy, but to adapt, as those needs shift with the times.

In 2005, APW worked closely with TW specialists and area school districts to ensure that TW's conservation education funding was put to best use. Opportunities to assist Tucson Unified School District (TUSD) in meeting state standards and science testing requirements were identified. The 3rd grade water curriculum was rewritten in 2006 by the APW Director, a TW specialist, TUSD science coordinators and master teachers. One third of the science taught at the third grade level for TUSD, Flowing Wells and Altar Valley is now this curriculum: Schwartz, K., Kottelman, M., Bouwens, E. and Bittel, K. (2006) **3rd grade Water Curriculum Unit**. A field trip to TW's Sweetwater Wetlands, with four learning stations, was built into the 3rd grade curriculum unit. This model is adapted from APW's **Arizona Water Festival Program** which began in 2000 (http://arizonawet.arizona.edu/programs/arizona_water_festival).

The groundwater system is the least understood and therefore, the least taught part of the water cycle. Yet, Tucson's entire water supply depends on it. Misconceptions develop from textbook drawings and analogies that use surface water to describe what



can't be seen beneath the ground. This essential component of the water cycle was not part of instruction at any grade level. **Therefore an in-classroom groundwater presentation was also built into the 3rd grade curriculum unit.** The key to this instruction is the use of interactive groundwater models that provide opportunities to see and explore the groundwater system. Teachers do not have the knowledge or models to teach about it. In their ability to build foundational knowledge about this complex system, so essential to Tucson, these presentations remain essential.

3rd Grade Students Exploring the Flow of Water Through Pore Spaces

In 2009, the APW Director worked with a team of specialists to develop the 6th grade science curriculum: Schwartz, K., Gilbert, J., Herron, P. & Kist L. (2009, edited 2011) *Energy & Environmental Science (EES) 6th Grade Science Unit*. Three school districts adopted this 6th grade science curriculum that

covers one-third of the year. A total of 16 APW lessons from two curriculum guides are included. In-classroom groundwater flow model presentations, delivered by APW educators, are essential to the curriculum.

The need to quantify water savings resulting from education programs prompted the development of the **School Water Audit Program (SWAP)** in 2008 and culminated with the publication of the SWAP curriculum in 2009: (Schwartz, K., Stoll, M.A., Rupprecht, C. and Crocker, N. (2009), School Water Audit Program Curriculum, Arizona Cooperative Extension, Pub. #1505, (167 p.) Viewed at: http://arizonawet.arizona.edu/programs/school_water_audit). The SWAP meets the ongoing need for STEM integration in the form of real world, rigorous and relevant learning experiences for students.

The **Water Scene Investigation (WSI) program** evolved from the SWAP homework assignment. Shorter and easier to implement than a SWAP, the WSI program was designed to inspire participants to adopt home water conservation practices through the installation of water efficient technology, and the comparison of their savings with other water users. This program was published as a stand-alone program in 2013: (Schwartz, K., Stoll, M.A., Rupprecht, C., Thomas-Hilburn H., Krecek-Lynch T., Prescott A. and Ramaswamy, S. (2013), Water Scene Investigation Program, Peer-reviewed Arizona Cooperative Extension, Pub. #az1594, Viewed at: <http://arizonawet.arizona.edu/programs/wsi>).

Teacher Workshops (http://arizonawet.arizona.edu/programs/teacher_academies) are an integral part of APW's mission. Each of the aforementioned curriculum units are supported with teacher professional development that models instruction and deepens content knowledge. Additionally, APW developed new workshops as needs arose and partnered with other local education providers that include Biosphere 2, Arizona Sonora Science Museum, Tohono Chul Park and the Arizona Hydrological Society to name a few.

In 2013, Arizona Project WET began working with Tucson Water to offer a 5-day **Teacher STEM Academy** focused on Tucson Water's mission. This program replaced the long-running Teacher Internship Program offered by TW, and 102 teachers have attended since 2013.



*Tucson STEM Academy Teachers Touring CAP Facility
At Twin Peaks*

Last year the APW Director worked with the Director of The STEMAZing Project to develop and conduct a three-day teacher institute on Water and Energy. TUSD master teachers and one district science specialist attended. A Western Resource Advocates specialist also attended and sponsored the development of an online curriculum unit (Hogan, D., Schwartz, K. and Wilkening, E. (2015) *Water Energy World Online Curriculum*, on STEMAZing website, Pima County School Superintendent Office, Viewed at: <http://www.stemazing.org/#!/water-energy-world/c1vz9>). This unit, which focuses on real-world data and problem solving, is currently being tested as a replacement for the 6th grade curriculum unit at TUSD.

Since 2006, with Tucson Water’s collaboration and support, Arizona Project WET has engaged 4,154 teachers, 224,488 students, and 21,885 adults in STEM-based water education in the Tucson Water Service Area.

III. School-Year Achievements

Educator Training and Management

Each semester, a group of ten University of Arizona (UA) students and/or AmeriCorps members trained as Water Educators facilitate lessons and work public events. Extensive training and mentoring ensures that Water Educators provide effective educational experiences to area students. All education components provide educators with a narrative that includes what to say, what to do, and what students at the target grade level might say in response. One-page lesson summaries are also used to ensure that the big ideas of each subject are stressed. In addition, classroom management skill development is also part of the Water Educators training.

Program coordinators model the interactive, inquiry-based lessons as they are to be taught to students, during the two-day training. After lesson modeling, Water Educators have the opportunity to study the written narratives and facilitate the lessons for the Tucson Program Coordinators and their peers. In order to build skills and confidence in both programs, new educators shadow teams of experienced educators in the classroom and at Sweetwater Wetlands. Returning educators provide advice and guide the team of new educators, effectively becoming mentors and leaders. After the shadowing phase, educators have gained confidence in their abilities and are ready to present. Later in the year, educators are observed using standard evaluation instruments to ensure that effective delivery is maintained.

Workplace and facilitation skills, keys to success in APW programs, assist University students in obtaining jobs beyond college, while also benefitting the community and region.

Program Innovations

3rd Grade Groundwater Lesson – Hands-on Science Learning

After close scrutiny of student evaluation data, APW revised the 3rd grade groundwater lesson to improve student engagement. Prior to this school year, the 3rd grade lesson utilized the same groundwater flow models used in the 6th grade lesson. The evaluation consisted of ten true/false questions that centered on the big ideas of: 1) Groundwater is between the grains of sand and gravel, 2) Groundwater moves through sand and gravel due to gravity, 3) Groundwater is connected to surface water, 4) Groundwater is part of the water cycle, and 5) We use groundwater. Reported student learning gains for the last two years were only 15% and 13%.

The Arizona English Language Arts/Literacy standards require 3rd grade students to *“Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).”* Furthermore, the Next Generation Science Standards (NGSS) practices ask students to *“Develop and Use Models.”* APW wanted to improve students’ foundational knowledge of the groundwater system, while addressing these visual literacy standards through the use of models.

The new lesson engages pairs of students through interactions with their own 3-D groundwater models. The students are better able to explore the system and make observations with these models. Facilitators then relate the 3-D models to a visual representation of the system (2-D model), while connecting both models to the real-world groundwater system. The same five big ideas are conveyed in this new lesson. Student learning gains have increased significantly through the use of this new lesson (details are included in Section IV page 15). Mrs. Howe, 3rd grade teacher from Soleng Tom School, exemplified many of the positive comments received from teachers, *“My students thoroughly enjoyed the experience of the presentation. I thought the hands on activities were engaging, kept the students interest, and allowed them to see the movement of the water as [compared] to just looking at pictures or diagrams. The presenters did a great job explaining the concepts and informing students on how to use the materials. Thank you so much for your time!”*

Systems Thinking

In 2015, the APW team launched into a year of discovery and improvement. Engaged in the Thinking 101 online course (<http://www.metamap.me/tabs/online-training>) and webinar sessions with the Cabrera researchers, the team learned the value of systems thinking and began to embed it in to APW instruction. As a partner of Cabrera Research Labs (<https://www.crlab.us/#home>), APW’s work focused specifically on giving thinking a structure and language, by making distinctions, identifying parts and wholes, making relationships and taking perspectives. With this structure and language students can think about their own thinking or reflect. Learning to think through issues using a common structure ultimately leads to the ability to make cognitive connections between fields and disciplines. This is true STEM education.

IV. Programs

Teacher Professional Development

Arizona Project WET Teacher Academies offer professional development that evolves teachers' instructional practice and water-related content mastery through STEM integration, student-directed learning, real-world and relevant application, and collaborative work. Academies provide the support that teachers need to adopt instructional practices that encourage students to apply their learning in developing ideas, designing solutions, and delivering positive change. As a result of our academies, students will be taught to think critically, gain deeper understanding, and evaluate, prioritize and apply knowledge to find solutions. APW's multi-day Teacher Academies and one-day workshops help teachers meet the goals of the Arizona College and Career Ready Standards and the Science and Engineering Practices from the NGSS Framework.

This year, **182 K-12 teachers** participated in APW's professional development, which improved their instructional practice through real world, relevant STEM integration. Those **teachers engage 13,107 students each year** in curriculum that advances critical thinking, problem solving and collaboration skills. At the beginning and end of each workshop day, teachers rate their level of mastery of academy-specific content and skills using a 1 (low level) to 10 (high level) point scale. This year, teachers' average knowledge gain was nearly two-fold. **The average gain for all workshops was 46.4%** using the following formula:

$$\frac{(Post\ Survey\ Avg - Pre\ Survey\ Avg)}{Post\ Survey\ Avg} \times 100\%$$

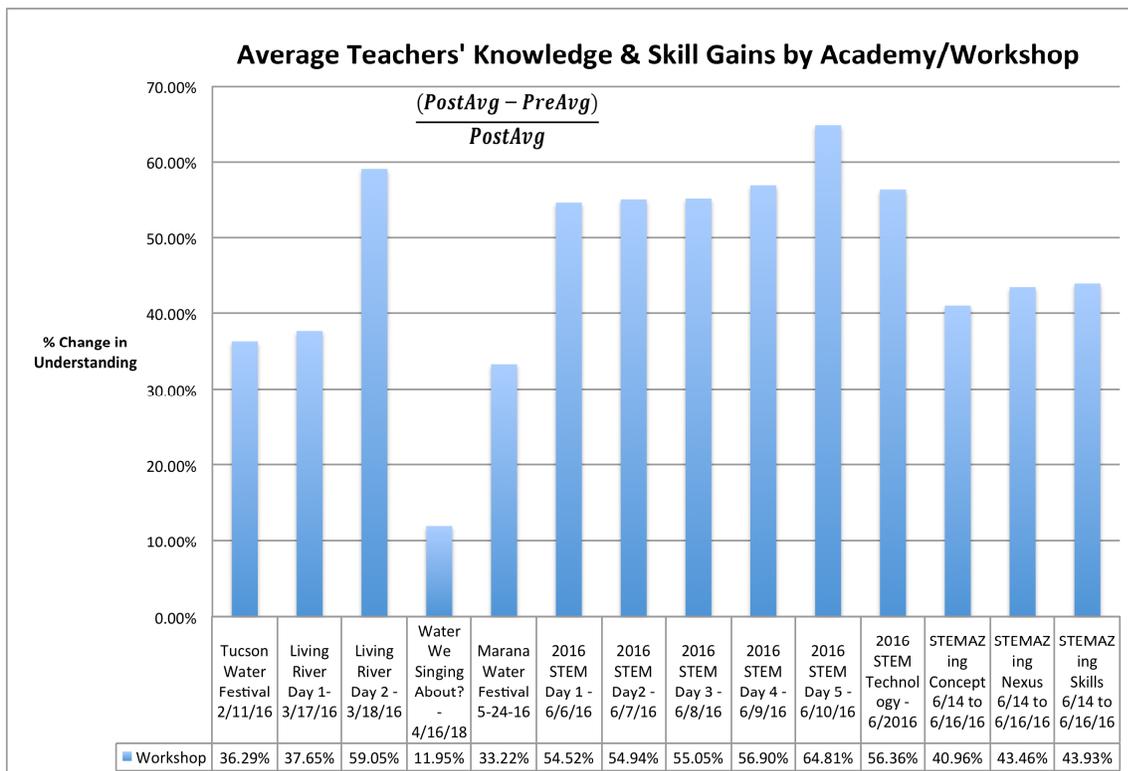


Figure 2

Post-academy or workshop, APW asks teachers to evaluate its utility and efficacy using a standard set of 12 questions on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). **In all the workshops, the majority of questions received 95% responses of “Strongly Agree” or “Agree.”**

Graphs outlining knowledge and skill gains, and evaluation results for each academy and workshop can be found in the appendix of this report.

Academies

Academies are characterized as multi-day offerings.

2016 Tucson STEM Academy – (June 6-10, 2016)

Tucson Water partnered with APW to deliver the fourth Tucson STEM Academy for 25 area teachers. The mix of teachers was fairly evenly split between intermediate (grades 4,5,6), middle school (grades 7,8) and high school (grades 9-12). Five school districts, one private school, and five charter schools were represented.

This STEM Academy immerses the teachers in learning about the urban water cycle, water supply, water quality, water treatment, and water efficiency, all components of Tucson Water’s reliability mission. Academy tours “follow the water” and collectively provide teachers with a cogent understanding of water management in our community. The multi-day tour destinations include Central Arizona Project (CAP) Twin Peaks pumping station, Southern Avra Valley Storage and Recovery Project (SAVSARP), Tucson Area Remediation Project/Advanced Oxidation Process (TARP/AOP), Agua Nueva Reclamation Plant, and UA Water & Energy Sustainable Technology (WEST) Center. The field experience is augmented by presentations and lessons that reinforce and expand ideas and understanding. The addition of systems thinking into the five days assisted teachers in understanding Tucson’s water distribution and management system. They left with a new confidence in Tucson’s water reliability.

