TEACHING AND LEARNING PORTFOLIO

by

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Delta Certificate in Research, Teaching, and Learning.

Delta Program in Research, Teaching, and Learning
University of Wisconsin-Madison

The Delta Program in Research, Teaching, and Learning is a project of the Center of the Integration of Research, Teaching, and Learning (CIRTL—Grant No. 0227592). CIRTL is a National Science Foundation sponsored initiative committed to developing and supporting a learning community of STEM faculty, post-docs, graduate students, and staff who are dedicated to implementing and advancing effective teaching practices for diverse student audiences. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

For more information, please call us at 608-261-1180 or visit http://www.delta.wisc.edu.
About me

Born and raised in a rural Wisconsin farming community, I obtained a B.S. degree majoring in Biology and Botany with a minor in Environmental Studies at the University of Wisconsin-Madison. I am currently a graduate student in the M.S. Environment and Resources program within the Nelson Institute for Environmental Studies at the University of Wisconsin. My research focuses on nitrogen cycling in perennial grassland systems managed for biofuels. Also at the University of Wisconsin, I am participating in the Delta Certificate Program for Research, Teaching, and Learning and have primarily focused on science outreach and informal science education. Through a career in science communications, Extension, or informal science education, I aspire to build open bridges between the scientific community and the public.

Introduction to this portfolio

I have structured my teaching portfolio around three significant outreach experiences to highlight the diversity of my teaching and how I incorporate my teaching and learning philosophy and the Delta pillars into my practice. These experiences differed greatly in their scale, audience, goals, and format. Together they showcase my achievement in curriculum development and evaluation and my success in reaching learning objectives through a variety of methods and with a diversity of audiences. Each experience includes a brief description, a series of artifacts that demonstrate my methods and successes, and a reflection on how these artifacts and the experience support my teaching and learning philosophy and how they have improved my teaching. At the end of the portfolio are a set of appendices. These appendices include a list of my experiences in outreach, teaching, and mentoring; a front-end and formative evaluation report from my work during the Informal Science Education course; and a summative report on the Lakeshore Video Walk outreach activity I developed and tested. Please note, some appendices include lettered sub-appendices.
Teaching and Learning Philosophy

Science is everywhere and it links people together. From the DNA a mother shares with her child, to the Midwestern crop served in a New York City restaurant, to the Detroit-made air bags that protect me in my car – science is a web that connects us all. Many scientists focus so single-mindedly on their research that they forgo any thought of the interconnectedness of their science outside the laboratory. I believe creating and enhancing these connections through outreach can result in stronger, more relevant scientific research and a more informed, engaged, and appreciative public. As an educator in science outreach, I believe it is important to contextualize science, to foster creativity, to build learning communities, to engage a diversity of learners, and to embrace evidence-based teaching.

I contextualize science so all can understand its importance.
The issues that we care about most and remember best are those that we can relate to and that affect us on a personal level. I believe the best way to engage a learner is to help her make personal connections to science. I feel it is my job to help learners see that science is part of their everyday lives. In a series of outreach videos I created for the Lakeshore Video Walk, I used real-world examples and discussed ways the environment can impact or be impacted by the learner. This provided the learner with a context to view science within her own life. Not only does this improve the learner’s understanding of science, but it also makes science more accessible, illustrating that science is not just for people in white lab coats. However, it is important to remember everyone views science through a different lens depending on their age, background, and experiences. It is important to understand a learner’s point of view in order to teach her from an angle she can best understand. By asking questions and keeping an open mind, I will continually alter my teaching to best connect with the learner.

I foster creativity and build learning communities.
Creativity drives scientific progress, and I believe it is important in science education to allow the learner to think creatively about the scientific process. As a teacher, it is easy to provide too much guidance and correction. I think allowing the learner to devise her own questions, make mistakes, and draw unique conclusions allows for a deeper understanding of science and the research process. I encourage creativity by designing activities that allow the learner to make her own hypotheses and think about the results, and I ask questions that facilitate reflection and further exploration. With a team, I developed a Science of Color exploration station for an informal science event. We designed an activity in which children used light projectors to mix colors of their choosing. With a little guidance, children used the hands-on experience to develop and test their own hypotheses about what happens when different colors of light are mixed.

