EPA SCAPE PROGRAM: FINAL REPORT

Arizona State University

Findings and Summary

University Office of Evaluation and Educational Effectiveness

Contents

METHODS

The SCAPE program aimed to implement a place-based curriculum in eleven schools in five states along the Colorado River. Comprised of seventeen lessons, the curriculum teaches students about the history and health of the Colorado River system, techniques for sampling and testing the river's water quality, measuring in-stream flow, gathering and identifying species living in the river, and investigating potential sources of pollution in the river.

During the 2017-2018 academic year, the University Office of Evaluation and Educational Effectiveness developed a quarterly survey for the eleven teachers participating in the program to provide feedback on the lessons they had implemented. Of a possible 44 surveys, 38 were completed (86%). In March and April 2018, the University Office of Evaluation and Educational Effectiveness conducted interviews with the teachers to gather feedback on their experiences in the SCAPE program. Of the eleven SCAPE teachers, six completed an interview (55%). Findings from the quarterly surveys and major themes from the interviews are presented below, along with recommendations for ensuring success in the next iteration of the SCAPE program.

SECTION I: QUARTERLY SURVEY FINDINGS

SCAPE SCHOOLS

Teachers implemented a total of 52 SCAPE lessons, an average of 4.7 SCAPE lessons per teacher, during the 2017-2018 academic year (Table 1). The most SCAPE lessons were implemented at Grand Junction High School (n=11), and the fewest SCAPE lessons were implemented at Telluride High School (n=0). The fewest lessons were implemented in Quarter 1 (n=6), as teachers dealt with the initial administrative tasks of acquiring equipment to implement the lessons and planning the logistics of field trips to local rivers. The most lessons were implemented during Quarter 4 (n=21), when teachers had acquired the necessary equipment and the weather had warmed enough for them to conduct fieldwork lessons at the river sites.

Table 1. SCAPE Lessons Implemented by School

School	Q1	Q2	Q3	Q4	Total
Boulder City High School	0	0	2	1	**3**
Pinedale High School	1	0	0	2	**3**
PPEP Tec High School - Jose Yepez Learning Center	0	-	2	3	**5**
PPEP Tec High School - Cesar Chavez Learning Center	-	0	1	3	**4**
Cedaredge High School	-	4	3	3	**10**
Grand Junction High School	2	4	1	4	**11**
Grand County High School	0	0	1	3	**4**
Maryvale High School - Gifted and Talented Academy	1	0	1	1	**3**
Telluride High School	0	-	-	-	**0**
Animas High School	2	2	0	-	**4**
Telluride Institute	0	4	0	1	**5**
Total	**6**	**14**	**11**	**21**	**52**

SCAPE LESSONS

The most frequently implemented lesson (n=10) was Lesson 2.3 - Water Characteristics and Chemistry. Three lessons were never implemented: 3.3 - Fusion Tables: Data Visualization, 4.3 – Story Maps, and 4.4 –

Collaborative Smart Map of All Partner Schools (Table 2). While the curriculum was divided into units that were to be implemented sequentially, this did not occur. Lessons in Unit I, titled "Pre-Fieldwork," were most frequently implemented in Quarters 3 and 4, after the lessons in Unit II, titled "Fieldwork," were implemented. Very little content from Units III and IV was implemented.

Table 2. Number of SCAPE Lessons Implemented

Lesson	Q1	Q2	Q3	Q4	Individual Lesson Total
Unit I – Pre-Fieldwork					
1.1 Environmental History and the Colorado River Basin	1	-	3		**4**
1.2 My Map = My Place	-	-	3	3	**6**
1.3 Doing Our Part	1	-	1	2	**4**
1.4 First Come, First Served	-	-		2	**2**
1.5 Environmental Ethics and Policy	1	-	-	-	**1**
Unit II - Fieldwork					
2.1 Riparian and Habitat Diversity	-	3	1	-	**4**
2.2 Streamflow = Volume x Velocity	2	3	1	2	**8**
2.3 Water Characteristics and Chemistry	1	4	1	4	**10**
2.4 Macroinvertebrates	-	3	-	4	**7**
Unit III – Post-Fieldwork					
3.1 Post Your Data to the Cloud - EZ Form	-	-	-	1	**1**
3.2 Using Pivot Tables	-	-	1	1	**2**
3.3 Fusion Tables: Data Visualization	-	-	-	-	**0**
3.4 Lab Report	-	1	-	-	**1**
Unit IV – System-wide Impacts					
4.1 System-wide River Water Quality, Security, and Supply Issues	-	-	-	1	**1**
4.2 Awareness to Action	-	-	-	1	**1**
4.3 Story Maps	-	-	-	-	**0**
4.4 Collaborative "Smart Map" of All Partner Schools	-	-	-	-	**0**
Total	**6**	**14**	**11**	**21**	**52**

In the quarterly surveys, teachers provided experiential feedback on each lesson they implemented. The feedback is provided here so that revisions and improvements may be tailored to each lesson. Additionally, the teachers provided a rating for each lesson they implemented. The rating was selected from a 6-point scale (1=Very ineffective to 6=Very effective). An average lesson rating is provided for each lesson implemented, as well as explanations for the rating, as provided by the teachers.

Unit 1: Pre-Fieldwork

Lesson 1.1 – Environmental History and the Colorado River Basin

- Strengths:
  - The background reading information was terrific - a little bit long to read at one time for the students, but I broke it up with a video from the Colorado River Water Conservation District.
  - How to interpret a map and photographic evidence to determine the nature of human interaction with land and water in a given time period.
- Weaknesses:
  - The map comparison was very difficult for the students to do on their own. I needed to help them interpret the maps by asking leading questions. We don't have good access to computers for the students to pull up the documents, and the copy I made of the maps was too small to show the images, so I ended up having to pull them up on my computer and show them on the overhead. I used a lot of paper.
  - The student responses need white-space or boxes for fill-in in Google Docs.
  - Reading engagement between students.
- Modifications:
  - I mainly had to make modifications due to the lack of availability of computers.
  - I added three videos as introduction: "I am Red," "Chasing Water," and "Chasing Rivers Part 1." I wrote a video guide worksheet and a reading guide worksheet for students to complete on paper while they watched the videos and read through the resources.
  - I used the projector to show them graphs and maps.
  - The adaptation I made to this lesson is that I included two short films about John Wesley Powell, an explorer who mapped the Colorado River Basin.
- Average Lesson Rating: 4.8/6 (n=4)
- Rating Explanation:
  - The content was good, I just wasn't 100% pleased with how I had to deliver it to students.
  - The writing assignments need prompts or boxes to guide the students and direct them to the learning points.
  - I found out that students are interested in the topic as they live close to the Colorado River. They were asking environmental questions and about issues involving water.
  - I noticed interest from students and they asked questions. They were eager to learn more about the Colorado River because we live near it, so this lesson makes it very relevant to them.