Technology applications, integrated into lessons throughout the week, challenge the teachers to learn new skills as they work to master the content. Nightly homework requires them to reflect and summarize their learning using technology. On the last day, using content that is meaningful to them and pertinent to their students, teachers construct and present an infographic. These shared products solidify their sense of accomplishment and excitement. Despite their exhaustion at the end of a long week, the teachers are appreciative, *“Thank you for facilitating this training, I am looking forward to put some of this to use at my school in the fall!”*

Across the week, teachers’ mastery of content and technology applications/skills averaged a 57% increase. Teachers’ understanding of STEM careers within Tucson Water increased 67% over the course of the academy. An average of 94% of the final evaluation responses were “strongly agree” or “agree” for this workshop. (Appendix, Figures 1 – 7)

The commitment, time and professional knowledge that TW employees provide in the planning and execution of this academy is invaluable. A testament to the APW-Tucson Water partnership and breadth of the Tucson Education Program, *“This is a strong training and I especially appreciate the information on resources and people that will come to school to supplement or give lessons and provide experiments to run with the students.”* At the culmination of the workshop, teachers rated Tucson Water’s quality, reliability, forward thinking and innovation. On a scale of 1 (low opinion) to 10 (high opinion), the four areas received an average rating of 9.4. (Appendix, Figure 8) **The teachers left the academy with a greater understanding of their community’s water supply and management system and a new confidence in the sustainability of that system.**

2015 Tucson STEM Academy Follow-up – April 30, 2016

Sometimes at the end of the STEM Academy week in June, teachers are so exhausted that they don’t always realize the value of the week, until they have time to process and utilize the material. The Follow-up Academy in the spring, provides this reflection and collaboration time. Nearly all of last year’s STEM Academy teachers returned to present and collaborate with each other during the follow-up workshop in April. The day was spent in peer-to-peer discussions and presentations where teachers shared how they implemented STEM Academy material in their classrooms. **All of the returning teachers did an excellent job incorporating APW lessons and information from Tucson Water into their curriculum.**

In the evaluation this year, teachers were asked to reflect and comment about their participation in the 2015 Tucson STEM Academy. The teachers value the impact the Tucson STEM Academy has on their instructional practices, technology skills and knowledge of water resources in Arizona. **On a scale of 1 (to a minimal extent) – 10 (to a great extent), teachers’ responses to the statement, “My knowledge of water resources in Arizona has increased because of my participation in the Tucson STEM Academy” averaged 9.24.** Teacher comments supplemented the numerical ratings of the impacts. One teacher has shifted to hands-on student learning, *“The STEM workshop gave me ideas and actual lessons I can use with my classes. I have been able to use hands on activities for my students which is much better for learning.”* The technology tools were incorporated into another classroom, *“Tucson STEM academy has expanded my use of technology in the classroom; giving me tools and strategies to guide students in technology.”* Content knowledge also made a big impact for these teachers, *“I came into this program knowing that I paid a water bill and that I lived in the desert where water is scarce. I was able to integrate the resources that I learned not only into my classroom but also into my everyday life,”* and *“In retrospect I realize that I had very little knowledge about the actual water delivery and storage systems in Tucson. The tours and information provided during the academy increased my knowledge about Arizona and the Colorado River Watershed 100-fold.”* **Teachers also valued and used the resources provided in the academy. Ninety-four percent of teachers used the Project WET 2.0 book and 64% used information from the tours. (Appendix Figures 9-10)**

Living River Academy – March 17 & 18, 2016

APW partnered with Pima County Natural Resources Parks & Recreation to provide a spring break academy to nineteen 4th – 12th grade teachers focused on the Santa Cruz River. Teachers developed a language and structure for systems thinking in order to; distinguish

between a living river and a non-living river; identify parts of the living river system; discover relationships to other natural systems, the urban water cycle and stormwater; and examine the river from many perspectives. They spent an afternoon in the field investigating the water quality & quantity, aquatic life, vegetation and wildlife of the river system. In the classroom, they used Excel to analyze their field data and compare it to real-world data from the Sonoran Institute and Pima County.

Teachers' mastery of the content areas increased an average of 48%, and 98% of the teachers rated the workshop favorably across all 12 areas on the post evaluation. (Appendix Figures 11-14)

STEMAZing Institute – June 14-16, 2016

APW partnered with the Office of the Pima County Superintendent to provide one of the five strands offered in this year's STEMAZing Institute. The workshop entitled, *Water Energy World*, provided 3 days of training, which culminated on the third day with engineering projects, data, discussion and case studies that made clear the interdependence between water and energy in our region. Teachers left with a clear understanding of the energy used to lift and move water to Tucson, and the water needed to produce that energy.

Teachers' mastery of the content areas increased an average of 43%, and the workshop received the highest possible ratings, where 100% of the responses were "Strongly Agree" or "Agree." (Appendix, Figures 15-18)

One-Day Workshops

Tucson Water Festival Teacher Workshop – February 11, 2016

The Arizona Water Festival program engages teachers in learning foundational knowledge about interconnected water resources, while also preparing their students for the Water Festival Community Education Event. A workshop was provided for 14 Tucson-area teachers in February. **Teachers' mastery of the content areas increased an average of 36%, and 98% of the teachers rated the workshop favorably across all 12 areas on the post evaluation.** (Appendix, Figures 19-20)

Water We Singing About? – April 16, 2016

APW partnered with Pennsylvania Project WET coordinator, Kevin Kopp, to provide a workshop for eight K-5 teachers focused on incorporating arts into STEM learning about water in the environment. APW modeled lessons and enhanced them with songs created by Mr. Kopp. The teachers in the workshop demonstrated a high level of background knowledge prior to the workshop, with an average content mastery of 8.06 (on a scale of 1-10). In most workshops, teachers average 4.04 in content mastery prior to the workshop. However, they still reported a 12% gain in the mastery of the content. **In the post evaluation, 96% of the teachers rated the workshop favorably across all 12 areas.** (Appendix, Figures 21-22)

Marana Water Festival Teacher Workshop – May 24, 2016

In preparation for a 2016-17 Marana Water Festival program, 25 Marana School District teachers engaged in learning foundational knowledge about interconnected water resources, while also preparing their students for the Water Festival event. **Teachers'**

mastery of the content areas increased an average of 33%, and 86% of the teachers rated the workshop favorably across all 12 areas on the post evaluation. (Appendix, Figures 23-24)

Student Educational Programs

Direct student education programs support curriculum units for 3rd, 4th and 6th grade students and Tucson STEM Academy teachers from the past 4 years. Programs this past year included in-classroom groundwater flow model presentations, Sweetwater Wetlands Water Festivals, school water audits, home water audits, community water festivals, the Discovery Program, and drinking water quality testing.

Third Grade Curriculum Unit Programs

3rd Grade Groundwater Presentations

A one-hour classroom presentation facilitated by APW Water Educators is an integral part of the 3rd grade water curriculum. The in-classroom presentation is supported by pre- and



*3rd Grade Students Interacting
With Groundwater Model*

post-instruction. Using the new individual groundwater models, Water Educators build foundational knowledge by asking questions and facilitating learning. Students learn that: 1) Groundwater is between the grains of sand and gravel, 2) Groundwater moves through sand and gravel due to gravity, 3) Groundwater is connected to surface water, 4) Groundwater is part of the water cycle, and 5) We use groundwater. Students are directed through a hands-on exploration of each of the concepts and then directed to a whiteboard to understand the visual representation of the concepts in a 2-D model. Lesson scripts are available upon request. **APW Water Educators conducted 131 in-classroom presentations for 3,220 3rd grade students and 136 teachers.**

The assessment consists of matching the big idea statements with a visual representation of the statement. It is administered prior to the presentation and revisited following the lesson. The assessment covers the main ideas of the lesson and requires students to make connections between illustrations and the text as outlined in the Arizona English Language Arts/Literacy standards. **Overall students' knowledge gain averaged 33%, compared to the old lesson where student gains averaged 14% over two years.** (Appendix, Figure 25) The concept, *Groundwater is connected to surface water*, posted gains of 43%, with the new lesson. In previous years, slight losses in understanding were reported for this concept. The revised 3rd grade lesson has provided very positive results. The assessment instrument is included as an attachment to this report.

3rd Grade Sweetwater Wetlands Water Festival

Also an integral part of the 3rd grade water curriculum, the Sweetwater Wetlands Water Festival is an event designed to synthesize students' conceptual understanding of the of the entire water unit. The Sweetwater Festival consists of lessons on the Water Cycle, Water Conservation Technology and Watersheds, which have been adapted from the Arizona Water Festival model. During the fourth lesson, students explore the wetland ecosystem and reflect on the uniqueness of the place. **The Sweetwater Festival instructed 2,996 third grade students in 135 classes, along with their teachers and an additional 481 parents during the 49 field trips.**

Teachers administer pre-assessments to students prior to their Sweetwater visit. Pre-assessments are provided to teachers when APW educators come in to deliver the groundwater flow model presentation. The corresponding post-assessment is administered during the festival after each lesson via a booklet that students wear around their neck on a lanyard. Copies of the assessment instrument are available in the attachments section. **Overall, student learning increased 46% as measured by the percentage of correct responses in the pre- and post-assessments.**



*Students Exploring Watershed Model
At Sweetwater Wetlands*

Past years' assessments showed that 3rd grade students often understand how individual actions can conserve prior to the water conservation lesson. This year the lesson was modified to introduce the use of technology as a means of saving water. **Students showed a 31% gain in learning about water conservation with the new lesson that introduces technology.** Last year's water conservation lesson that focused solely on actions only posted a 9% gain in student understanding.

The average learning **increase of 58%** shows student understanding for the concept that a "Watershed is a **land area** that drains to a **low point**, and water in a watershed moves because of **gravity**." Students gained 56% in understanding the concept that, "The wetlands provide food, shelter and water." Moreover, 97% of the students could name a bird/animal that lives at the wetlands. **Understanding of the water cycle increased by 54%.** (Appendix, Figures 26-28)

At the end of the wetlands tour, students are asked the following questions. "What is different about this place compared to where you live?" (Appendix, Figure 29) "How did it feel to be here?" (Appendix, Figure 30) Student responses were placed into a word cloud. The words that were repeated most often appear larger in the image.

Sixth Grade Curriculum Unit Programs

6th Grade Groundwater Presentations

Sixth grade Arizona Science Standards incorporate earth science and water concepts into the curriculum. APW Water Educators provide a 1-hour groundwater presentation to 6th grade classrooms as an integral part of their science curriculum. The science standards were written to have older students spiral back to important concepts to build on the foundational knowledge acquired in earlier grades. For APW, first and foremost, that content is groundwater, the least understood and least taught part of the hydrologic cycle. **APW Water Educators facilitated 82 classroom presentations, reaching 2,054 students and 33 teachers in 25 schools throughout Tucson.**

Students are assessed on their understanding of key concepts by differentiating between diagrams that depict the key concepts of: 1) *Groundwater moves underground*, 2) *Groundwater is in the pore spaces*, 3) *Groundwater is connected to surface water* and 4) *Groundwater is part of the water cycle*. The assessment instrument is included in the Appendix of this report. **The students averaged a 31% increase in overall learning.** The most dramatic increases in learning involved the understanding of Tucson's sources of drinking water. Gains of 75% were seen in the understanding that a portion of Tucson's supply of drinking water comes from the Colorado River, and there was a 55% gain in understanding that groundwater is a source of Tucson's water supply. (Appendix, Figure 31)

Tucson STEM Academy Teacher Support Programs

Groundwater Presentations

In support of STEM Academy teachers, 9 additional groundwater presentations were provided to 221 students this year at the high school level and above. One presentation was provided to pre-service teachers in a Northern Arizona University teacher certification program at their Tucson campus.

An interactive summary (a click on each marker brings up the summary of that presentation) of the distribution of all APW groundwater presentations across Tucson is available on Google Maps at: <https://goo.gl/rkaM9S>. A screenshot of the map is provided in (Appendix, Figure 32)

School Water Audit Program

The School Water Audit Program (SWAP) is unlike the hundreds of audit programs found online. Most are simple inventories of water use. Students in the SWAP collect real data (e.g. measuring flow rate) using a scientifically replicable process, and grapple with that data to find meaning. The curriculum units on both the indoor and outdoor audits move students through a thinking process, which is designed to teach them to apply their learning by asking their own questions and designing a means to find the answer. They use their data as evidence to make claims about their understanding and take action to implement changes or make recommendations for solutions.

The SWAP is specifically designed to improve critical thinking and problem solving skills through a focused and innovative educational program that yields water savings through

technological and behavioral change. In each module, applied mathematics is utilized to analyze real-world data and make claims, arguments and recommendations based on that data. The SWAP offers a perfect union of real world, rigorous and relevant STEM learning while also addressing Arizona's growing water deficit through water efficiency and conservation.

Tucson Unified School District (TUSD) is one of Tucson Water's largest customers. As part of a long-term drought preparedness plan, Tucson Water conservation specialists are working closely with TUSD personnel to make recommendations for using water more efficiently. APW assisted Tucson Water and TUSD staff in the audit of two schools. In conjunction with this effort, APW guided students of Tucson STEM Academy teachers in performing irrigation audits of athletic fields at Magee and Hollinger schools. Magee students and teachers along with TUSD staff were recognized for their efforts and recommendations at a District Board meeting.

Additionally, APW assisted Canyon del Oro High School students in a multi-day irrigation audit and Amphi High School students in a one-day irrigation audit. Distribution uniformities and student recommendations were provided to district personnel.

Water Scene Investigation Program

The Water Scene Investigation (WSI) program offers students an opportunity to apply their learning and skills regarding water audits and water efficient technology at home. Water Scene Investigators measure the average flow rate of their bathroom faucets before and after the installation of a new water efficient aerator, and interview family members about their water use patterns. Back in the classroom, they file their report online at the WSI Reporting Portal, where they can also compare their water savings with Water Scene Investigators across the state.

APW facilitated the WSI curriculum at three schools for 204 students, and 77 students installed a water efficient aerator on a home bathroom faucet. A projected water savings of 432,521 gallons/year was reported by the participants on APW's website. The actual water savings may be higher, since many students did not report data online.

Arizona Water Festival Program

Arizona Water Festivals (AWF) instill a deeper understanding of water in the earth system and Arizona's water resources through a community water festival event, teacher professional development workshop, and extensive volunteer and community involvement. The AWF program first engages teachers in professional development that builds understanding about water and water resources, knowledge not covered in a primary grade teacher's preparation. After attending the workshop, teachers implement the standards-aligned curriculum modeled in the workshop, which prepares students for the water festival. The curriculum also deepens students' investigatory learning subsequent to the water festival. The one-day Community Water Festival has trained volunteers from the community engaging up to 1,000 children in an interactive and fun exploration of the groundwater system, watersheds, water conservation technology, and the water cycle.

The Tucson Water Festival serves school districts not reached by the Sweetwater Wetlands Water Festivals. **A total of 32 classrooms from 10 schools** in Amphitheater Unified School District participated in the Tucson Water Festival on March 31st at James Kreigh Park. **Tucson Water volunteers assisted APW in educating 878 students at this festival. The participating fourth grade students showed a 24% overall average increase in their understanding of the groundwater system, watershed, water cycle and water conservation.** (Appendix, Figure 33)

Discovery Program

Participants in the Sweetwater Wetlands Discovery Program utilize a QR code reader on a smart device to explore the wetlands through the lens of a hydrologist, botanist, ornithologist or wildlife biologist. Students hypothesize, record observations and data, draw conclusions based upon their evidence and post them online. The hydrology journey investigates the surface water-groundwater connection at Sweetwater Wetlands utilizing measurement instruments. Students have the opportunity to physically measure the depth to groundwater and compare that with data from a data logger.