I also work to build learning communities that enhance creativity. In a learning community, learners are brought together to achieve a common learning goal through interaction, collaboration, and shared learning. The diversity within a learning community can provide learners with alternate perspectives and new ways of thinking about the content. At the end of each outreach video I created for the Lakeshore Video Walk, I posed questions for the viewers to discuss with one another. These questions helped the learner to connect what they had learned to their own experiences and allowed them an opportunity to
learn from the experiences of fellow viewers. Though it can be difficult to build learning communities in outreach settings where learners are transient, I will continue to push the bounds of traditional learning practices, implementing new methods to increase engagement among learners.

**I build an inclusive learning environment to engage learners of all ages and backgrounds.**
I strive to connect a diversity of learners to the world of science. Diversity comes in many forms: ethnic, gender, scientific and personal experience, learning style, and more. By thinking about diversity, I have improved my teaching in many ways. I use universal design concepts to make content accessible to all learners. When creating the Lakeshore Video Walk, I added captions to the videos so that participants with hearing impairments could receive the information. Captions helped all participants when ambient noise made the narrative difficult to hear and especially aided those who learn best by reading. I also consider the diversity within my audience when I lay out learning goals and design activities. All learners have had different experiences with science. I believe it is important to understand how those experiences affect the lens through which a learner views a scientific concept. By trying to understand my audience better, I can communicate science in ways that allow learners at all levels of understanding and from a variety of backgrounds to connect with the material.

**I embrace evidence-based teaching.**
I have learned something new about teaching from every one of my outreach experiences. Using a scientific approach, I have reviewed my own outreach techniques using front-end evaluations, pilot tests, formative evaluations, and questionnaires. These tools help me to assess the base knowledge and demographic of my audience and evaluate the effectiveness of my teaching for different audiences. I then use data-supported decision making to alter my teaching style and improve the educational activity. By rigorously evaluating my outreach work, I will continue to improve my ability to truly connect with the learner and to achieve learning goals. The results of these evaluations also lead me to think about new and innovative ways to teach. As the public becomes increasingly tech savvy and digitally connected, it will be important for educators to find ways to teach with this technology. I have begun using technology in my outreach activities and will continue to incorporate science outreach into the world of smartphones and tablets.

These four statements make up the core of my teaching and learning philosophy. Following this framework, I believe science outreach can directly align with my goals as a scientist. Teaching children to appreciate and understand science will encourage more of them to become scientists and carry on the research I feel is so important. Engaging with the adult public will result in more informed citizens who make decisions based in an understanding of science. Sharing with stakeholders will allow research to reach those who depend on it most and will bring science out of the ivory tower and into the real world. Through contextualization, fostering creativity and building learning communities, connecting with diverse audiences, and embracing evidence-based teaching, I endeavor to improve the public’s understanding of science and to continually develop my skills as an educator. I look forward to the challenges of science education and working towards the goals of my teaching and learning philosophy.
Participation in the UW-Madison Delta Program

The University of Wisconsin-Madison’s Delta Program in Research, Teaching, and Learning provides a complete curriculum of professional development in teaching and mentoring. As part of the National Science Foundation’s Center for the Integration of Research, Teaching, and Learning (CIRTL) and through support from the UW-Madison Office of the Provost and the Graduate School, Delta provides graduate students, post-doctoral researchers, and faculty the opportunity to learn best practices in formal and informal science, technology, math, and engineering (STEM) education.

*Delta Program Mission Statement:* ([http://delta.wisc.edu/About/mission.html](http://delta.wisc.edu/About/mission.html))

“The Delta Program promotes the development of a future national faculty in the natural and social sciences, engineering, and mathematics that is committed to implementing and advancing effective teaching practices for diverse student audiences as part of their professional careers.”

Towards this mission, the Delta Program has established three pillars: teaching-as-research, learning-through-diversity, and learning community.