Lesson 1.2 – My Map = My Place

- Strengths:
  - Students discovered Google My Maps and its features.
  - Good step-by-step instructions.
  - The use of computers to create the area where the study samples will be taken was not difficult for the students because they like to work with computers.
  - There are vast applications for when and where this skill could be useful to students in their future. Most student[s] are familiar with Google Maps, but using the My Map function from Google Drive is something that they had never done before and they didn't even know it existed. They were also able to compare it with Google Maps and see how the editing functions were more useful in the My Maps.

    - The main strength is the use of computers, software, maps, and history about the Colorado River.
- Weaknesses:
    - Needs formatted instructions with bullet-points or numbered steps. Also, add more pictures or examples of what the students should have produced.
    - Students were struggling with maps and the meaning of new vocabulary.
- Modifications:
    - I had students use the guide from Google Docs, Google Classroom on their phones and use a laptop to create their polygons. I wrote a response sheet directing students to sketch their maps and identify landmarks via longitude and latitude.
    - I used the projector to show them the graphs and maps.
    - Foreign exchange students mapped their homes in Thailand, Brazil, Spain, and South Korea and shared their maps with their classmates. It was great to compare their latitude/longitude of their homes with ours.
    - I had to use the projector to show students the maps and how to use them.
    - I first had them map their homes, then they mapped different field locations for water quality studies.
- Average Lesson Rating: 5.2/6 (n=6)
- Rating Explanation:
    - Although the students successfully created a map, we have been unable to post it on the SCAPE website.
    - Again, students need specific directions for responses.
    - In general it was a very illustrative lesson of how to create maps.
    - It was easily implemented in each class and was easy to tailor the lesson to multiple applications.

Lesson 1.3 – Doing Our Part

- Strengths:
    - The 'Setting the Stage' demonstration captured the students' attention. The diary shocked many of the students on how much water they used in showering.
    - Easy to do, very little prep time.
    - It teaches and shows the students the amount of fresh water around the world, and what we have to do to conserve it. It creates a personal plan of fresh water conservation to share with family and friends including our community.
- Weaknesses:
    - It would be nice to have an activity on indirect water use involved in food production.
    - There were no resources in the binder, but I found plenty online.
- Modifications:
    - I modified the demonstration to use 1000 mL of water and then colored various portions of the water to represent the different types. I like doing it in this manner because it was easy for students to see the relative percentages.
- Average Lesson Rating: 5.3/6 (n=4)
- Rating Explanation
    - Most of the students are pretty aware of the water cycle, forms of water, and how to conserve, so the information was a little for a younger age student. Indirect and direct water use was a new concept, so I think this part could be expanded.

- It was a good way to raise awareness of just how much water is used in the average American home. Most students were surprised.
- It was a very interesting and important lesson for students because of the importance of the use and conservation of fresh water.

Lesson 1.4 – First Come, First Served

- Strengths:
  - It teaches the students a little about the history of the use of the Colorado River water through its seven states and how Mexico also claims the use of water, as some regions in the Mexicali Valley in Baja California do not have water from the Colorado River to irrigate their crops.
- Weaknesses:
  - The activity using Water User & Action Cards was an activity of little interest for the students, although for me it was very interesting.
- Modifications:
  - None noted.
- Average Lesson Rating: 5/6 (n=2)
- Rating Explanation
  - It was a very interesting and important lesson for the students because of the importance of how the Colorado River water is used in the different states it irrigates.

Lesson 1.5 - Environmental Ethics and Policy

- Strengths:
  - Great starting point for environmental discussion. Classroom discussion was based on the video suggested. Students' art work depicted the environmental dilemmas.
- Weaknesses:
  - Help students understand that they have a role to play in this bigger picture.
- Modifications:
  - I only did part of the suggested ideas.
- Average Lesson Rating: 5/6 (n=1)
- Rating Explanation:
  - None provided.

Unit 2: Fieldwork

Lesson 2.1 – Riparian and Habitat Diversity

- Strengths:
  - We did two 100-ft transects - one close to the river and one about 200 meters away. Recording the data of the variety/sizes of the plants helped the students see the variety of habitats in the two locations to a greater extent than if they just sat and looked at the areas from afar. Students were able to see how the degree of human use of the two areas impacted what grew there.
  - Hands-on, outside data collection.
  - Procedures were demonstrated prior to field collection, and all students participated in the collecting of several water quality parameters. The procedures built on and reinforced the experiences students had already had with their teacher.

  - Hands-on, on-site activity.
- Weaknesses:
  - Because we did our transects in mid-October, plant identification was difficult.
  - We did not have all of our equipment yet, and time is always a challenge.
  - A little more time is needed to understand plants and plant diversity.
- Modifications:
  - We made no modifications to the field work or classroom portions of the lesson, however we have not yet posted the results to a site map.
  - We had different groups complete each lesson in this Unit instead of the entire class complete lesson 1, then 2, then 3, and so on.
  - This class was an introductory experience, so students did not collect the full selection of measurements and parameters for the entire unit. They will be completing data collection and digitally reporting the results at another time with their teacher.
- Average Lesson Rating: 5/6 (n=4)
- Rating Explanation:
  - It would be most effective to do the fieldwork portion of this lesson in August when the plants are more actively growing.
  - These lessons are mostly effective as students are able to relate to the area where the data was collected and understand how the parameters being tested affects their lives. Not all students understand/appreciate the economic, aesthetic, and environmental value of our local waterway, but through education programs such as SCAPE, they see pros and cons of how the waterway is used.
  - Students were engaged and all participated in the class and field portions of the lesson. It gave an introduction and background for the purpose of, and procedures for, collecting water data.
  - Students do not have an in-depth understanding of plants, thus only the essence of biodiversity was emphasized.

Lesson 2.2 – Streamflow = Volume x Velocity

- Strengths:
  - The hands-on experience measuring the flow.
  - It allowed the students to become technically proficient with the process, and it gave them a reason to care about streamflow because it established its importance for water quality/aquatic health.
  - Hands-on, outside data collection.
  - Procedures were demonstrated prior to field collection, and all students participated in the collection of several water quality parameters. The procedures built on and reinforced the experiences students had already had with their teacher.
  - Students became familiar with the term ‘discharge’ and how it was calculated. Students could relate velocity and discharge rate to the erosive power of the river.
  - Hands-on, outside of the classroom, cross-curricular (mathematics, calculations and graphing), communication among students, use of electronic sensor (flow rate sensor).
  - Teamwork and outside of classroom data collection.
- Weaknesses:
  - Not all students could participate at the same time, as we had only a few flow meters.