This year 254 students from 13 classes in 8 field trips participated in the Discovery Program. APW interviewed Amphi High School students following their Discovery Program field trip. Of the students interviewed, 92% reported enjoying the program, 55% reported that they would do the program on their own outside of class, and 100% said the experience made them want to return to the Sweetwater Wetlands. Teacher enthusiasm is also high as witnessed by Rivera 6th grade teacher Myrna Grijalva, *“Our students had a blast! I believe this is the first fieldtrip where I saw them so engaged and participatory. They are all talking about the great time they had and how they want to go on more fieldtrips. They have been writing about their observations, taping samples in their journals and looking up plants to identify specimens. Your program is very well thought out and informative. There was no time wasted and no room for misbehavior. Mr. Matsushino and I think this is one of the best organized trips we have attended. Keep up the good work and we hope to take more classes to Sweetwater in the future.”*

Drinking Water Quality Testing

APW provides support to teachers who implement drinking water quality testing in their classrooms. Training on the use of the kits is offered at the STEM Academy, and as part of a GK-12 Heatwaves program in the UA Engineering College. Teachers check out testing kits to use in their classrooms and report back as to their use with their students. Tucson Water Quality reports, data tables, directions, and APW’s *How To* videos are available for classroom use. **APW supported 25 classrooms in the use of the drinking water quality kits totaling 611 students.**

Community Outreach

Arizona Project WET provided coverage for Tucson Water at 36 events reaching 2,890 adults and 5,772 students. Large events included Arizona STEM Adventure (formerly Tucson FunFest), Ted Walker Youth Day, and Science City at the Tucson Festival of Books. Family science days/nights at the Tucson Children’s Museum, Biosphere 2, Tucson Botanical Gardens, and local schools were also included. APW provided interactive

lessons including engineering challenges for students, along with water conservation information for adults. Details on individual events are included in the *IGA2016 Reporting* spreadsheet. **Tucson Water promotional items were distributed at events.** (See Table 3)

2015-16 School Year Summary	
Arizona Project WET Programs	
Materials Distributed at Outreach Events	
Sponges, stickers, sticky note pads, pencils, pens	Yes
Faucet Aerators & Flow Bags (1 gpm)	88
Rebate Flyers	Yes
Tucson Toolkit Booklets	297
Water Smart Activity Booklets	2,547
Desert Wash Safety Booklets	84
Sweetwater Wetlands Guides	49
Da Drops Booklets	93
Totals	3,158