- *Teaching-as-research* is the use of scientific research methods to develop and implement educational materials and teaching practices that effectively advance the learning experiences and outcomes of students and teachers.
- *Learning-through-diversity* is the principle that teaching should make the most of the diversity of backgrounds, skills, and knowledge that students and teachers bring to a learning experience. It recognizes that diversity is necessary for excellence.
- *Learning communities* bring people together to achieve a common learning goal through interaction, collaboration, and shared learning. Within a learning community, students bring their diverse experiences together to teach to and learn from each other.

During my participation in the Delta Certificate Program I have developed a deeper understanding of these pillars and how they can be incorporated into my informal science education work. Whenever I design an educational activity, the Delta pillars guide that process, helping me become a more effective teacher. I am continually discovering new ways to integrate what I have learned through the Delta Program into all aspects of my science outreach.

*Delta coursework:* Informal Science Education Practicum, Effective Teaching with Technology

*Delta learning community:* Research Mentor Training

*Teaching-as-Research Internship:* The Lakeshore Video Walk

Additional teaching and outreach experiences can be found Appendix I.
The Science of Color Exploration Station

Description

As part of the Informal Science Education Practicum course, a group of fellow students and I designed, implemented, and evaluated an exploration station for the UW campus-wide science outreach event, Science Expeditions in April 2011. With an audience largely composed of young children, our exploration station, entitled “The Science of Color”, had a primary learning goal of “white light is made of all colors”. Our full set of learning goals is displayed in our Learning Goals Triangle (Art. 1). While designing this station, we conducted a series of evaluations to hone our message, improve the activities, and determine whether participants achieved our learning goals (Art. 2). A full report on our front-end and formative evaluations can be found in Appendix II. The final version of the station consisted of four hands-on activities shown in Artifacts 3-6.

Artifact 1: Finalized learning goals for “The Science of Color” exploration station presented at UW Science Expeditions event. Lowest level of the triangle represents primary learning goal aimed at all learners, while higher levels represent more complex concepts aimed at more advanced learners.

1. How interesting were the activities?
   - Very interesting
   - Interesting
   - Somewhat interesting
   - Not interesting

2. How fun were the activities?
   - Very fun
   - Fun
   - Somewhat fun
   - Not fun

2a. Why did you think it was fun or not fun?

3. How easy was it to understand the activities?
   - Easy
   - Somewhat easy
   - Somewhat difficult
   - Difficult

3a. What did you find hard to understand?
4. Do you have any questions about what you saw or did?

5. What did you learn from these activities?

6. What was your favorite activity? Why?

Tell us a little bit about yourself so we can better serve our audience.

7. How much do you like science on a scale of 1 to 10 if 1 is “I hate science” and 10 is “I love science”? (Circle only one number)

1  2  3  4  5  6  7  8  9  10

8. What is your age?     ______

9. Are you...   ☐ Male   ☐ Female

Thank you!
Artifact 3 (left): Me, introducing children to white light and rainbows using diffraction glasses.

Artifact 4 (above): Discovering the different energies of light using colored lasers and plastic tubes.

Artifact 5 (left): Revealing that different light bulbs emit different colors of light.

Artifact 6 (above): Mixing colors of light to produce other colors.
Reflection

As we designed these activities, we thought it important to provide participants with examples of the science of color within their everyday lives. During the final run of our exploration station, I was largely in charge of introducing the children to the concept of “white light is made of all colors” (Art. 3). Rivet and Krajcik (2008) found strong evidence regarding the power of contextualizing instruction in science education to support student learning. I attempted to contextualize the science of light by asking them questions about the color of the lights around them, how the lights looked when they put on the diffraction glasses, whether they had seen a rainbow before, and whether they knew how a rainbow was formed. 

**Most children have enjoyed seeing a rainbow, so incorporating that experience into my explanation of the science was quite successful.** Even parents seemed to appreciate the contextual example, as several of them provided anecdotes to remind their children of their experiences with rainbows. This type of interaction between adults and their children may assist children in making connections between the science activity and the child’s prior knowledge and experience which can improve learning (Dierking & Falk, 1994). The light bulbs activity provided additional context for the participants (Art. 5). Most children have some experience with different types of light bulbs – incandescent, compact fluorescent, and neon – and using these household objects as part of our demonstration allowed children to take what they learned back home to test the diffraction glasses on their home light bulbs. We hoped this would create an opportunity for continued learning, outside of the outreach event.