  - If you want students to figure out how to measure flow volume on their own, it could be modified into a guided inquiry.
  - We did not have all of our equipment yet, and time is always a challenge.
  - I intended to implement this lesson on the Colorado River with the idea that once the data were shared with other schools, the data would provide a better comparison with other sites. I had hoped that by doing the fieldwork the third week of October that we could find a stretch of the river that we could wade in, but the river was far too deep and swift. These factors really aren't a weakness of the lesson itself, just a limitation on how meaningful any small stream data is to other sites.
  - Time of lesson – It takes more than a fifty-minute class period to complete with a small group.
  - The time needed for everyone to use the flow meter.
- Modifications:
  - I used a flow meter to have the students take the measurements. We did not do the manual measurement of the flow with the stopwatch and floating object, so it decreased the time of lesson.
  - I provided the students with a different template on which to record all the measurements. It specified a particular length of stream (50 feet) and had them do three transects as opposed to one. Typically, I prefer to have students devise it all themselves, but I was in a time crunch with this particular lesson. I also had student groups compare data with each other and discuss the reliability of the measurements. Given we are at a low flow time (~ 2cfs), the numerical differences in data were small but percentage differences were high.
  - We had different groups complete each lesson in this Unit instead of the entire class complete lesson 1, then 2, then 3 and so on.
  - This class was an introductory experience, so students did not collect the full selection of measurements and parameters for the entire unit. They will be completing data collection and digitally reporting results at another time with their teacher.
  - We completed Method 1. On Method 2, we could only measure depth for the first 20 feet across the river. We were unable to do float trials because the only bridges in the area that spanned the river were too dangerous from a traffic perspective to send students out on. On Method 3, we did use a flow meter to measure velocity near the shore.
  - Completed the lesson in multiple days. Data was not taken on the same day due to 50-minute class time constraints.
  - I had students sit by the river and list various aspects of the stream and what they might measure instead of playing a YouTube video. Also, we used string to measure distance instead of tape measure
- Average Lesson Rating: 5.3/6 (n=6)
- Rating Explanation:
  - It was easy to follow and easy to implement in class.
  - It provided the students a reason for the work they were doing and tools for how to do it. The only downside could be that it was "cookie-cutter," so students didn't necessarily need to understand what they were doing.
  - These lessons are mostly effective as students are able to relate to the area where the data was collected and understand how the parameters being tested affects their lives. Not all students understand/appreciate the economic, aesthetic, and environmental value of our local waterway, but through education programs such as SCAPE, they see pros and cons of how the waterway is used.

- Students were engaged and all participated in the class and field portions of the lesson. It gave an introduction and background for the purpose of, and procedures for, collecting water data.
- The logistics of this lesson made it somewhat difficult.
- Very effective lesson that demonstrates flow rate throughout sections of the stream. Many students commented that they did not know how to find flow rate before and they were able to realize how much more efficient collecting flow rate is with the use of an electronic sensor.
- The three methods of determining flow rate are good for students to analyze and identify differences, as far as which method may be most efficient/effective. Writing their assessment of each method is a good way for students to reflect and explain the most efficient/effective method to measure stream flow. Also, having students predict attributes that can be measured on a stream is a good introductory and engagement activity.
- I have implemented the streamflow and water characteristics/chemistry lessons two or three times now throughout the semester and I have gotten better and understood the material more with each implementation. I feel it will only improve throughout the remainder of the year and into next year.

Lesson 2.3 – Water Characteristics and Chemistry

- Strengths:
  - I like how there are tutorials for each of the tools the students will use. The idea of getting water from different sources and comparing them is also good.
  - Hands-on, outside data collection.
  - Procedures were demonstrated prior to field collection, and all students participated in the collection of several water quality parameters. The procedures built on and reinforced the experiences students had already had with their teacher.
  - Students really enjoy being outside, collecting data from real streams, and working in pairs.
  - Vernier equipment makes this lesson easy to do and therefore easy for all students to try it out in a short amount of time.
  - Hands-on outside of the classroom, cross-curricular (mathematics, calculations and graphing), communication among students, use of electronic sensors (quick to collect data, allows for data collection not normally collected in class with titrations such as conductivity and turbidity).
  - Hands-on, real life authentic experience.
  - Students working with probeware.
- Weaknesses:
  - The wrap-up of the lesson (parts 5, 6 & 7) were unclear and lacked relevance for my classroom, so I altered them.
  - We did not have all of our equipment yet and time is always a challenge.
  - Time of lesson - It takes more than a fifty-minute class period to complete with a small group. Calibration of the equipment (specifically the DO optical probe). Lack of instruction for the probeware - confusing instructional video links, as some of the equipment in the videos are not the same as our Labquest 2 computers or probes.
  - Getting the equipment.
  - Comparative data was difficult to view.
- Modifications:
  - I spent the first class period teaching students how to use the interfaces and probeware from Vernier. This included teaching them how to calibrate the instruments because I want them to understand the role of calibration and reliability in scientific work. Then we all went to the

field to make measurements on three streams which converge. I had each of the three sections of my class measure the water in a different one of the streams multiple times. Then they used the body of their data to predict the values of the water quality parameters after the streams converge and compare their predictions to real-time USGS data. I think having multiple students make measurements of the same water allows for conversations about precision, accuracy, reliability, and uncertainty.
    - We had different groups complete each lesson in the Unit instead of the entire class complete lesson 1, then 2, then 3 and so on.
    - This class was an introductory experience, so students did not collect the full selection of measurements and parameters for the entire unit. They will be completing data collection and digitally reporting results at another time with their teacher.
    - Completed the lesson in multiple days. Data was not taken on the same day due to 50-minute class time constraints and from learning how to use the equipment.
    - We added wildlife and forest conservation to the unit.
    - Rewrote the entire lesson to high-school level.
    - Included an introductory lesson that allows students to research each stream attribute in small groups (the how, what, & why) and present their findings to the class through a presentation so they all have an understanding of what each attribute is before collecting data.
    - Included student assessments (SAT/College Board format assessments) and opportunities/suggestions for students to learn from water experts through field trips/advanced classes, etc.
- Average Lesson Rating: 5.1/6 (n=7)
- Rating Explanation
    - The lesson was technically sound and could be taken a lot of different ways by different teachers. To be an excellent lesson it should be embedded in a larger context or investigation which would be specific to a particular classroom and it should involve field measurements.
    - These lessons are mostly effective as students are able to relate to the area where the data was collected and understand how the parameters being tested affects their lives. Not all students understand/appreciate the economic, aesthetic, and environmental value of our local waterway, but through education programs such as SCAPE, they see pros and cons of how the waterway is used.
    - Students learned proficiency with the measuring devices, enjoyed collecting the data, and did some critical thinking in the field. The only aspect of the lesson which needed to be improved was having students understand what each of the water quality parameters are measuring and why they are important.
    - Students were engaged and all participated in the class and field portions of the lesson. It gave an introduction and background for the purpose of, and procedures for, collecting water data.
    - Data were reproducible. Lesson was easy for students to understand and perform.
    - We spent a lot of our time learning how to use the equipment -watching the videos and reading how to calibrate. Once we got that done, we were able to collect data pretty efficiently and compare it with previous data. The equipment is great, but there is a slight learning curve to overcome in the use of the probeware.
    - Water chemistry made more sense and relevance when done outside the classroom in a real water body (Salt River).
    - To stay on task, students need instructions simple and data acquisition streamlined.