Table 3

V. Appendix - Graphs

2016 Tucson STEM Academy

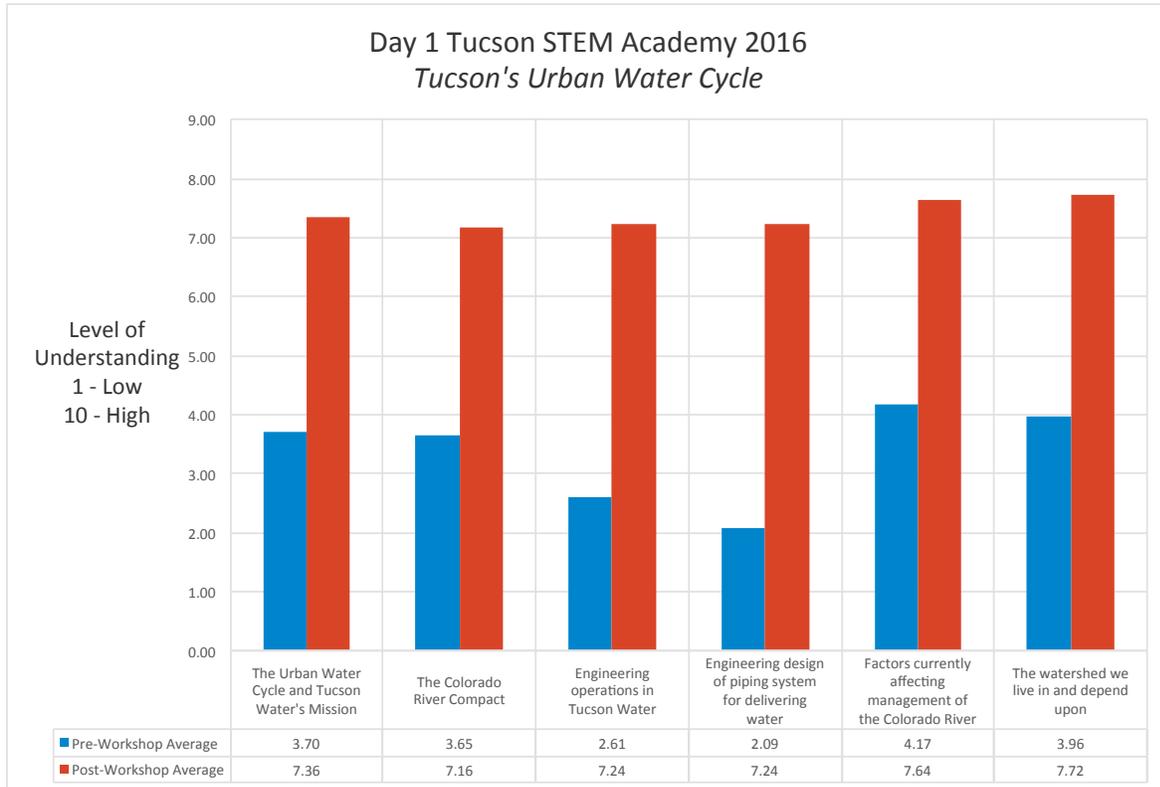


Figure 1 – 2016 STEM Academy Mastery of Content: Day 1

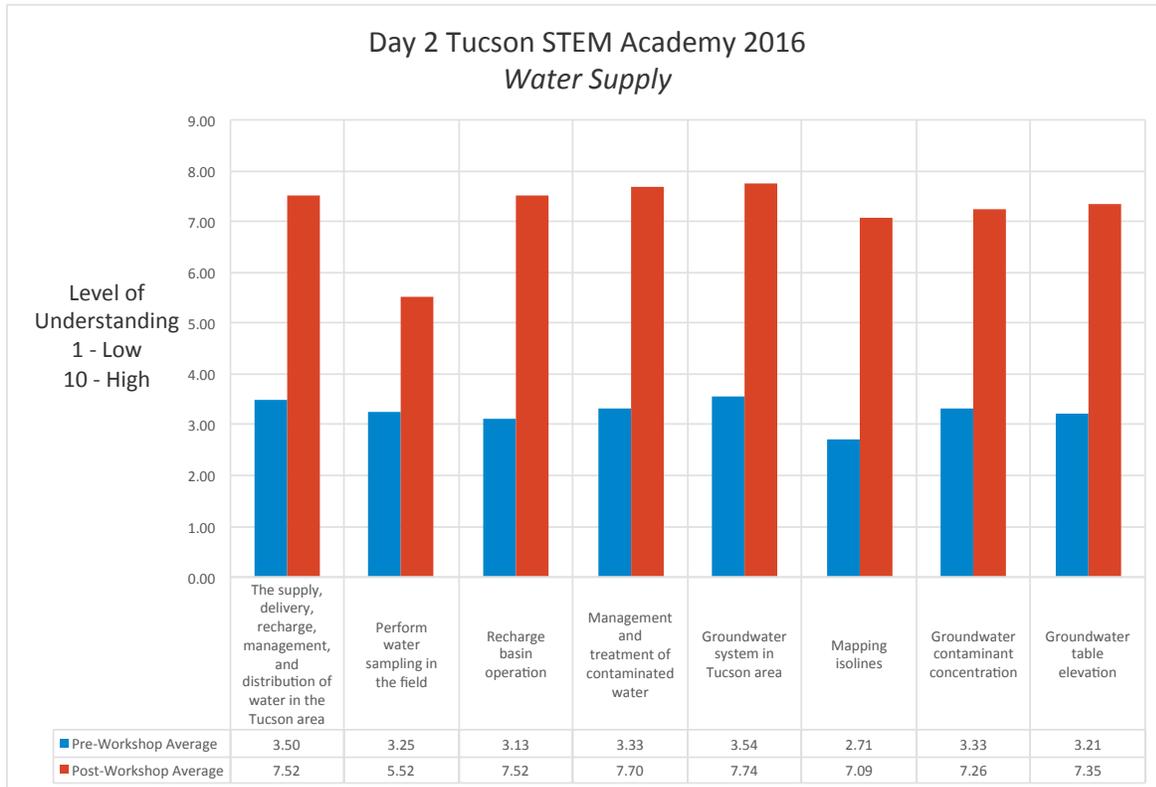


Figure 2 – 2016 STEM Academy Mastery of Content: Day 2

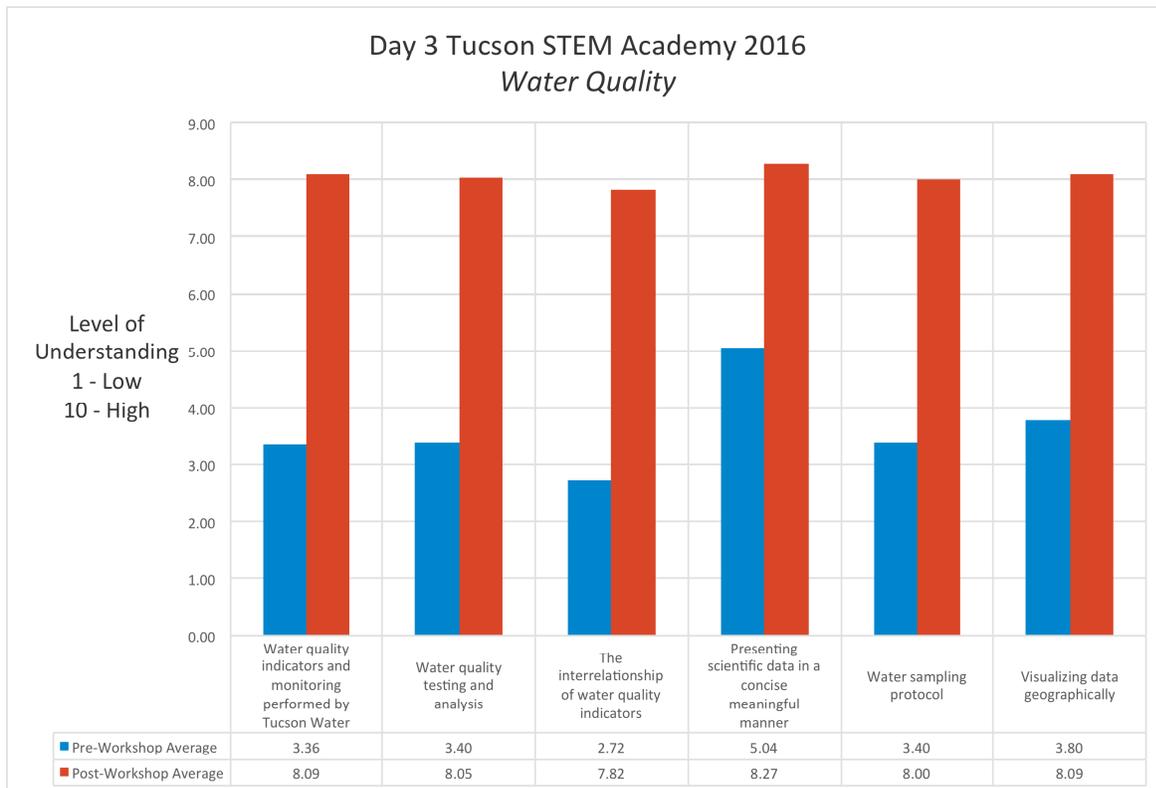


Figure 3 – 2016 STEM Academy Mastery of Content: Day 3

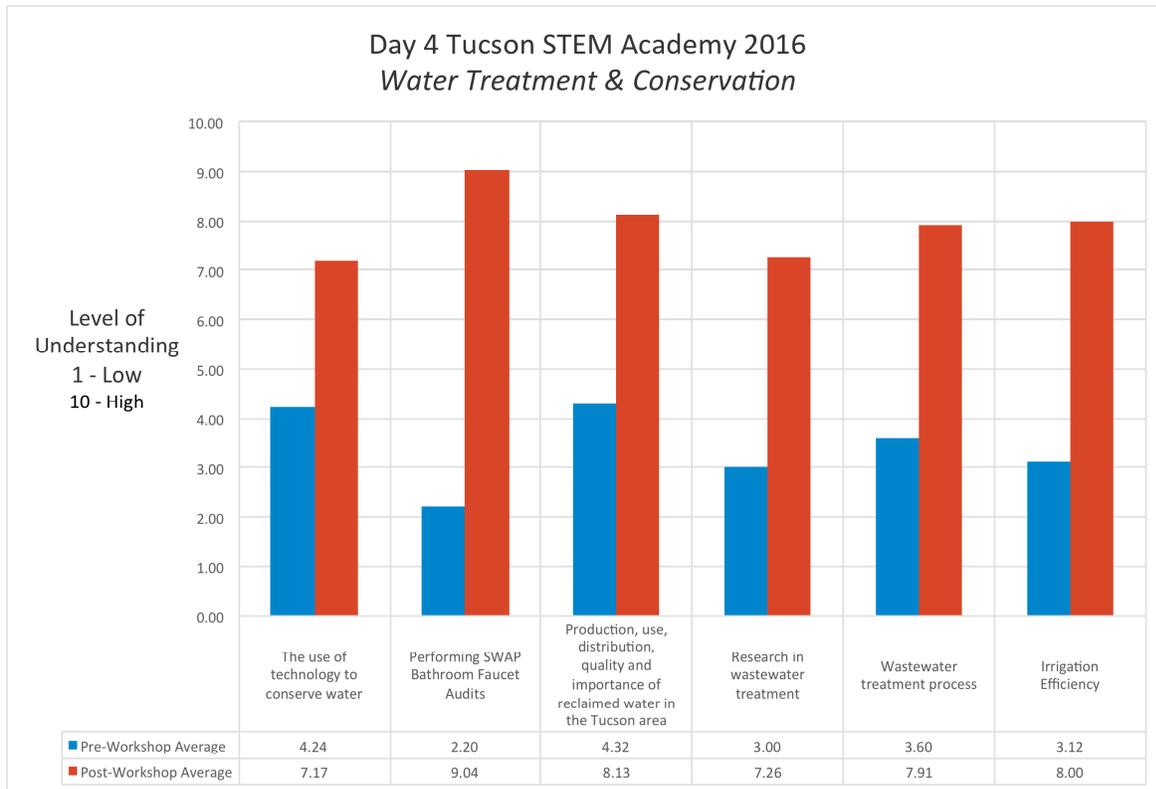


Figure 4 – 2016 STEM Academy Mastery of Content: Day 4

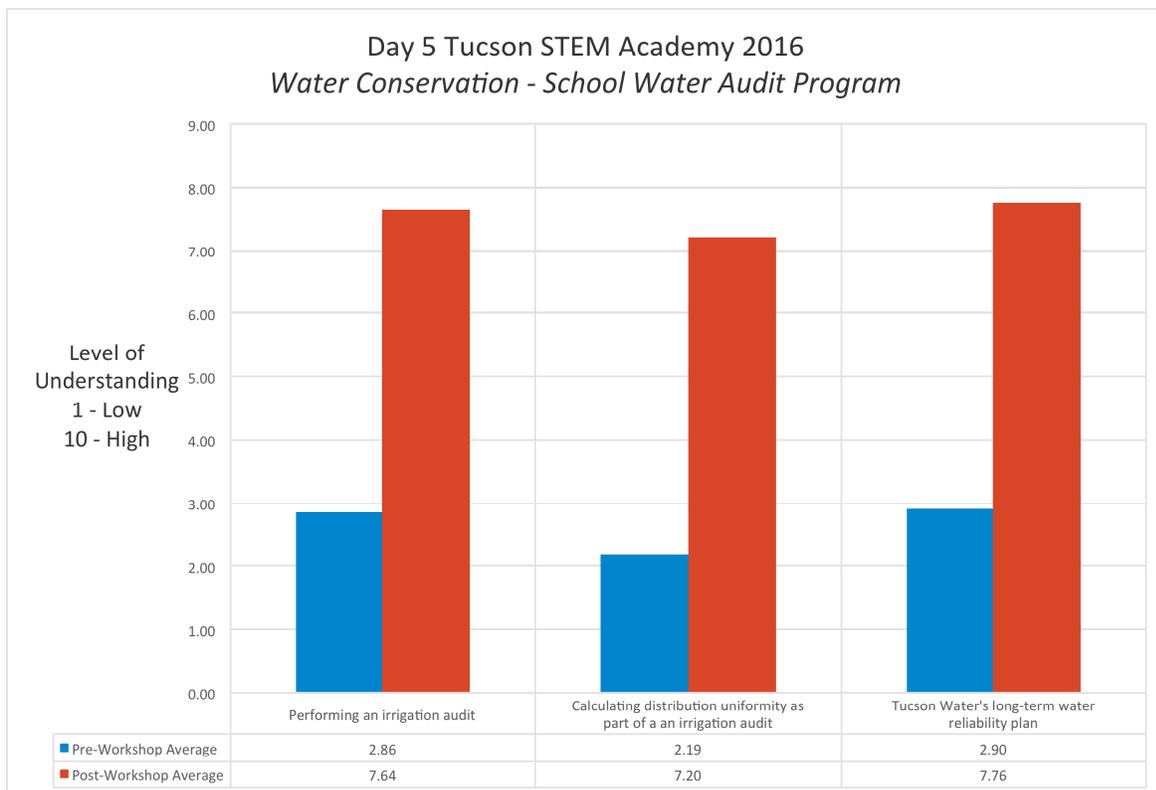


Figure 5 – 2016 STEM Academy Mastery of Content: Day 5