One of the most important aspects of science is hypothesis creation and testing. We incorporated this into our exploration station through a color mixing activity. Using red, green, and yellow light projectors and a control panel, we allowed children to take control of their learning (Art. 6). Children were able to choose colors to mix and we prompted them to hypothesize what the result of that mixing would be. **The scientific process is a creative one, and through this activity, children were able to be imaginative in the hypotheses they tested.** The sense of independence in using the equipment may also have promoted creativity as participants could explore any combination of colors and light intensities that they desired. During one of our pilot tests, the situation did not allow for all the children to mix the lights. Instead, I asked the group to choose colors to mix and to hypothesize the results while my teammate mixed the lights for them. Though not as interactive as using the projector controls on their own, this situation created an environment where children were able to share hypotheses and ideas with one another. This allowed shyer children to hear answers to questions they may not have been willing to ask and gave the children an opportunity to explain things in terms other children might understand. Asking questions, hypothesizing, formulating ideas together, and explaining are important mechanisms in peer discussions which have been shown to play an important role in sharing, clarifying, and distributing scientific ideas among students (Rivard & Straw, 2000). **Although this set-up did not initially seem ideal to us organizers, the inadvertent creation of a learning community may have made the activity just as educational (or more so) as the final hands-on version.** This reminded me that I must be adaptable during outreach and that there are many avenues to achieving a learning goal.

To create the final version of this exploration station, we used front-end evaluations, pilot testing, and a formative evaluation. Surveys of our expected audience allowed us to determine the base knowledge of
likely participants and to change our learning goals to fit this audience. Our final learning goals are shown in Artifact 1. Through test-runs and evaluations, we were able to learn what participants did and did not like about the activities, what concepts were confusing to them, and whether they achieved our learning goals. An example of one such evaluation is given in Artifact 2. By listening to participants early-on, we were able to make improvements to all four activities prior to the Science Expeditions event.

During the Science Expeditions event, I evaluated the success of our station through brief oral surveys; however, I was often too busy introducing the rainbow activity to survey participants. To obtain improved data in the future, I think it would be best to have a separate individual focus solely on evaluation.

Although our data set was small, based on the responses I received, participants reached at least our primary learning goal and enjoyed the activities. I believe the success of our exploration station at Science Expeditions was due in large part to the effort we put into learning from our expected audience beforehand and adapting to its needs.
The Lakeshore Video Walk

Description

As part of an NSF funded project, I developed the Lakeshore Video Walk (LVW), a video guided walk along the Lakeshore Path that allows users to learn about water issues within the Yahara watershed while walking along the trail using their personal mobile devices (e.g. smartphone, tablet PC). The LVW consists of a series of seven, 3-5 min videos I created. Videos can be viewed at http://tinyurl.com/LakeshoreVideoWalk. Each video is aimed at the general public and consists of photos, videos, interviews with scientists, and narrative. Videos include information about the Yahara Watershed, water issues within the watershed, and steps participants can take to mitigate these issues (Art. 7). Each video ends with a “Let’s Talk” segment consisting of a set of discussion questions to create a learning community among viewers (Art. 8). Using signs, QR codes, and scripting, participants were engaged in place-based learning (Art. 9). My learning objective for the LVW was to increase public understanding of Yahara Watershed issues. I pilot tested the LVW with a group of adults at UW-Parents’ Weekend and used pre- and post-questionnaires to answer the following questions: (1) Is the LVW enjoyable and is the technology easy to use? (2) Does the LVW increase knowledge of water issues within the Yahara watershed? (3) How can the LVW be improved? A selection of participant comments is given in Artifact 10. A full report on the pilot test of the Lakeshore Video Walk can be found in Appendix II.