- I have implemented the streamflow and water characteristics/chemistry lessons two or three times now throughout the semester and I have gotten better and understood the material more with each implementation. I feel it will only improve throughout the remainder of the year and into next year.

Lesson 2.4 – Macroinvertebrates

- Strengths:
  - Hands-on, outside data collection.
  - Procedures were demonstrated prior to field collection, and all students participated in the collection of several water quality parameters. The procedures built on and reinforced the experiences students had already had with their teacher.
  - Students were able to learn how to use a dichotomous key and were able to characterize the quality of water based on the organisms they identified.
  - This SCAPE lesson complements the field ecology course, which will be divided into three stations: fish habitat, water quality, and food. Students learned about how the presence of macroinvertebrate species indicates the quality of a stream.
  - The hands-on nature of the tasks.
- Weaknesses:
  - We did not have all of our equipment yet, and time is always a challenge.
  - It can be difficult to quickly and efficiently separate out the macroinvertebrates in the field when there are large quantities of them. I have a 50-minute class period and sometimes this presents a challenge.
- Modifications:
  - We had different groups complete each lesson in the Unit instead of the entire class complete lesson 1, then 2, then 3 and so on.
  - This class was an introductory experience, so students did not collect the full selection of measurements and parameters for the entire unit. They will be completing data collection and digitally reporting results at another time with their teacher.
  - We collected the samples during one day and then identified the organisms the next day in the classroom, returning the water and macroinvertebrates to the river after identification.
  - Because this is a younger group, we are not doing as much data input; just collecting field data to be analyzed later in the classroom.
  - Prior to our field trip, I had the students create a macroinvertebrate slide show with all of the species to familiarize themselves with the identification of each. They also labeled them by niche and sensitivity ahead of time.
- Average Lesson Rating: 5.8/6 (n=4)
- Rating Explanation:
  - These lessons are mostly effective as students are able to relate to the area where the data was collected and understand how the parameters being tested affects their lives. Not all students understand/appreciate the economic, aesthetic, and environmental value of our local waterway, but through education such as SCAPE, they see pros and cons of how the waterway is used.
  - Students were engaged and all participated in the class and field portions of the lesson. It gave an introduction and background for the purpose of, and procedures for, collecting water data.

- Students loved doing this activity and were amazed at the variety of macroinvertebrates that they found.
- This is a comprehensive lesson, which is very engaging. Students are enthusiastic about observing and identifying the different species. They became aware of how different species are more tolerant of pollutants and higher temperatures than others.
- This is a great way to tie biological indicators of water quality into chemical indicators of water quality. It gave students numerous ways to assess the health of a waterway.

Unit 3: Post-Fieldwork

Lesson 3.1 – Post your Data to the Cloud

- Strengths:
  - Having students access data from other locations.
- Weaknesses:
  - SCAPE manual directions and the numerous folders on the SCAPE site were confusing.
- Modifications:
  - None noted.
- Average Lesson Rating: 4/6 (n=1)
- Rating Explanation:
  - The water quality data table format would be better if it mirrored how the field data sheet looked.

Lesson 3.2 – Using Pivot Tables

- Strengths:
  - Allows students to view summaries of the collected data and compare with other groups (schools) that have collected and posted data on the SCAPE portal datasheet.
  - Ability to link data with the tables.
- Weaknesses:
  - I just gave a tutorial and projected the data and how to create the pivot table. We are still missing data to assess a complete database.
  - Students were familiar with Excel tables and were frustrated by the different format.
- Modifications:
  - Projected the data and gave an overall class tutorial, then compared data to other schools.
- Average Lesson Rating: 4.5/6 (n=2)
- Rating Explanation:
  - We did not get to have the kids create their own pivot tables and fusion tables. I think they got the idea, but lacked the application component, which we will get to later in the year.
  - Pivot table are clumsy in comparison to Excel.

Lesson 3.3 – Fusion Tables, Data Visualization

This lesson was not implemented by any SCAPE teachers during the 2017-2018 academic year.

Lesson 3.4 – Lab Report

- Strengths:

    - Having the students analyze real (i.e., 'messy') data and use it to make predictions required higher order skills. They also validated their predictions in several ways and had to think critically about the nature of their measurements and what they meant. Also, writing forces students to really understand their own thinking and is a great tool to promote understanding.
- Weaknesses:
    - Lack of a real-world audience. Students did a lot of critical thinking but weren't as intrinsically motivated as they might have been if their product was for someone other than myself and the math teacher I collaborated with.
- Modifications:
    - We went to a location where three streams converged into one. We measured the water quality parameters in each of the streams and then used them to predict the water quality parameters after the confluence. We were also able to compare student measurements to USGS monitoring data because each stream had a monitoring station near where we measured and because there was a monitoring station below the confluence. This produced a large amount of data for the students to evaluate reliability of their measurements and predictions. It taught them about how to model systems and how to evaluate uncertainty. I partnered with a math teacher to teach statistics of central tendency (median, mean), statistics of variability (standard deviation, range), and weighted averaging. This lesson also had embedded complexity. For example, pH did not behave as anticipated because of the buffering capacity of one of the streams. If I were to do this again, I would segment the data collection into 2 or 3 chunks and use it over a much longer period to teach more about acids/bases, buffering and pH, along with more about solubility of gases in a solution (DO) and to teach more about measurement reliability. The amount of science here is really rich and could be stretched out over an entire semester.
- Average Lesson Rating: 5/6 (n=1)
- Rating Explanation:
    - I was really pleased with the critical analysis of data my students performed, their increased skills with Google Sheets, and the quality of their writing. My only disappointment was not having them motivated to ask deeper questions of their own, but instead needing to be guided/driven by me.

Unit 4: System-wide Impacts

Lesson 4.1 - System-wide River Water Quality, Security, and Supply Issues

- Strengths:
    - This is a currently relevant topic, so student interest was high.
- Weaknesses:
    - None noted.
- Modifications:
    - None noted.
- Average Lesson Rating: 5/6 (n=1)
- Rating Explanation:
    - Very nice, summative project.

Lesson 4.2 – Awareness to Action

- Strengths:

    - Students related their knowledge of the Colorado River Basin to public service.
- Weaknesses:
    - None noted.
- Modifications:
    - None noted.
- Average Lesson Rating: 5/6 (n=1)
- Rating Explanation:
    - Good summative project.

Lesson 4.3 – Story Maps

This lesson was not implemented by any SCAPE teachers during the 2017-2018 academic year.

Lesson 4.4 - Collaborative "Smart Map" of All Partner Schools

This lesson was not implemented by any SCAPE teachers during the 2017-2018 academic year.

Survey Themes - General Comments and Barriers Faced

In the quarterly surveys, SCAPE teachers were provided an opportunity to share comments about their general experiences in the SCAPE program as well as describe any barriers they have faced while implementing the lessons. Themes and supporting quotes from these responses are provided below.