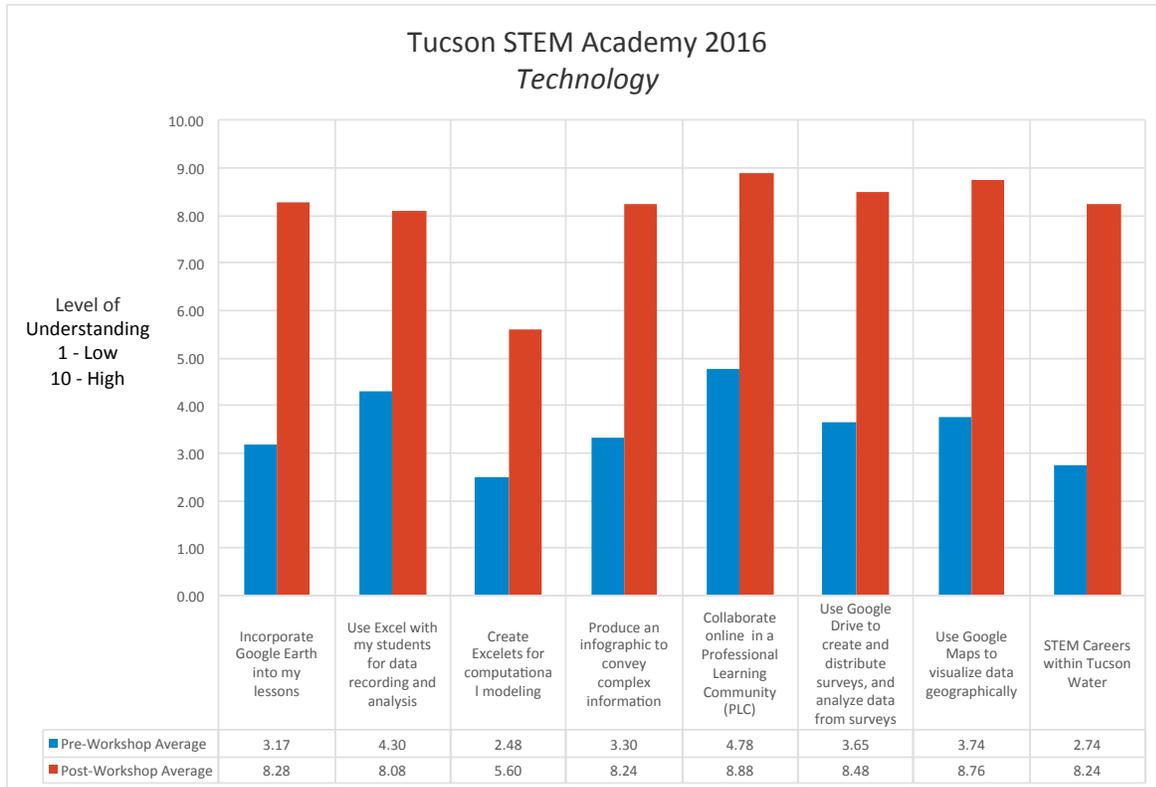


Figure 6 – 2016 STEM Academy Mastery of Content: Technology Skills

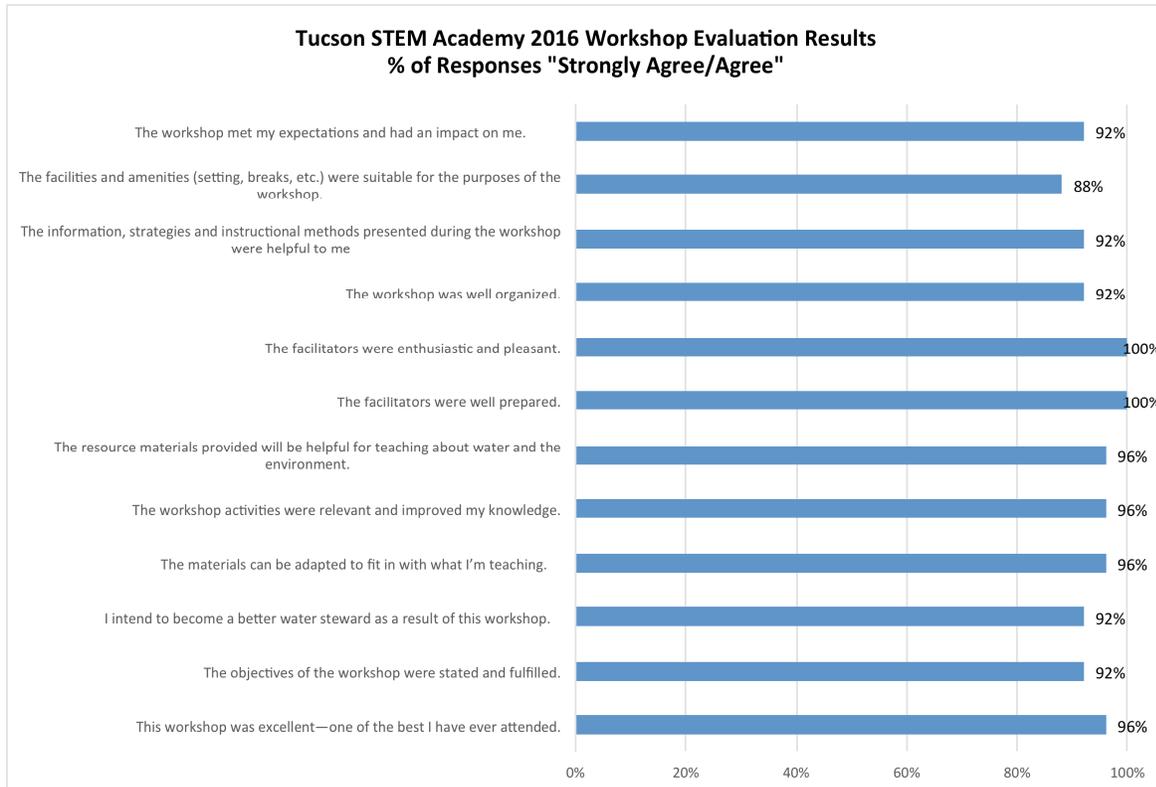


Figure 7 – 2016 STEM Academy: Workshop Rating

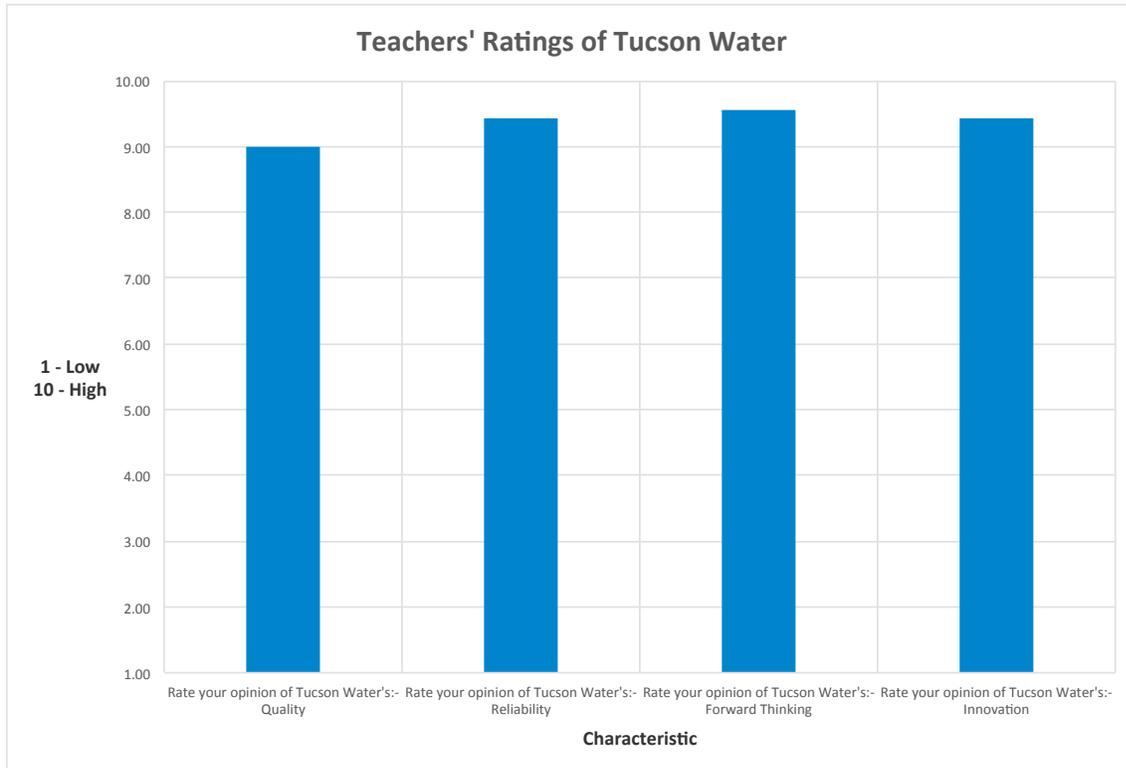


Figure 8 – 2016 STEM Academy: Teachers' Ratings of Tucson Water

2015 Tucson STEM Academy Follow-up

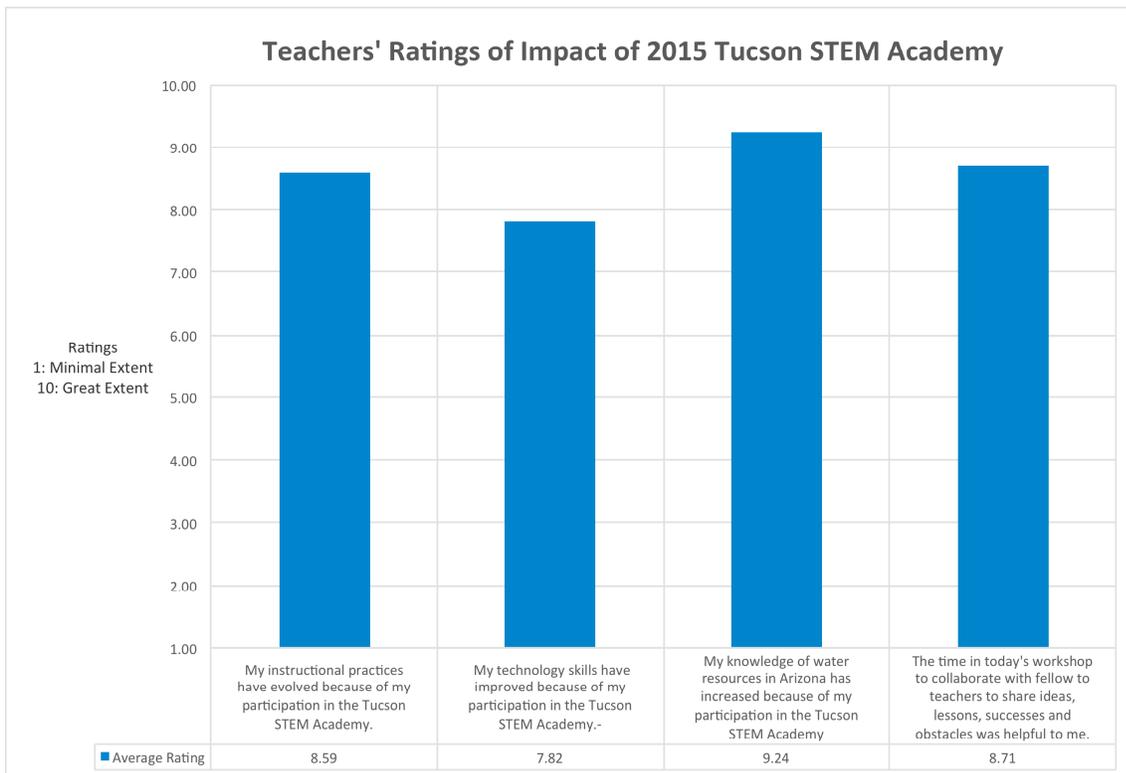


Figure 9 – 2015 STEM Academy Follow-up Impact

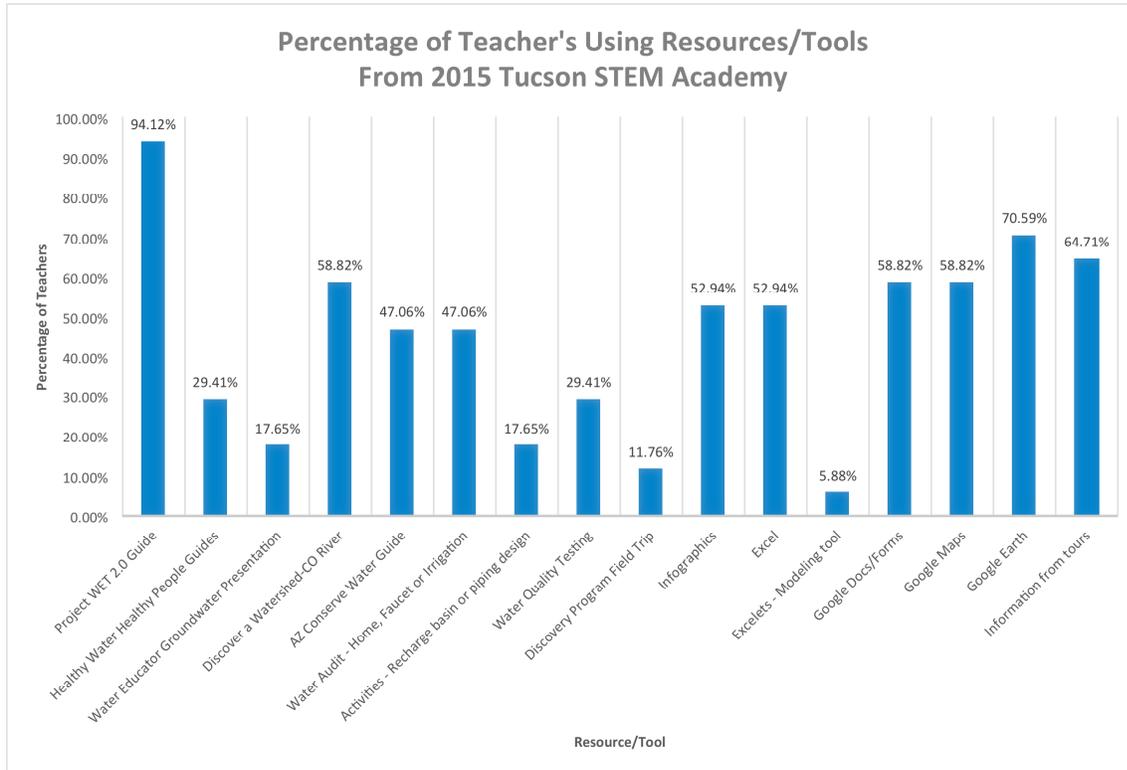


Figure 10 – 2015 STEM Academy Follow-up Use of Resources

Living River Academy