Artifact 7: Screenshots from video “Urbanization: What can you do?”
Artifact 8: Screenshots from video “Groundwater Quality in the Yahara Watershed,” depicting the “Let’s Talk!” segment.
Artifact 9: Photo of sign located along the Lakeshore Path, with video title and quick response (QR) code and a screenshot from the same video that draws learner’s attention to the environment around her. Also a map, given out to participants, depicts the location of each sign and where each video should be watched.

Artifact 10: Selection of participant comments from post- Lakeshore Video Walk questionnaires.

- Very educational and eye-opening.
- It was cool, good project.
- Nice job! I enjoyed the learning experience and will put some of my learnings (sp) to use in my home and neighborhood.
- Well put together. Informative.
- So glad I took the time to do it. Learned so much and really appreciate the opportunity. Thank you!
Reflection

Mobile technology has become a part of many people’s everyday lives, and by using it in outreach, learners can be engaged anytime and anyplace. I was really excited to integrate this innovative technique into my own outreach. For the Lakeshore Video Walk, participants could use either iPads or smartphones to view the videos as they strolled along the Lakeshore Path. I used small signs and quick response (QR) codes to indicate where participants should watch each video (Art. 9). **I also used the narrative and “Let’s Talk!” questions to encourage participants to incorporate what they were learning with the real-world and especially the environment around them.** Need an example of an impervious surface? Look no further than the parking lot behind you! Mobile learning in real-world contexts that have personal meaning and relevance allow for deeper understanding (Herrington, Herrington, & Mantei, 2009). Plus, the experience of walking along the trail involves many of the senses – sight, smell, hearing – and may be an especially effective learning experience for kinesthetic learners (Fleming & Mills, 1992).

Not only did I have a great time scripting videos, interacting with my interviewees, and learning to both film and edit video while creating the Lakeshore Video Walk, but participants also really enjoyed the learning experience (Art. 10).

I learned a great deal about science outreach throughout the process of creating and testing the LVW. First, personalizing science is a successful way to engage learners. Research has shown that learners sustain their attention more continuously and process information at deeper levels when they have personal interest and investment in the content (Brophy, 2004). Analysis of the questionnaires and discussions with participants indicated that participants both learned from the Lakeshore Video Walk and enjoyed it. **In particular, inclusion of ways participants could reduce human impacts on water issues was especially well-received** (Art. 7). More generally, participants appreciated explanations of potential solutions rather than simply descriptions of the problems. As one participant put it, “…the tips were good because learning all of this isn’t helpful otherwise.” I think it will be important to incorporate actions that the participant can take, in addition to discussions of the environmental problems, when I create content for outreach activities in the future.

I also learned that simple steps can build learning communities. Because the LVW used a transient, independent learning environment, it was difficult to incorporate the concept of a learning community into the activity. I used a “Let’s Talk!” segment of discussion questions at the end of each video to indicate to participants that these were questions they should discuss with others rather than simply think about internally (Art. 8). This was an effective technique. **All the participants responded in the questionnaires that they talked with someone else about the “Let’s Talk!” questions, indicating collaborative learning.** Group discussions are important for sharing knowledge (Rivard & Straw, 2000), and although I do not know the content or length of these conversations, the fact that participants discussed them at all is a positive step in creating a learning community. As I continue to incorporate technology in my outreach, I will consider innovative ways to engage learners with one another. For instance, it may be helpful to create an online learning community for the LVW. This might include a way for participants to share their perspectives, questions, and experiences online directly through their device.
When I pilot-tested the LVW, I only captioned half the videos to determine whether or not learners found them helpful. One of the guidelines for universal design for learning is to provide options for perception because solely auditory information may not be accessible to all learners (CAST, 2011). An example of captions can be seen in Artifact 7. Though captions are typically thought to be used primarily by individuals with hearing impairments, I found that all learners preferred the captioned videos. Participants stated that they liked captions not just because the audio was sometimes difficult to hear, but also because they felt it increased their comprehension of the concepts. This reinforced the idea that universal design techniques, such as captions, can improve learning for everyone—not just those with impairments or disabilities. Incorporating universal design into an activity is an important way to reach a diversity of learners.