Administrative Logistics

SCAPE teachers noted three areas in which they struggled with the administrative logistics of implementing the SCAPE program in their classrooms. First, teachers shared their difficulties in planning the field trips necessary for implementing the lessons in Unit II of the SCAPE curriculum. One teacher shared, "The field trip has not happened, as no allowance to the Lower Colorado River has yet been authorized." Another teacher stated, "Field trips have been very difficult since I cannot take students out of state. And the only location on the river I could survey was on the Arizona side." While most teachers were eventually able to secure the necessary permits and authorization to conduct a field trip with their class, one teacher recommended that teachers that plan to participate in the SCAPE program "get the permits and bureaucracy taken care of long beforehand, perhaps before committing to the project."

Second, teachers shared challenges in acquiring the necessary equipment and supplies for implementing the SCAPE lessons. Initially, some teachers faced challenges in procuring the funding to purchase the equipment, as many had to navigate their school district's bureaucracy to obtain it. One teacher shared, "I don't know how to fix the bureaucracy, but that would help, since I didn't have the funds available to buy what I needed out of pocket and then wait for reimbursement." Another teacher noted, "I have found the process for securing funds to be slower and more paperwork heavy than I was led to believe." Once funding became available, one teacher faced challenges in "finding the right vendor to order the equipment." Some teachers who purchased the equipment then faced challenges in securing reimbursement for the purchase. One teacher noted, "Getting reimbursed for expenses related to the SCAPE program has been difficult. In part this is because my school is authorized by a state-chartering body, so there is an additional layer of bureaucracy, and in part because the process for getting reimbursed is unclear."

Third, teachers described challenges in a few areas of the SCAPE program's operations. One teacher noted that the program funding did not adequately cover the amount of equipment needed for a large class. In reference to accessing the program's online resources, another teacher stated, "The SCAPE drive had so many

folders that it was sometimes difficult to know where to go. I think it would benefit partner schools if the drive was reorganized before the curriculum was implemented again."

Weather

As a place-based curriculum, the SCAPE program relied heavily on its participating schools to conduct field trips to the Colorado River and its local tributaries. For many schools, weather, particularly during the winter months, posed limitations on the extent to which the curriculum could be implemented. One teacher shared, "Weather is my biggest challenge. I've been focusing on other content, mainly snow science, during the winter months, but will transition to the SCAPE curriculum in March 2018." Another teacher noted the difficulty of implementing the fieldwork lessons when coupled with the logistical challenges faced: "My district office finally let me know they received the funds to purchase the equipment on December 5th. Unfortunately, it has now gotten quite cold, and we are not at a place for any of my classes to conduct SCAPE lessons at this time."

Integrating with State Curriculum

A few schools participating in the SCAPE program provide their teachers the flexibility and independence to develop their own curriculum. In these cases, teachers shared that implementing the SCAPE curriculum was quite smooth. However, a few schools mandate that their teachers follow state curriculum guidelines. For the SCAPE teachers in these schools, implementing the SCAPE curriculum proved more difficult. One teacher shared, "The biggest challenge at our school is finding the time to squeeze the SCAPE curriculum into the curriculum that I need to cover for the AP exam." Another teacher noted, "The primary barrier was finding the time to take away from our regular course curriculum to do the SCAPE lessons." A third teacher described the general challenge of finding creative ways for the SCAPE curriculum to "mesh with the state's core requirements and standardized testing."

Length of Lessons

Several teachers shared that the activities and content that some lessons endeavored to cover was greater than the time allotted for the lesson. One teacher stated, "I would like more lessons that do not require so much demand for time. Many are multi-day activities." Another teacher shared, "I feel that [the lesson] has a lot of information for two 45-minute sessions." A third teacher said, "The biggest barrier was finding enough time back in the classroom to process the data. We have not had the time to upload any of it yet."

To deal with this, teachers either broke up single lessons into multiple classes or eliminated some portions of a lesson. Some teachers experimented with offering some of the content after school, but ultimately abandoned the idea. One teacher expressed, "Time was always an issue. Few students wanted to work after school or on their own, even when grade incentives were offered." Another teacher shared, "We face many time constraints. Classes are only 50 minutes and the students involved are involved in many different activities."

Grade Level Appropriateness

While all 52 SCAPE lessons were implemented at the high school level, a few teachers noted that there was some unevenness to the lesson content – some lessons were deemed too easy for high school students and others were deemed too difficult. One teacher stated, "Some lessons are more challenging to students than others. For example, the data mining through pivot tables and producing story map lessons are a little more challenging for the younger grades." Another teacher shared, "Rewrite the lesson to the high-school level, with specific and clear instructions." To address this unevenness, one teacher recommended: "I would have one or some of the authors of the SCAPE curriculum sit down with a new partner teacher and have that teacher use the manual to identify confusing sections while the authors could revise the manual." Another teacher recommended that assessments be added to each lesson.

Learning Curve

Implementation of the SCAPE curriculum required participating teachers to train themselves and their students on a variety of new technology, including water testing equipment, Google fusion tables, Google My Maps, and Excel pivot tables. Even though the SCAPE teachers were trained to use these new technologies in the summer prior to the school year, several teachers struggled to apply these skills during the academic year. One teacher shared, "It's going to be a challenge for me to know how the devices work so I can teach my students how to use them, because it's something new for me." Another teacher noted, "If a probe isn't working like it should, or if we are struggling to calibrate the equipment, or need help creating a pivot table, it takes time to find help and implement a solution."

Teachers understood that technical help was available from SCAPE program leadership, but some discussed their limited windows of time to access this assistance. One teacher shared, "A challenge is getting the help I need to navigate through the Google docs when I need it. I have small windows of time when I can turn my attention to this project. I get frustrated when I try to accomplish something in preparation for doing a lesson and then get stalled by not being able to navigate between the documents/spreadsheets." Another teacher stated, "I may need a little refresher on some of the technology components when it comes time for my students to start uploading their data. I haven't played around with the fusion tables for a few months, but hopefully that content will be easy enough to teach to the students." A third teacher said, "I'm having some difficulty getting things uploaded to the SCAPE site. I have the maps of our locations & water quality data, but have some difficulty with the pivot tables and fusion table capabilities. I need a bit of a refresher to how to best accomplish the upload of the data."