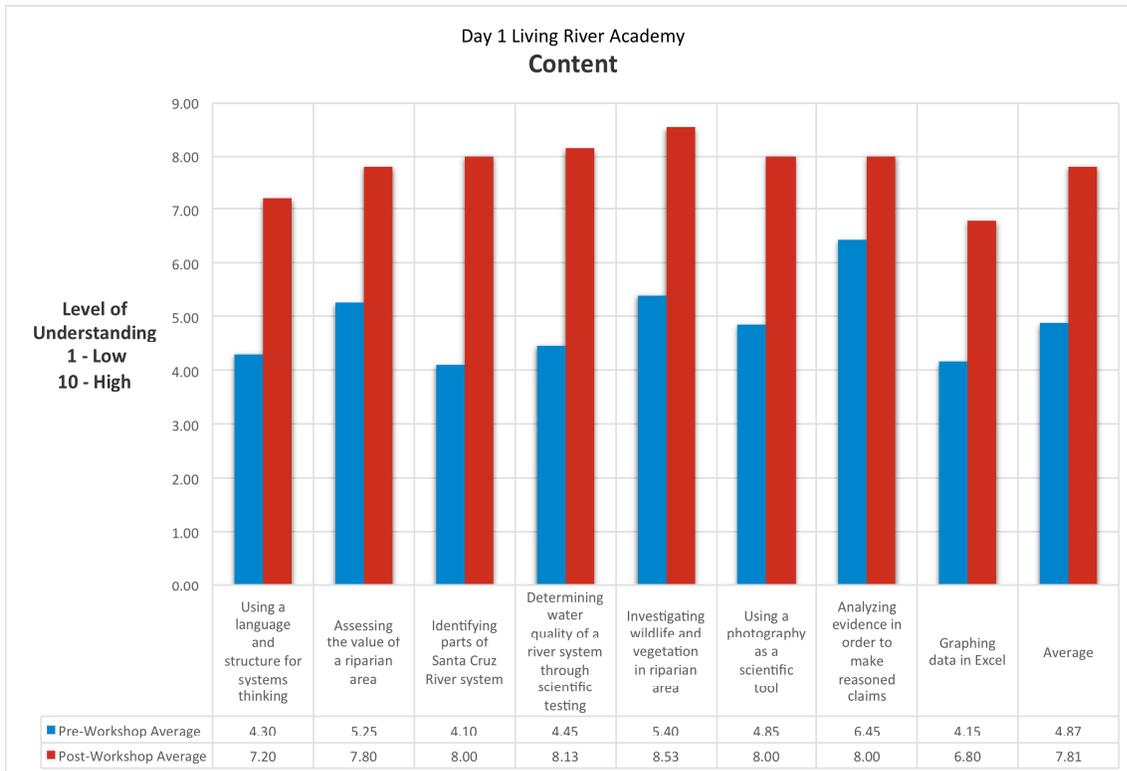


Figure 11 – Living River Academy Mastery of Content: Day 1

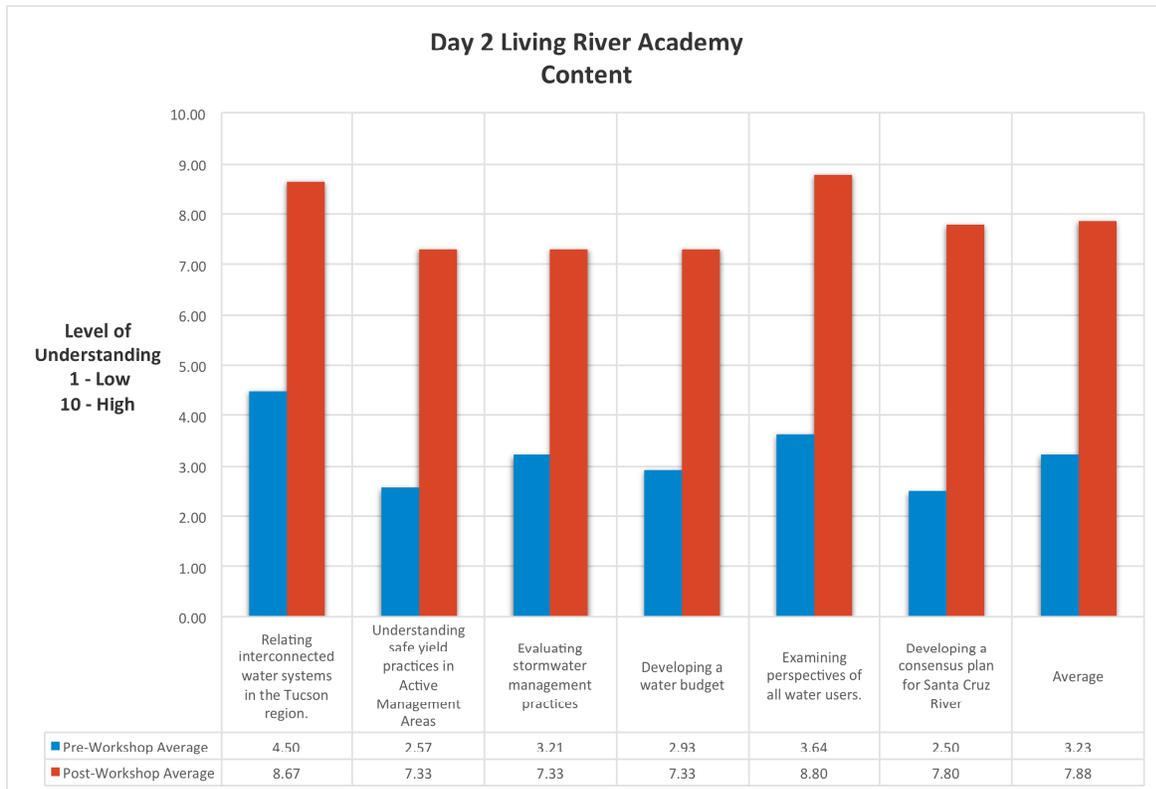


Figure 12 – Living River Academy Mastery of Content: Day 2

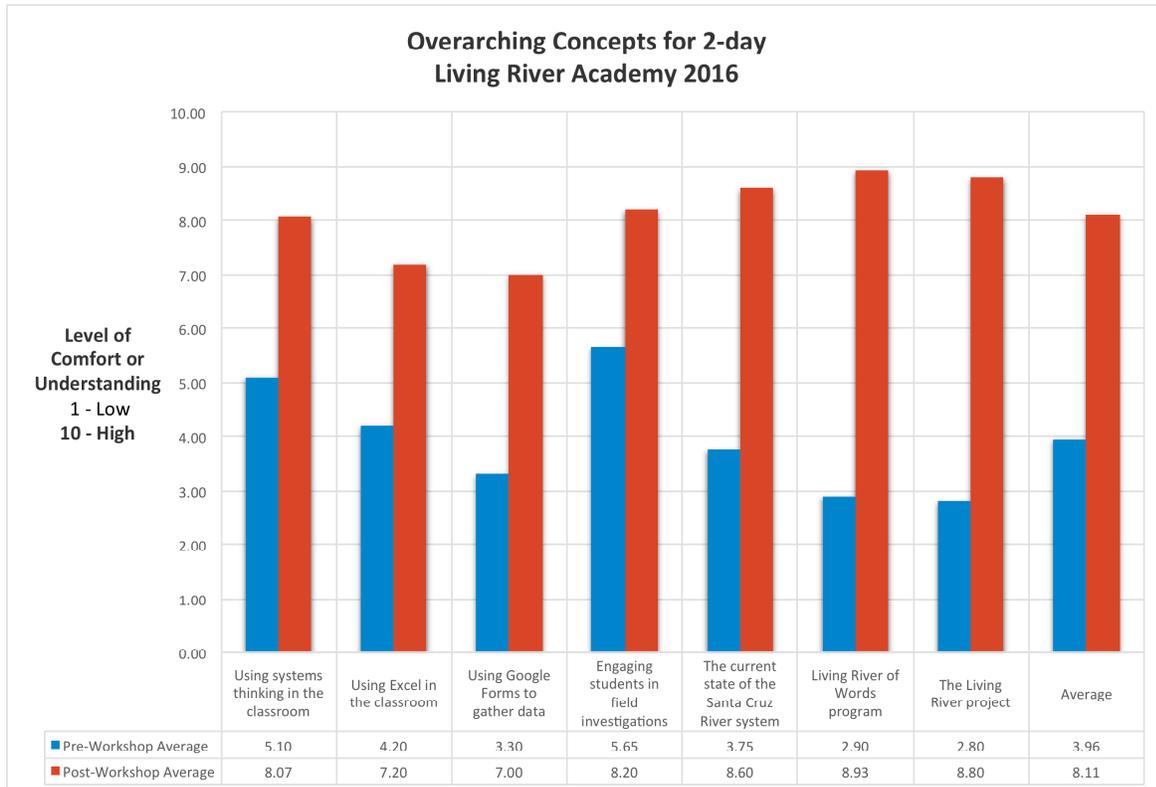


Figure 13 – Living River Academy Mastery of Overarching Concepts

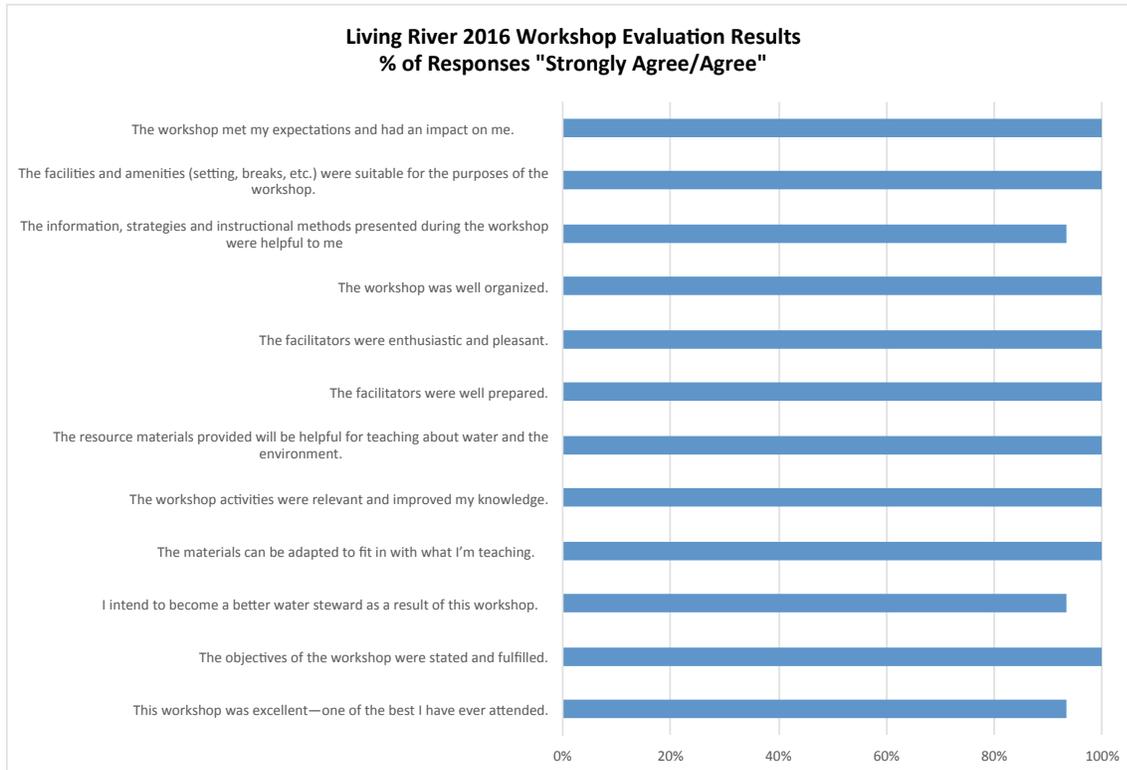


Figure 14 – Living River Academy Workshop Rating

STEMAZing Institute – Water-Energy-World

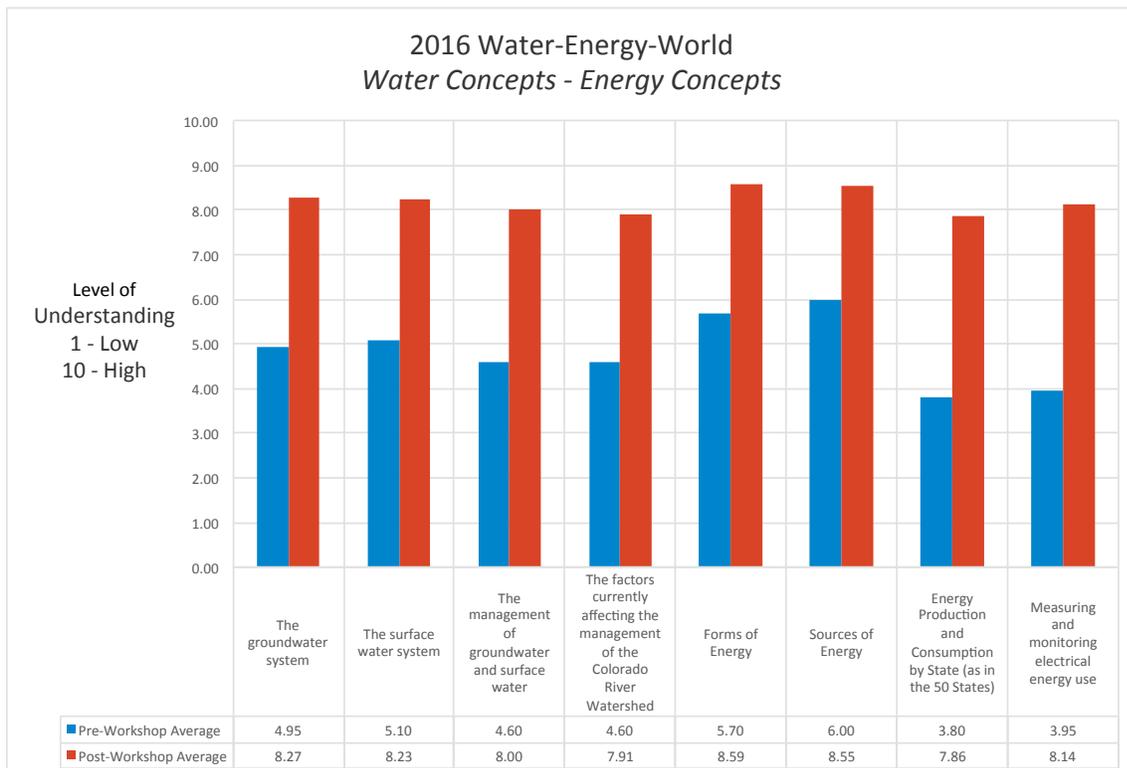


Figure 15 – STEMAZing Institute Mastery of Water and Energy Concepts