The hardest lesson I learned from this experience is that it can be difficult to gain participation in an outreach activity. Unlike in formal classroom situations, outreach activities are optional. If the weather is bad, as was the case for this project, or something else comes up, it is easy for participants to not show. Although everyone who participated enjoyed the activity, it can be difficult to effectively advertise the fun-factor. After all, it is still an educational activity and this does not garner the same sort of participation that a solely entertainment activity might. Next time I pilot-test an activity, I might first assess the activity with a class of students. It would be easier to require students to participate in the activity and extra credit might be given as an incentive for survey completion. I might also provide incentives for participation from the general public, such as including participants in a drawing for a prize. I would also commit more time to advertising the outreach event. It is not always easy to promote an educational event, but advertising using flyers, emails, and social networking may help. After all, no matter how engaging your activity, you can’t teach if your learners don’t show up!
Middle School Science Symposium Mentor

Description

Through the Madison School District, I mentored a group of three 6th grade boys for the Middle School Science Symposium. Students participating in the science symposium were charged with conducting independent scientific research and sharing it with other students. I laid out my learning goals for my mentees at the beginning of the project in the form of a syllabus (Art. 11). I then mentored them weekly throughout the semester as they learned the scientific process through the development, testing, and analysis of a research question about sugar crystal formation. At the end of the semester the boys gave a PowerPoint presentation on their project to their peers from across the district (Art. 12).
Artifact 11: Syllabus for my Middle School Science Symposium students.

**Middle School Science Symposium Syllabus**

There are no grades for the science symposium. Instead, I want you to have fun learning how to do real scientific research and how to present the cool results of your research to your families and friends! Below are some of the learning goals I hope you’ll achieve in the next couple months. If we don’t get to all of them, that’s OK! I’ve also written up a schedule. Though we may not stick exactly to it, it will give you some idea of how much time we have to get everything done between now and the symposium.

**Learning goals**

I hope by the end of this program you will be able to:

- turn an idea into a scientific research question
- use the internet and books to do background research on a scientific subject including keeping track of sources
- produce a TESTABLE research question (hypothesis)
- test your hypothesis using replicated experiments (if possible)
- collect data from the experiments
- figure out (analyze) what the data from your experiments mean
- explain your experiment and its results to others and help them to understand why your research is important
- create a scientific poster or powerpoint presentation (or something else?) to share your research with others
- have fun with scientific research!

**Schedule (Meeting on Mondays after school)**

- **Feb 27**: 1st meeting, brainstorming project ideas
- **March 5**: Making a research plan and beginning to learn about the subject we chose
- **March 12**: Discuss what background information you’ve found, teach it to everyone else in the group. Continue research if needed/begin to develop hypothesis
- **March 19**: Confirm hypothesis and develop research design. Research what is needed for experiments that will help us answer our hypothesis.
- **March 26**: Begin experiments! Collect and record data.
- **April 2**: Continue experiments. Discuss the results you’ve found so far.
- **April 9**: Finish discussion of experiment results. Begin working on presentation.
- **April 16**: Work on presentation
- **April 23**: Practice presentation
- **April 25**: Day of the symposium. Good luck!

**Brianna’s Contact Information**

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Phone/Text: 608-558-0712
Artifact 12: Selection of PowerPoint slides created by the boys for their final presentation at the Middle School Science Symposium.

Dear : Kelvin, Brandon and Sai
From : A Crystal Lover
Q : What are Crystals?
A: Crystals are solids that form by a regular repeated pattern of molecules connecting together. In crystals, a collection of atoms called the “Unit Cell” is repeated in exactly the same arrangement over and over throughout the entire crystal.

Methods 2
- We dissolved the sugar with tap water or distilled water.
- We cooled the crystals in refrigerator or room temperature.

### Table

<table>
<thead>
<tr>
<th>Number of jars</th>
<th>Tap</th>
<th>Distilled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room temperature</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Hypotheses
We happened to run into hypotheses when we were trying to figure out what would make our crystals big and better.
- Do sugar crystals grow better in tap water or distilled?
- Will the cooling temperature affect the way the sugar crystal will grow?

Room temperature
Refrigerator
This is a picture of our 2 crystals at different cooling temperatures
See a difference, the crystal on the left has bigger building blocks while the one on the right has smaller crystals.