Community of Practice

In the interviews conducted at the beginning of the academic year, SCAPE teachers looked forward to participating in a community of practice, with many citing the data sharing and collective mapping technology that was a hallmark of the SCAPE program. It is unclear the extent to which this community of practice was established. One teacher noted, "I would really like to collaborate with other SCAPE teachers. However, because I did the training at an alternate time, I have not yet established those connections. I hope to do so during the conference calls." Another teacher stated, "Creating a common email listserv for us might be helpful. In the next quarter I am hoping to collaborate with other SCAPE teachers by having students share data and discuss local vs. basin-wide water quality issues. Having a simple and unobtrusive way to make contact and communicate with other SCAPE teachers would make initiating this process much easier." A third teacher shared:

> "At the beginning of the semester, it was my hope that I would use the SCAPE curriculum as a focal point for my class. I had hoped to have my students create Data Visualizations and reports to share with students in other communities along the Colorado River Watershed. I had also hoped to organize online discussions between my students and students in other communities so that my students could learn about local and 'global' water quality issues. But I have moved away from that because I have been unable to coordinate and collaborate with the other SCAPE teachers. I opted to change the focus of my semester to something that did not rely on collaboration with other teachers."

SECTION II: INTERVIEW THEMES

Alignment – Planned versus Implemented Lessons

Teachers first discussed how closely the number of SCAPE lessons they originally planned to teach aligned with how many SCAPE lessons they actually taught. Three teachers implemented fewer lessons than they originally intended. One teacher attributed the shortfall to the time needed to plan field trip logistics for their students: "It's a little on the low side. I had hoped to do more, but things got in the way. Primarily on my end, the bureaucracy involved in getting kids out of the classroom for field trips became an issue." Another teacher cited their own communication errors, which limited their collaboration with SCAPE participants: "It's a bit lower. I expected it to be closer to one-half to three-quarters when I initially signed up for the program. The difference is largely because of a mistake on my end. I somehow blocked all emails from [SCAPE leadership] and didn't figure out what was going on until December. Some of the connections I hoped to build with other SCAPE teachers, I was unable to do so because I wasn't getting any of the communications because of my own error. And it prevented me from collaborating with the other teachers in the program." A third teacher noted that the length of the SCAPE lessons limited the number of lessons that could be implemented: "I think there's a lot of work in the lessons. I did two lessons in three sessions. It's a lot information for the students, too many things they had to learn. It's why I took a long time to do it."

Three teachers implemented the same amount of lessons that they originally intended. One teacher noted, "So the plan was that every quarter I do at least one lesson from the units, and I'll end up doing about four or five of the lessons. The only thing different is the number of lesson[s] not syncing with the number of quarters. I think in one quarter there were three and in one quarter there was none. But we did not lose the initial concept." Another teacher shared, "It aligns perfectly. These are topics that I've been teaching anyway, this just packages it a little differently." A third teacher stated, "I think I'm about halfway through. So I've completed the first and second units pretty much in their entirety. And in the third unit, all the uploading to the cloud and Google docs and using the fusion tables, I haven't done that yet. It's my fault, I've never used them before. So, that's been the stumbling block, but we'll finish them."

Teachers also described the personal benefits the SCAPE program offers in terms of their own professional development and continued learning. One teacher stated, "As teachers, we lead these types of trips, but in this project we would be getting more of the technology piece into our offerings and receive some training ourselves." Another teacher stated, "This is my environment and I'm very interested to know about the quality of the river here."

Student Learning Outcomes

Teachers were asked to describe the main learning outcomes for their students from the SCAPE curriculum. One teacher indicated that they are unknown at this point, stating, "It's hard to say, because it's something new." Two teachers focused on the knowledge gained about the history of the Colorado River. One teacher stated, "So far, it's primarily been history and knowledge of the Colorado River Valley. They did the Google Maps and they did the place-based lesson. It feels like it was more tacked on. I hoped it would be more integrated to what we were doing, but it just didn't end up being the case." Another teacher shared, "I think that for the students, they're learning something new about the history of the Colorado River. They got a lot of information about the area they are living right now, and they know how the Colorado River is providing water to this area." One teacher focused on the technical skills gained by students: "They learned how to use field monitoring equipment. They learned, most importantly to me, how to analyze real-world datasets and do statistical analysis of those and use those to model and make predictions." Three teachers described the benefits from getting students outside the classroom to explore nature, better understand their environmental surroundings, and think about conservation. One teacher stated, "It opened their eyes to the fact that it's not

all just streets and businesses and homes and schools. A lot of kids in my class don't spend very much time in nature, so I think that was really advantageous to the kids." Another teacher shared, "It does give them an idea of what's going around them and the effects on the people downstream from us. And that they have to be concerned about it, because they're depending on the water as well." A third teacher said, "The environmental concept of conservation, and water conservation, and the process of water and water chemistry. How water is such a unique substance. And drinking water, the water we consume, is such a precious resource. And it's time that we became aware of its conservation and how important it is for the human survival." Finally, one teacher shared how the SCAPE curriculum influenced their career goals: "One student told me he wants to study about the environment, environmental science. I think this kind of work influenced to the students to study something related to science."

Place-Based Curriculum

Teachers were asked to reflect on how the place-based learning resonated with their students. One teacher acknowledged that the students enjoyed it, but struggled to integrate the place-based nature of the SCAPE lessons into the curriculum: "I think they enjoyed it, but it just felt a little out of place in our curriculum. I did it after a unit on gases and the weather, so I figured that would be the best place if we're talking about the weather anyway. It still didn't feel like it gelled, like it transitioned well between units."

Three teachers described how the relevance of the lessons connected with their students. One teacher shared, "I had kids that are usually the kind of kids that would roll their eyes at me when I try to introduce them to things…but they were actually getting excited." Another teacher said, "They love it. And I realized that, being freshmen, they are becoming a lot more environmentally aware as compared to students before. So that's change I am seeing. They connect - water is a topic that they connect to easily. So they enjoy it, they understand it, and they have already started thinking at a deeper level and are asking questions, probing questions. So there is a lot of support for sure." A third teacher noted, "Using water quality as a focal point, particularly in our community where the river runs straight through the community, it's a very obvious connection to chemistry. And we also have issues with the EPA Superfund site that's being studied, so that's a very relevant question for our community. It was a really relevant way for students to study science."

Three teachers discussed the value of getting students outside the classroom to collect actual data. One teacher explained, "I think the ability to get out and do real world data collection and get them out of the classroom was valuable. Beyond just the parameters that we were looking at in the riparian habitats and stream velocity, just making them aware of their environment." Another teacher shared, "Analyzing data that they themselves and their peers collected was more valuable than making up datasets or grabbing mock datasets online. For part of our field trip, we did a service project and they, to an extent much greater than I could've ever imagined, enjoyed picking invasive thistles that were encroaching on the riparian habitat. The fact that [the lessons] did have local meaning was really impactful for them."

Personal and Professional Development

The objectives of the SCAPE program did not focus solely on student outcomes, but on the personal and professional development of the participant teachers as well. When asked what they personally learned or gained from their experience in the SCAPE program, teachers provided answers on a variety of topics. One teacher acknowledged not learning much from the curriculum content, but appreciated the equipment funded by the SCAPE program: "Since I studied watershed science in college, I would unfortunately have to say not much, because it basically emphasized things that I've already learned. But, I like the curriculum, the way it was put together, and the SCAPE program. I definitely appreciate the money for the equipment and supplies, because I wouldn't have been able to afford very much of it otherwise."