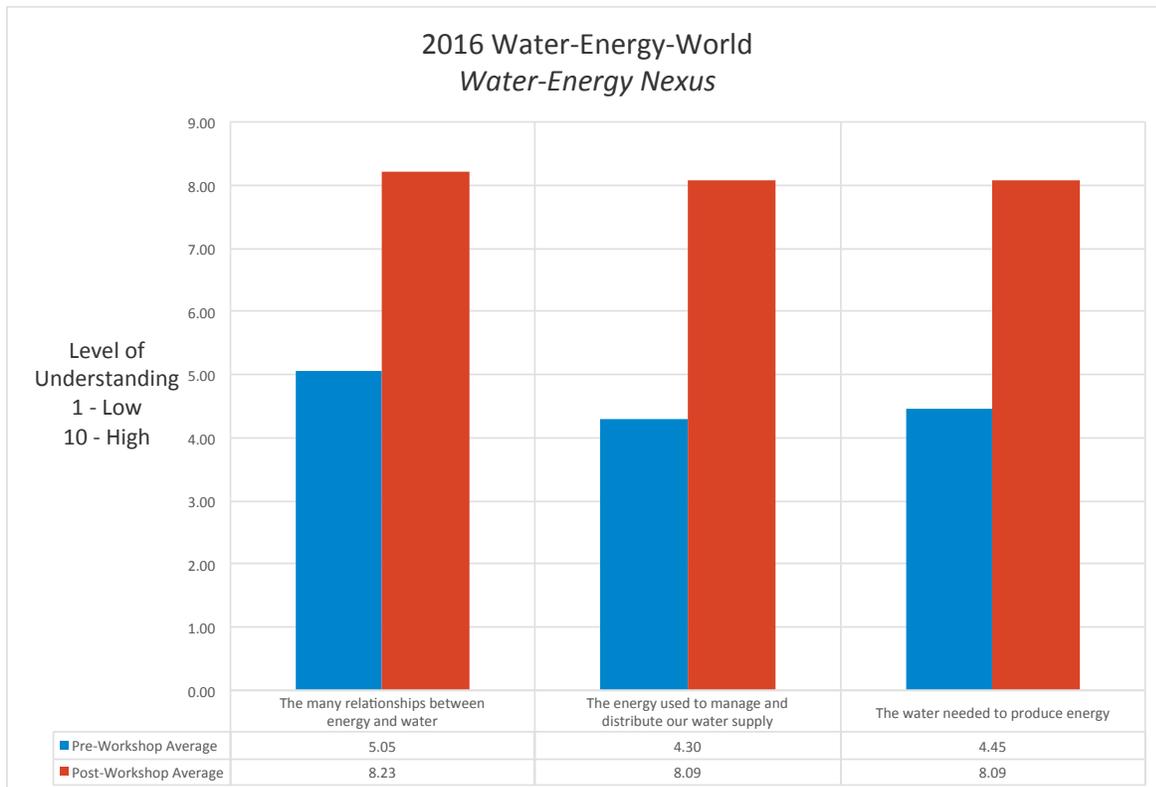


Figure 16 – STEMAZing Institute Mastery of Water/Energy Nexus Concepts

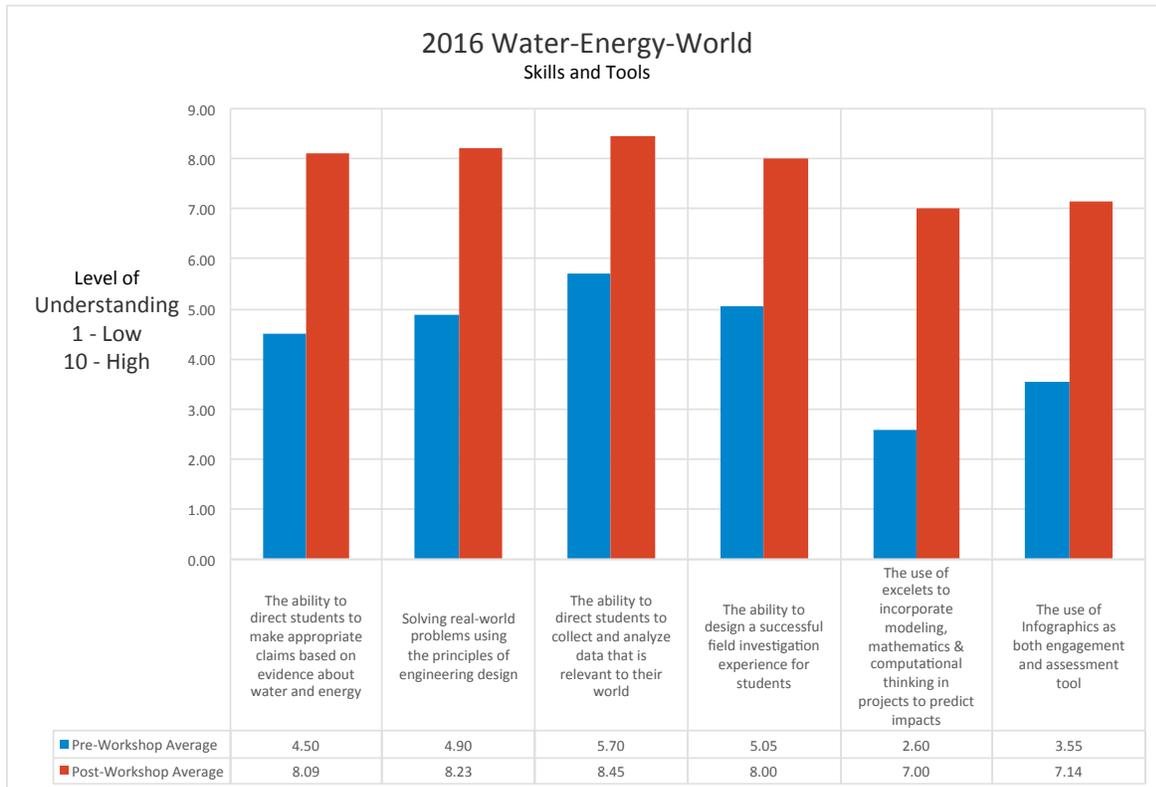


Figure 17 – STEMAZing Institute Mastery of Skills

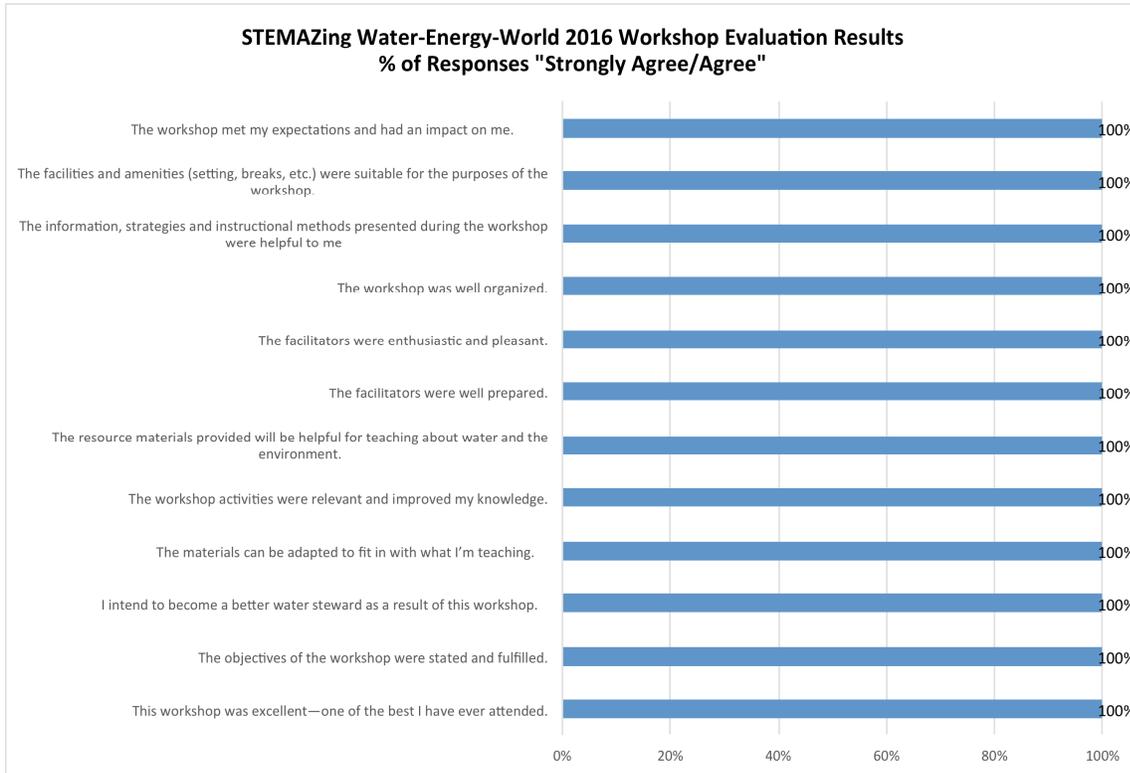


Figure 18 – STEMAZing Institute Workshop Rating

Tucson Water Festival Teacher Workshop

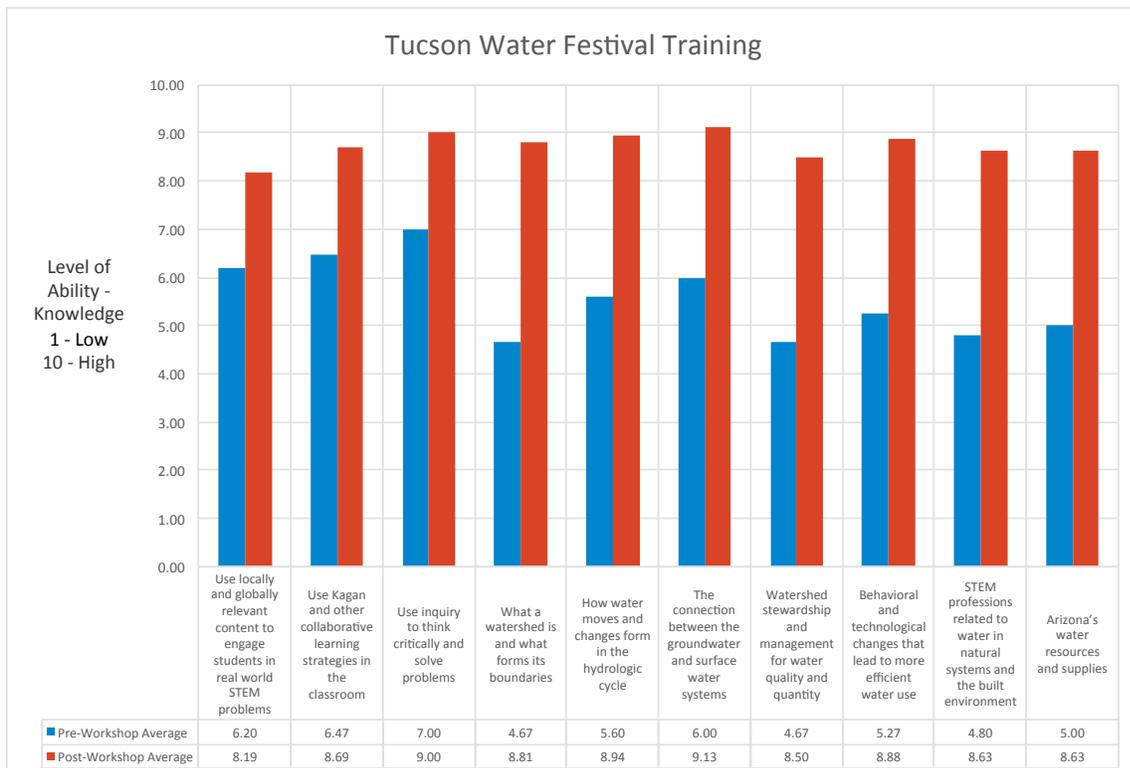


Figure 19 – Tucson Water Festival Workshop Mastery of Content

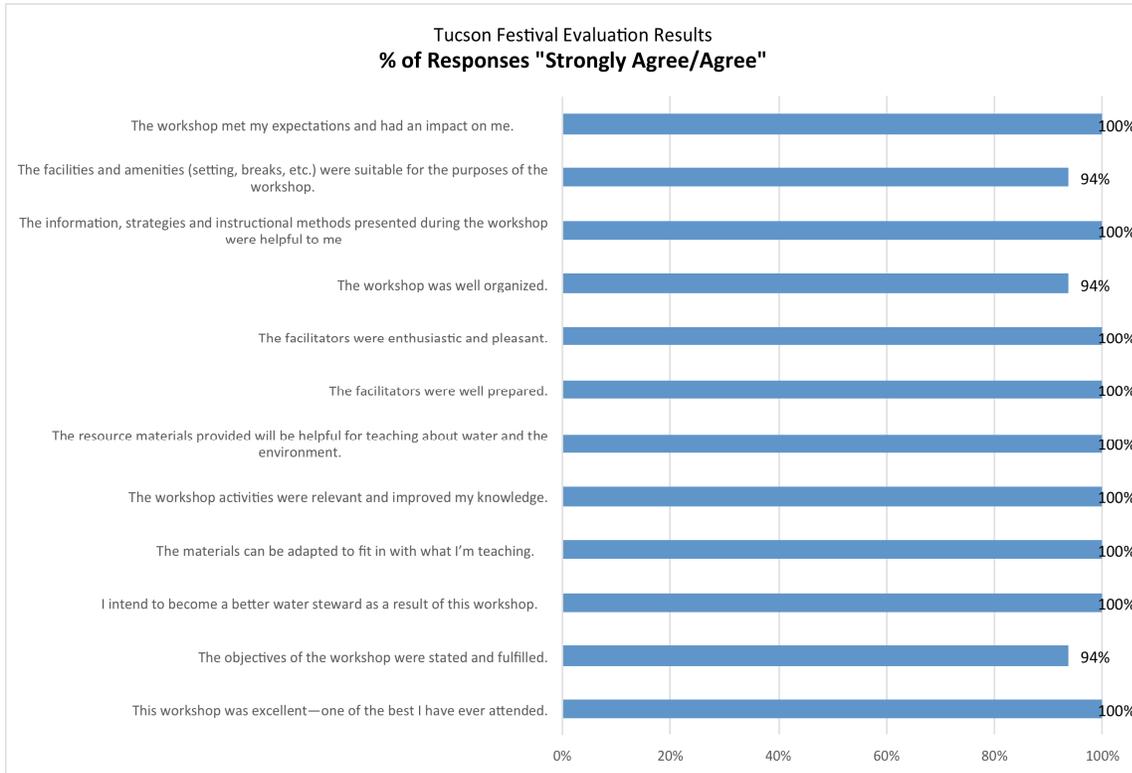


Figure 20 – Tucson Water Festival Workshop Rating

Water We Singing About?