Will the cooling temperature affect the way the sugar crystal will grow?

Here we have a single graph that shows growth of crystals in different temperatures.

As you can see, we had longer crystal length for the refrigerated temperature.

Dear : Kelvin, Brandon and Sai
From : Your Name Here
Q: Why do crystals grow bigger in room temp. than in the refrigerator?
A: Because the way a crystal grows is by the sugar molecules bumping into each other then sometimes when they bump together they stick together and slowly form a crystal. Now when things get colder the molecules move slower and so then the refrigerator the molecules have less of a chance to form a crystal before we take them out of the refrigerator.
Reflection

Mentoring for the Middle School Science Symposium was one of my more challenging outreach experiences. Though these 6th grade boys were very intelligent and interested in doing science, they were also easily distracted and at times difficult to rein in. They were old enough to want to work independently, but too young to handle a great deal of responsibility, forgetfulness being their key struggle. I found that structure was very important but I had to balance this so that they could be creative and have fun. After all, this was a voluntary after-school activity and I did not want it to feel like school work to them. I wanted them to enjoy the experience so that they might someday want to be a scientist.

To provide them the structure they needed, I gave them each a syllabus at the start of the project and we read through it together (Art. 11). The syllabus laid out the learning goals for the project, though I was careful to explain that we did not have to achieve all of these goals to be successful. I wanted to give the boys direction without being so rigid that we would move too quickly for them to really learn. I wanted to leave time for exploration and questions. This turned out to be a good attitude because we rarely got as far during each meeting as I expected. A study by Crawford, Krajcik, & Marx (1999) also found that this balance of structure and independence was important for building a community of middle school learners. They state that, “The teacher’s instructional support facilitated the students’ group decision making...however, there was a delicate balance between guiding…and too much teacher direction, which could reduce student collaboration.” We spent a lot of time brainstorming research topics and learning how to use the internet for research, but I think it was time well spent. I enjoyed seeing how enthusiastic the boys were about a wide variety of science subjects. At the start they wanted to investigate plant biology, at one point were interested in asteroids, and by the end settled on crystals and how they are formed. These science discussions gave the students a chance to hear each other’s ideas and consider topics they might not have come up with alone. I also learned the boys’ strengths and weaknesses. With this, I was able to help them use their diverse skills to work together as a team. The community we built during these early meetings made me a more effective mentor because I better understood the students and it gave the students a chance to learn more than they would have alone.

Although it took us some time to get there and the road was winding, by the end the boys had carried out the entire scientific process and learned a lot along the way. Artifact 12 displays a selection of slides they created for their presentation to their peers. This collection of slides demonstrates the balance between structured learning and creativity that I worked towards throughout the project. These slides highlight the students’ understanding of all stages of the scientific process, including background research, experimental design, quantitative and qualitative data analysis, and discussion of results. The slides also reveal the boys’ imaginations. It would have been easy for me to over-edit their slides to make them more “professional.” By allowing the students to explain the content in ways that made sense to them, they processed the information more deeply than if I had told them how to explain it. Plus, it made the information more accessible to their audience, other children.
Working with this group of students taught me a lot about mentoring young children in research. First, I should not assume children have a base knowledge of the scientific process. I was sometimes overly concerned with getting through the entire experiment in time and glossed over topics that might have been helpful to the boys. A more thorough understanding of the steps of research before starting may have made the process run more smoothly. I now also better understand how to manage middle school children, especially boys. At first I did not want to be too authoritative, but eventually realized they needed me to give them instruction and keep them on task. They didn’t resent me in the least and learned a lot more than when they were running wild. Importantly, I learned to relax and let the boys’ imaginations go. Scientific research is a creative process. **Although it got us behind schedule, allowing the boys to think about science in new ways made it more fun for them.** After all, no matter how much I teach him about the scientific process, no child will become a scientist if it isn’t fun!
Reference list for Teaching and Learning Portfolio


Appendix I: Experiences in Outreach, Teaching, and Mentoring

Science Outreach, Education, and Communication Experience

Bioenergy Research Presenter
Great Lakes Bioenergy Research Center (GLBRC)  University of Wisconsin-Madison