Two teachers focused on the technical skills they gained from participating in the program. One teacher stated, "Oh, I learned tons. I learnt how to use new probes I hadn't used before, and I learned how to use Google Maps in a different way." Another teacher shared, "I was exposed to some new tools I hadn't seen before, like the Google fusion tables and some of the very rough exposure to ArcGIS. I had not had the opportunity to design a lesson where I collaborated with a math colleague like I did this year to implement the field trip, as well as the analysis that came with it. I was exposed to a little bit of new software. I then had a driving force to try something new in the classroom and that was valuable. That sort of growth and professional development, I would say has also been valuable and impactful."

Two teachers discussed the knowledge they gained about the Colorado River Valley. One teacher summarized, "I learned a lot about the Colorado River and its history, which was very, very fascinating to me."

One teacher described the value of connecting and collaborating with similar-minded teachers, stating, "Being able to connect with peers and people who are environmentally aware as well as having a global mindset. Working as partners, where everyone brought a different set of skills to the table. So these connections were immensely beneficial."

Program Challenges

Next, teachers were asked to describe the challenges they faced as participants in the SCAPE program. Many of the areas that teachers cited as challenges echo those described earlier from the quarterly surveys. Four teachers faced challenges with the technological aspects of the SCAPE curriculum. One teacher explained, "My only problem is probably going to be getting the stuff into the SCAPE website, since I haven't yet done that. And I'm just not real Google-savvy. So I'm going to have an interesting time with that part of it just because that's a new thing for me." Teachers remarked that technical help was available from SCAPE program leadership, but some described how there are limited windows of time to access this assistance during the academic year. One teacher noted, "It really helps to have someone around you that is knowledgeable, so you aren't just spinning your wheels as you're trying to use it. But, like most high school teachers, your windows of opportunity for connecting to someone are so small." Another teacher shared, "It becomes too much on just the teacher to do everything we normally do as well as doing a project of this scale."

One challenge that many teachers described facing throughout the program was overcoming administrative and bureaucratic obstacles. One teacher shared, "The biggest challenge was the bureaucracy on my end and how difficult it is to get the kids out of the classroom for field trips. What I ended up doing is just training a couple of groups to go out on their own with the equipment, so that there wasn't any paperwork involved. Another teacher noted, "Understanding the district requirements for ordering equipment, getting permission to take kids to river, these were all time-consuming learning curves."

One teacher found it challenging to collaborate with other SCAPE teachers to share and compare data results and findings: "Because I didn't get to take the lessons as far as I wanted, some challenges were in collaborating with another school to have the students create shared data visualizations and develop fusion tables in ArcGIS."

Finally, one teacher found the SCAPE curriculum did not align well with a chemistry curriculum: "It doesn't align well with the curriculum that we're doing in chemistry. It would have been better in an Earth science or a geo-science class. But our Earth science teacher wanted no part of it, so we did it in chemistry. It's okay, but it would have fit better in an Earth science class."

Curriculum Improvements

Teachers were asked to discuss the improvements that still needed to be made to the SCAPE lessons, and offered a variety of recommendations. One teacher noted that some of the lessons did not seemed to be designed with the 16-year old student in mind:

> "It didn't feel like the lessons were all that well designed for a 16-year old, so I went and I rewrote some of the lessons and got rid of a lot of open ended questions that were vague for the kids, because we had trouble understanding them, and framed them in more specific terms. I think the lessons need to be collaboratively designed with kids in mind. Get a bunch of kids together over the summer - not the best of the best, not the worst of the worst, but average kids. Just ask, 'Does this make sense, what we're asking you to do?' Then you can write to their level."

One teacher added in multimedia content to the lesson plans: "For my students, they are visual learners, so I prefer to show videos about all the content I teach in my classes. I teach and explain it, but I include videos." One teacher advocated for ensuring that the SCAPE curriculum meets science curriculum standards: "The lessons are pretty good and extensive. And I think there are fine standards and that can be added on. Then it will be really nice to show that this is not just some fuzzy water stuff we are teaching. That we are actually hitting on those science standards in biology, environmental science, and chemistry." One teacher noted the benefits and possible challenges of the multi-disciplinary nature of the SCAPE curriculum:

> "They're very cross-curricular in design, which I think is outstanding. But I also think that leads to a challenge, because most teachers are 'siloed' into a particular classroom. Some of the initial lessons about water and mapping in the West and how we approach water, and then connecting those to the science, and connecting that to the technology, I think that would be hard for a lot of teachers to do unless they have a lot of freedom in the classroom. It's just kind of a challenge we face with education these days - we compartmentalize ourselves to a high degree."

Two teachers advocated for improving the instructions to teachers on how to upload and share data collected through the SCAPE lessons. One teacher shared, "I don't know that there's really any improvements to the lessons themselves. Maybe just more detail for the teachers on where to go to upload and do things. And an example of that would be my SCAPE map of our sampling locations. There seem to be an awful lot of different places and folders on the SCAPE website to look in, and I'm not quite sure what locations I should be entering this all under." Another teacher stated, "Provide instructions for getting the data into the SCAPE website. Just because that's a new thing for me."

Program Support

Teachers were asked to describe the level of support they have received to implement the SCAPE curriculum. Two teachers described the support they received from their school leadership as limited to completing the paperwork required to secure the equipment necessary for implementing the SCAPE curriculum. One teacher stated, "I never really asked for additional support, other than ordering equipment, which was done with the finances that the SCAPE program provided." Another teacher shared, "They haven't had any contact with me with regard to the lessons, but they have been helpful in securing the equipment that we were able to purchase with grants. Two teachers described the positive support they have received from their school leadership as well as their district office. One teacher expressed, "The school's been supportive in letting me have the time over the summer when I went to the seminar over there in Telluride. And the principals, they're onboard and provided moral support. And the district office, at least once they've figured out how the whole grant money thing was supposed to work. I think they finally figured that out." Another teacher shared, "I will say the district was supportive because the grant had to go through the district protocol. The district was very, very supportive and took care of it." One teacher shared how the number of SCAPE lessons implemented was

be contingent upon the flexibility granted to adjust the class curriculum: "The school has been completely supportive. I've got a lot of freedom to design my curriculum. The administration definitely bought in to the work I was doing and let me take it as I went. Parents provided support to help get the students on the field trip. I partnered with another local organization to make that field trip more impactful, which was great."

When asked to discuss the support received from their fellow SCAPE teachers, the interviewees acknowledged that the SCAPE community of practice did not develop to the extent that they had hoped. One teacher stated, "I have not reached out to any of them, and none have reached out to me." The teachers attributed this situation to poor communication and time management. One teacher noted, "One just gets overwhelmed doing the classes and all kinds of stuff." Another teacher shared, "I would say none, because I was only able to participate in one conference call. Although we talked about the program I was part of on that call, and some of the work I did, [the program director] had to talk about it. I could not, because I could hear the call going on, but the audio was really bad. It wasn't something where I could actively participate."