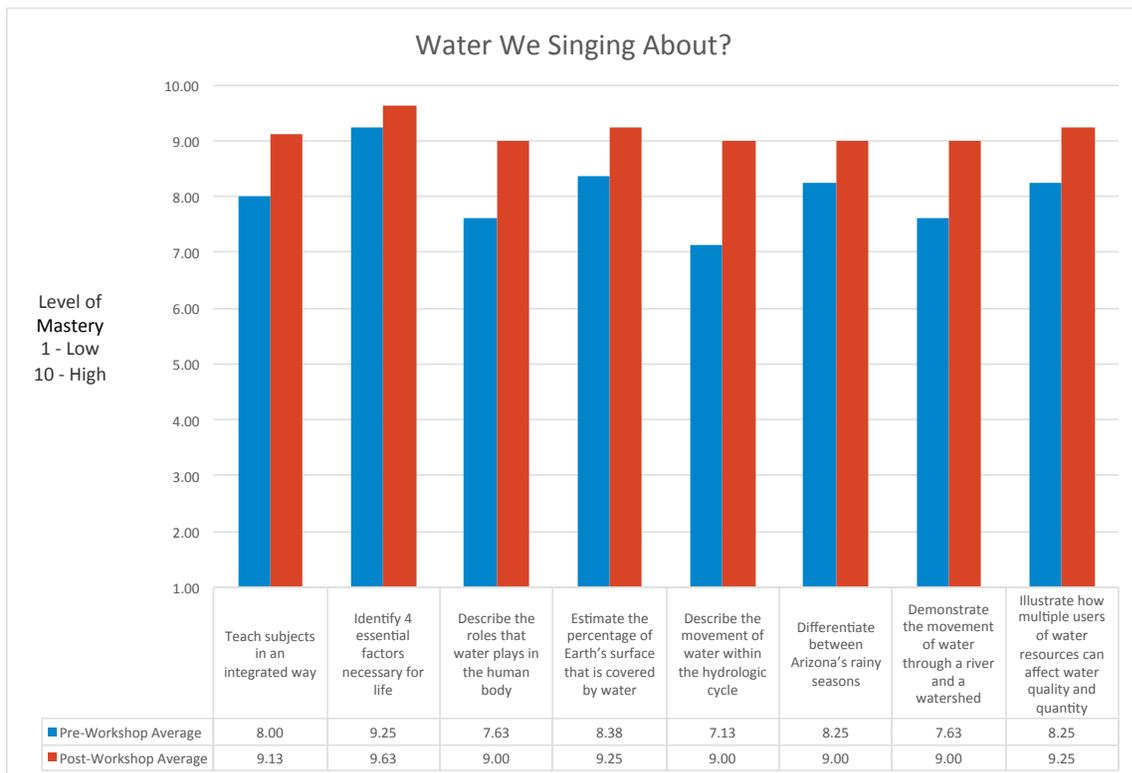


Figure 21 – Water We Singing About? Workshop Mastery of Content

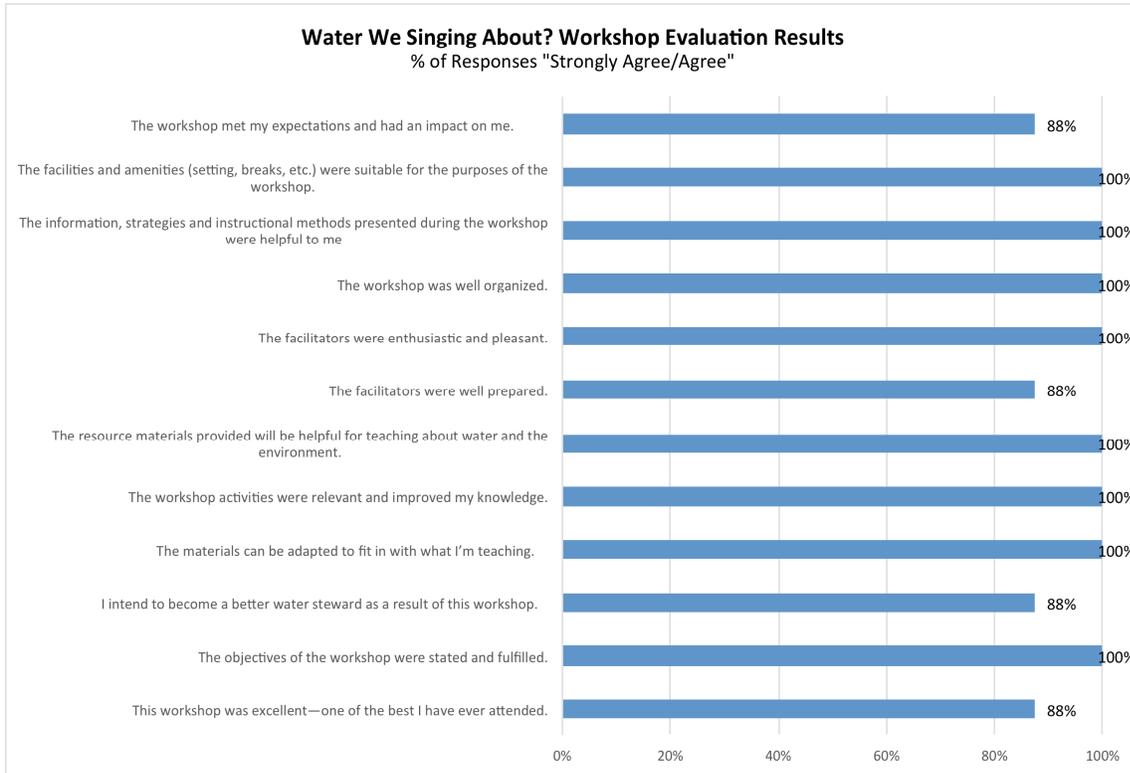


Figure 22 – Water We Singing About? Workshop Rating

Marana Water Festival Teacher Workshop

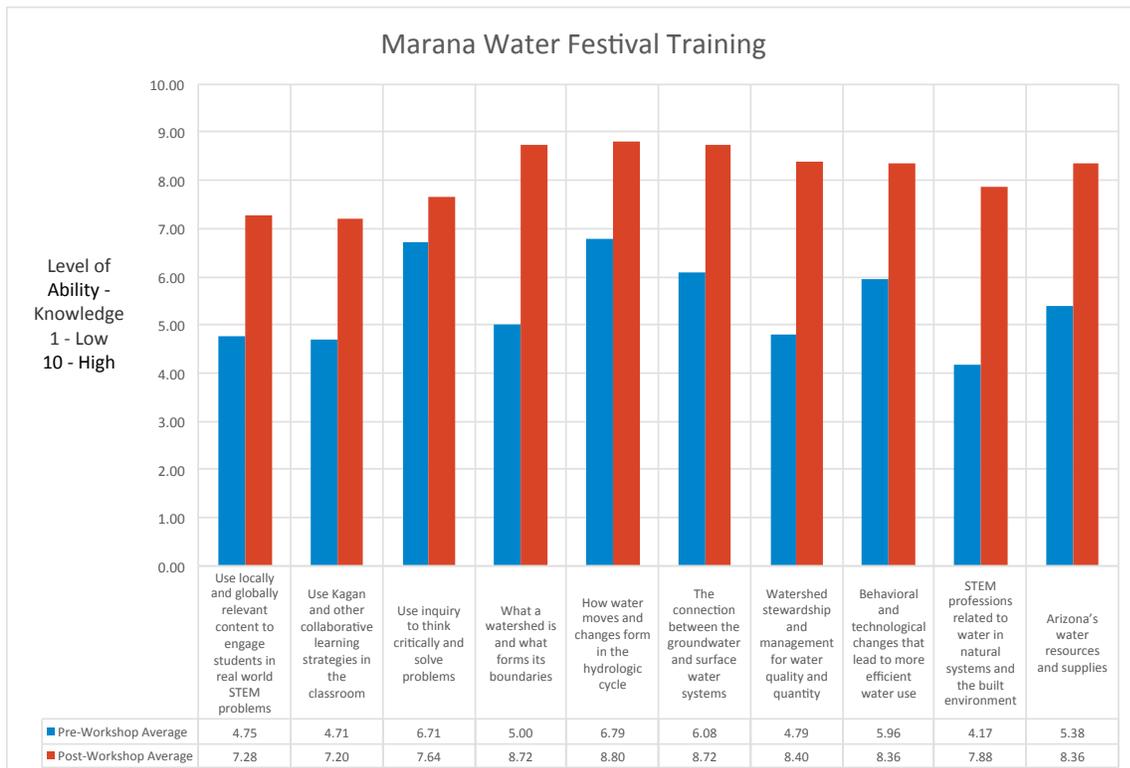


Figure 23 – Marana Water Festival Workshop Mastery of Content

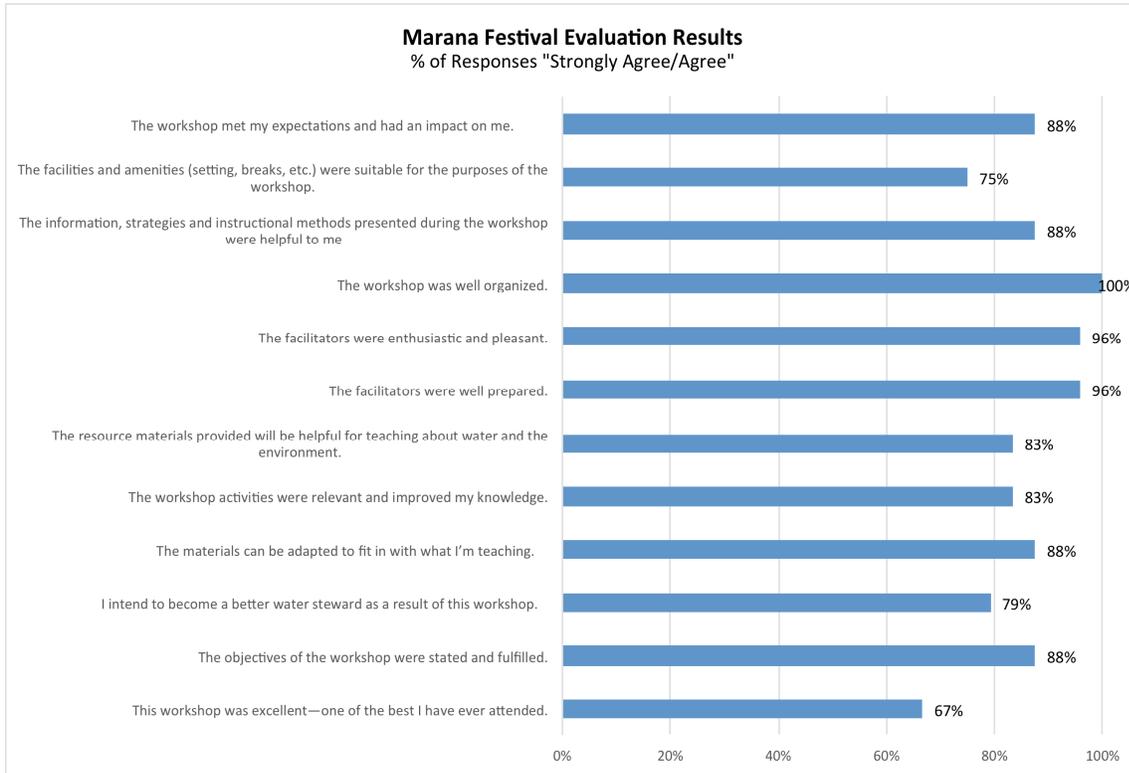


Figure 24 – Marana Water Festival Workshop Rating

Third Grade Curriculum Unit Programs

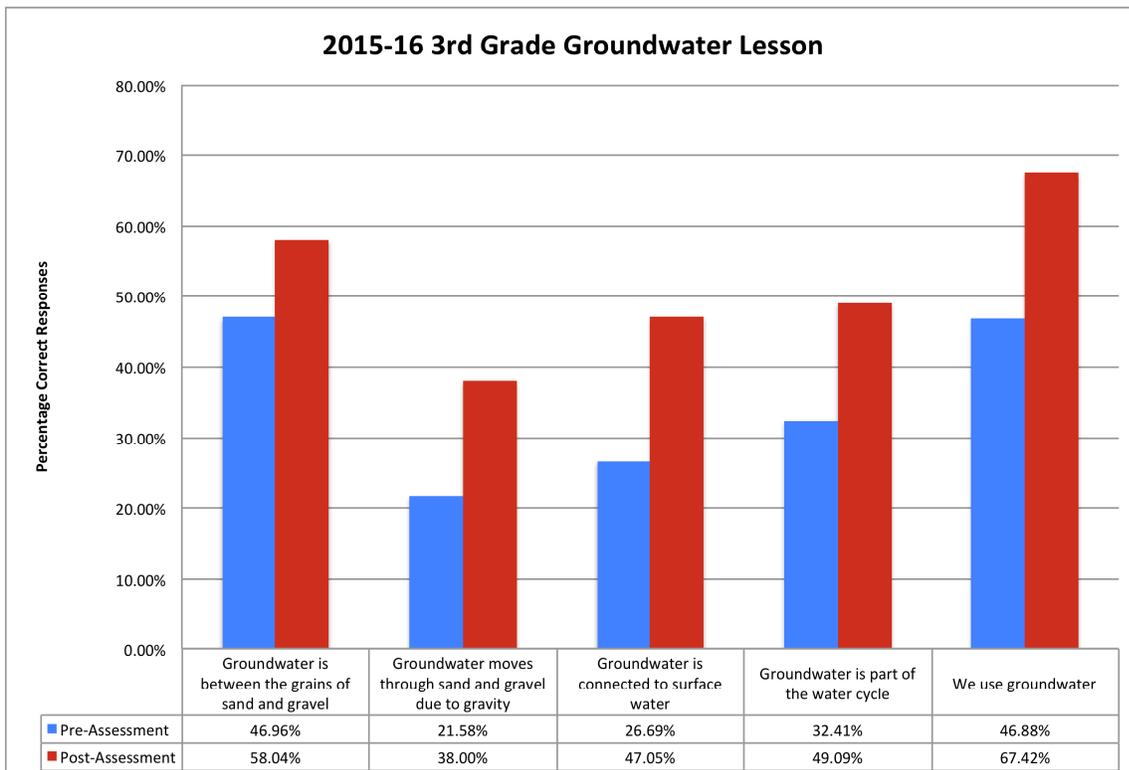


Figure 25 – 3rd Grade Groundwater Evaluation

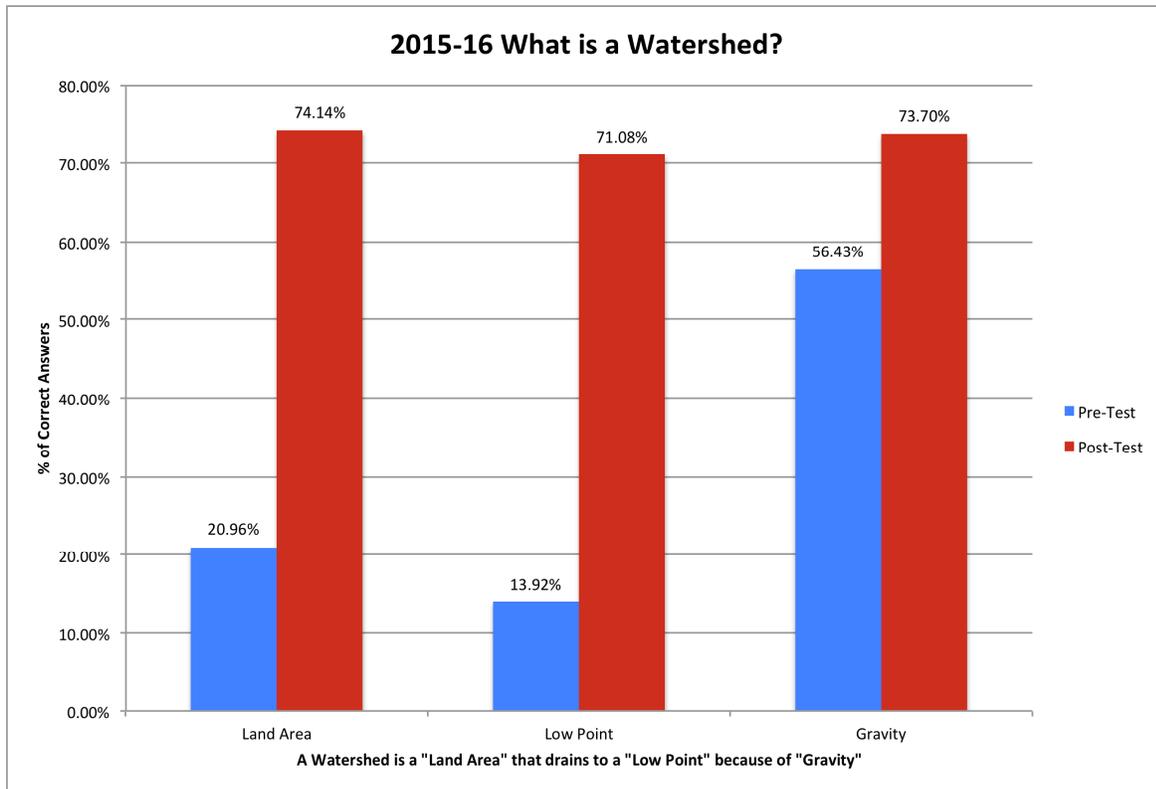


Figure 26 – Sweetwater Wetlands: Watershed

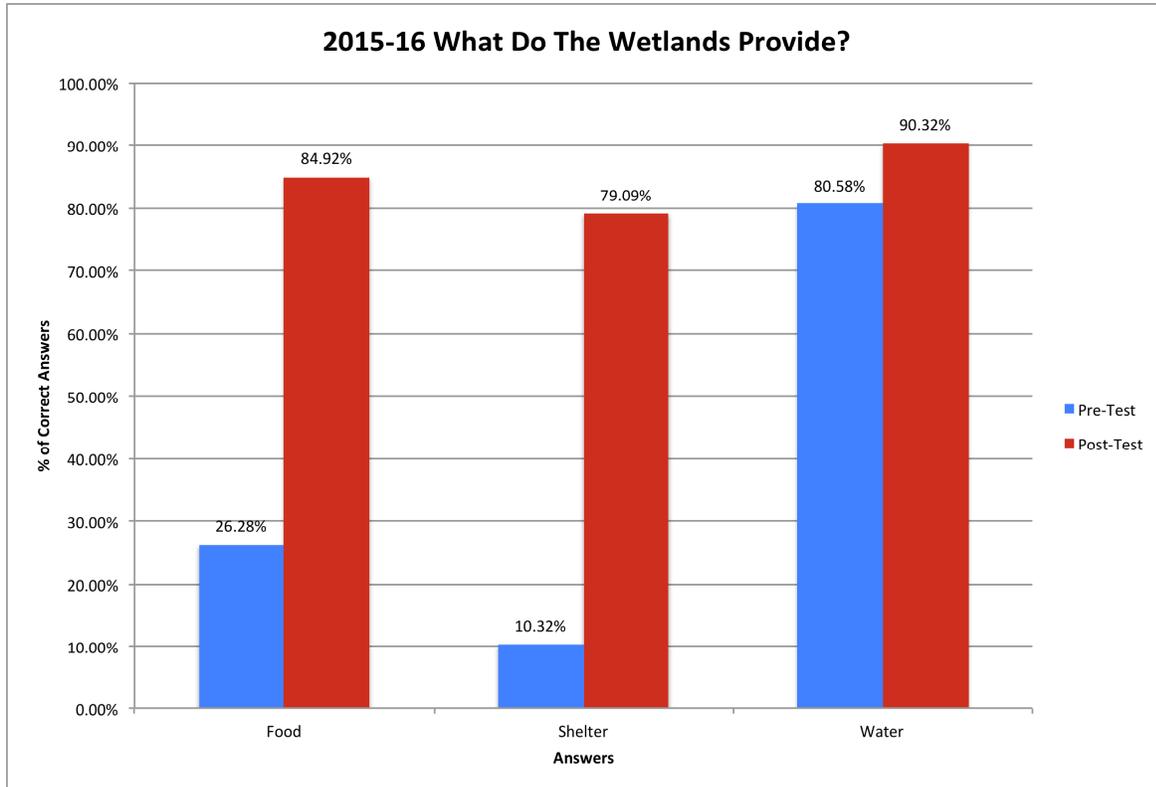
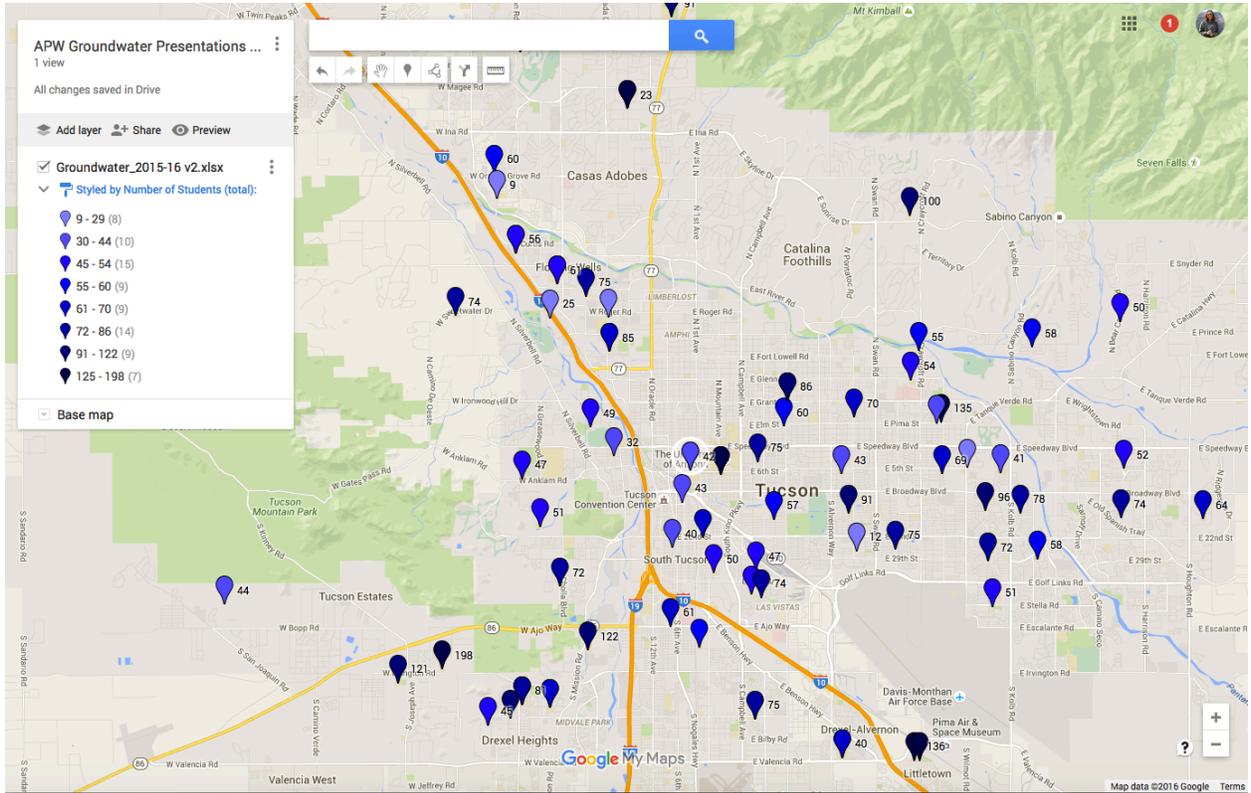


Figure 27 – Sweetwater Wetlands: Wetlands Provide

Groundwater Presentations



Arizona Water Festival Program

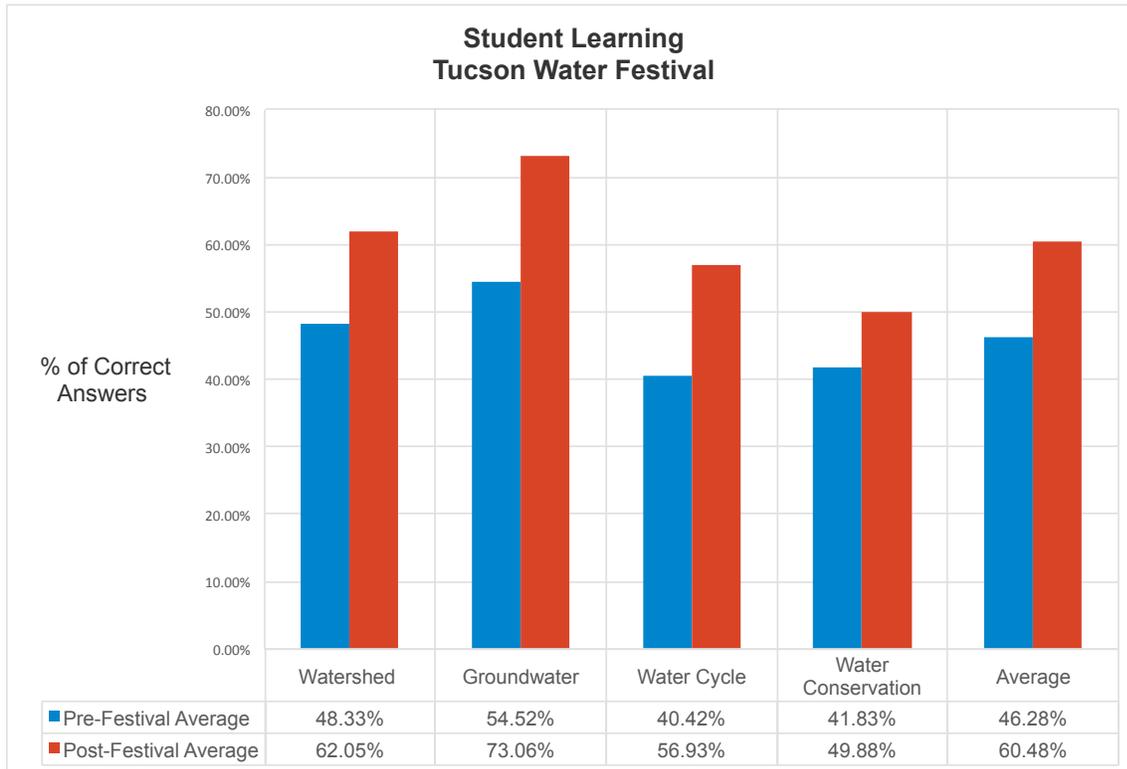


Figure 33 – 2016 Tucson Water Festival Student Evaluation

VI. Attachments

File Names

Wetlands-passport-15-16.pdf
 3rd-eval-GW-final15-16.pdf
 6th-grade-Pretest15-16.pdf
 IGA2016Reporting.xlsx

Description

3rd Grade Sweetwater Wetlands Evaluation
 3rd Grade Groundwater Evaluation
 6th Grade Groundwater Evaluation
 Data sheet of all presentations by location