When asked to discuss the support received from SCAPE program leadership, the teachers expressed a high degree of satisfaction. The teachers appreciated the quality and timeliness of communication: "[They] would always be on the spot. [They] responded immediately with emails and, even if they didn't have the answer, they would get back to me pretty quickly, so that was great." The teachers also appreciated the personalized training they received, although most agreed that a lot of information was covered in a short period of time: "When he came to do the training about this program, the training was very good. [The program director] explained all the steps and all the process we had to do to teach our students. It's too much information to get in one day, but it was good information." The teachers also appreciate the equipment provided to them in the program, which will continue to enrich their lessons in the future: "The SCAPE program provided support in providing the money to acquire a lot of the water monitoring equipment, which was super valuable and has continued to provide support."

Overall Level of Satisfaction

Teachers were asked to describe their level of satisfaction with their involvement in the SCAPE program. All teachers expressed satisfaction with the SCAPE curriculum and the individual lessons, but acknowledged that a steep learning curve limited their first-year effectiveness:

> "I would say that it's been reasonably good. I think it's a very beneficial program. The first year, the learning curve is really on the teachers. And then maybe the second year, we could do a much better job at it. I think from planning these things for the first time with a group, and just even assembling the equipment and the waders and all that kind of stuff, and procuring a bus and the permission slips, is a pretty big time crunch. But then if you then go back and do it again, it would go much more smoothly."

Teachers also expressed frustration with the logistical barriers and bureaucracy that they faced, while continuing to express satisfaction with the SCAPE program overall. One teacher shared, "This is going to sound weird, but for the SCAPE program, it was great. I just think it didn't fit well into my district and my curriculum. On a scale of 1 to 10, I would give the SCAPE program an 8, and I would give my district a 3. It was just difficult to put everything together." Another teacher stated, "It's been high. The only aspect of dissatisfaction is the bureaucracy connected to getting the money, which was challenging for our business office. I think its part the structure of our school. There are a number of people that have to sign off on this and it makes it a pretty lengthy and tedious process to get that paperwork approved. That was the only challenge that I've encountered."

Future Implementation

As the first year of the SCAPE program drew to a close, teachers were asked to discuss their intentions to continue to implement the SCAPE lessons in their classes in the future. One teacher acknowledged that the SCAPE curriculum will not be a continued part of their curriculum: "Probably not. I wanted it to feel like a good transition into other activities and it just didn't feel like a good transition. It wasn't a good use of time for my chemistry kids. Again, in an Earth science class, great. Chemistry, not as much. If we get an Earth science teacher who actually wants to do some broad activities, especially field trips and probewear work, then I'll make them available to him or her."

Four teachers plan to either utilize the SCAPE lessons, or integrate their concepts and activities into their curriculum. One teacher shared, "I certainly will be implementing the field lessons with the kids from here on out in my classes. They were completely beneficial, and so much more applicable to what someone might actually do in their life than bringing the sample in and just testing it in the classroom. And so, I definitely will do that again." Another teacher stated, "I liked the way we had the pilot this year, being able to add a couple of small things in. I'll continue being mindful of how to scatter the concepts throughout the year."

One teacher plans to utilize the SCAPE lessons as part of an ongoing rotation of project-based curriculum:

> "The school I teach at is an intimate-type of school. It has a project-based curriculum where teachers get to decide what the curriculum looks like year-to-year. So I don't teach the same project every year. So I won't teach water quality next year. But I will likely come back to it in two years, at which point I will try to extend it a little bit and use some of the lessons I have gathered from the SCAPE program, for sure. And I hope to flesh out some of these ideas of what it looks like to collaborate with other schools more. That was supposed to be one of the benefits of the program, the connection of the teachers and the learning about the water quality from different areas. I'm not sure about the extent to which that actually happened yet. Hopefully, there's still a little bit more time for that to happen."

Final Thoughts

Finally, teachers were provided an opportunity to share any additional thoughts and ideas about the SCAPE program that had not been covered during the interview. Two teachers provided responses:

- "If the impression you're getting is that things didn't go well, it's primarily on my end. Dan and the ASU crew have been just great. The workshop over the summer was phenomenal. It's just I wish it fit better into my school and my bureaucracy."
- "I think the only thing that I would like to share is that I have felt, although I haven't been probably the best participant, that it is a worthwhile program. And I think the goal of getting kids to share the story of the Colorado River and how it changes throughout the different states and all its varied uses, are all really important concepts to be asked. And so it would be nice if people agreed and could continue that on into the future, whether it's on a smaller scale or just huge program."

SECTION III: SUMMARY AND FINAL THOUGHTS

Overall, the SCAPE teachers consistently expressed their enthusiasm for and confidence in implementing and integrating the SCAPE curriculum in their classrooms. They also shared their satisfaction and appreciation for the training and ongoing program support they have received from SCAPE program leadership.

Based on their responses, we make the following recommendations for future iterations of the SCAPE program:

- **Convene a curriculum review board.** With the pilot year of the SCAPE program complete, there is an opportunity to apply what was learned about the strengths, weaknesses, and modifications made to each of the 17 lessons to improve the quality of the overall curriculum. Recommendations from the teachers included bringing together a small, select group of SCAPE teachers and students to review each lesson, ensure the instructions and content are appropriate for the high school level, and improve the instructions for the recording, uploading, and sharing of fieldwork data.

- **Proactively address administrative and logistical challenges.** SCAPE teachers will face challenges in three main areas: 1) Working with their district office or school to procure funding for acquiring the equipment necessary to implement the SCAPE lessons, 2) Gaining access to, and in some cases, permits for access to the Colorado River or its local tributary, and 3) Gaining school and parental support for, and planning the logistics of, class field trips to the Colorado River or its local tributary. Instructions and guidance for any advanced work that can be completed by teachers participating in the SCAPE program prior to the academic year will mitigate the frustration that these teachers will face. Additionally, addressing these logistics and administrative tasks early on will open up time and space for teachers to implement more of the SCAPE program, particularly during Quarter 1 when the lessons in Unit 1 should be being implemented.

- **Proactively develop a SCAPE teacher community of practice.** When describing their level of support and overall satisfaction with the SCAPE program, many of the teachers' responses focused on the program's failure to develop and maintain an active community of practice. The teachers desired to share their own experiences and learn from other SCAPE participants as they implemented the SCAPE lessons. When asked to provide recommendations on how to actuate this idea, teachers provided a few actionable activities, including sharing an email list of teacher participants among the community, setting up a communication platform, and providing opportunities for open dialogue during the quarterly meetings.

- **Develop a plan for technical support.** When describing their challenges in implementing the SCAPE lessons, the teachers described needing additional technical support when entering and sharing their data collected from the field. As this component of the project was one of the key elements that attracted the teachers to the program, SCAPE leadership should anticipate, plan, and implement a strategy for ensuring that SCAPE teachers are fully supported as they implement these program components.