- Demonstrated field research techniques to groups of 10-15, K-12 educators to support the GLBRC’s Bioenergy Institute for Educators
- Developed, with colleagues, an interactive station entitled “Everything Breathes” for children and families to engage in research methods for measuring plant and soil respiration for “Exploring Energy at the Wisconsin Energy Institute” event
- Spoke to Beloit College undergraduates and faculty from a diversity of science disciplines about bioenergy research
- Guided children as they participated in a hands-on activity about bio-ethanol production at UW-Madison’s “Science Expeditions” event
- Summarized research and addressed listener questions as a guest on Wisconsin Public Radio’s Larry Meiller show (can be heard at: http://tinyurl.com/afkogyl)
- Presented field research techniques for Wisconsin Public Television show In Wisconsin on bioenergy research

Educational Video Writer, Producer, and Videographer
Water Sustainability and Climate Project  University of Wisconsin-Madison

- Scripted, interviewed experts, and narrated the Lakeshore Video Walk: The Yahara Watershed (LVW), a series of seven short videos, aimed at the general public, to be used for place-based education within the UW-Madison’s Lakeshore Nature Preserve (can be viewed at: http://tinyurl.com/cyqqkly)
- Filmed, edited, and produced the LVW videos and laid out a video guided walk within the Nature Preserve using signage, quick response (QR) codes, and iPads
- Pilot tested and evaluated the effectiveness of the LVW in meeting learning goals and engaging participants using pre- and post-participation surveys approved by the UW-Internal Review Board
- Directed two undergraduate interns assisting with video editing

Middle School Research Mentor
Middle School Science Symposium  Madison, WI

- Mentored a group of three middle school students as they used the scientific method to carry out an experimental research project on crystallization

Science Club Leader
YMCA  Madison, WI

- Prepared and guided hands-on science activities for a weekly K-5 after-school science club

Outreach Activity Designer and Presenter
Science Expeditions Event  University of Wisconsin-Madison

- Collaborated with a team to develop, pilot test, present, and evaluate an interactive exploration station, entitled “The Science of Color”, aimed at children and their families
Teaching and Mentoring Experience

Undergraduate Research Mentor May 2011-present
Department of Agronomy University of Wisconsin-Madison
• Trained 2-3 undergraduates each year in the basics of field research, lab techniques, and data management
• Mentored an undergraduate participating in the Integrated Biological Sciences Summer Research Program for which the student conducted an award-winning research project

Teaching Assistant August 2012-December 2012
Department of Agronomy University of Wisconsin-Madison
• Taught undergraduates from a range of academic backgrounds in the laboratory portion of Agronomy 100: Principles and Practices of Crop Production
Appendix II: Front-end and Formative Evaluation Report for “The Science of Color” Exploration Station. Front-end evaluations provide background information about the prior knowledge, experiences, learning styles, and expectations of the audience of interest before development of an activity. Formative evaluations are implemented with an audience of interest while activities are being designed to gain information about how well the activity will work and how it can be improved. Note, this appendix contains several lettered sub-appendices.

Blakesley Burkhart
Brianna Laube
Tam Mayeshiba
Josh Weber
3/24/11

Front-end Evaluation

Previously, our idea for an exploration station was based on the theme of “the usable energy of light.” After conducting some front-end evaluation, we decided to switch our theme to “the science of color” with the bottom part of our learning goal triangle being: “white light is made up of all colors of light.”

We conducted extensive front-end evaluation and testing, reaching over one hundred people aged 3 to adult over the course of several weeks. The following are some examples of front-end evaluation feedback that we received that led us to change our theme.

From a librarian at Edgerton Middle School in Edgerton, WI, we received, “I just spoke with a woman who teaches light and light energy to freshmen in high school. She teaches the very topics you were asking about. From what she said the kids had little knowledge of this prior to her instruction.”

From a retired Madison-area child-care/special-education worker, we received comments to the effect that if we talk about the wavelengths of light, we should ideally set up the similarity between light and waves using the classic experiments (diffraction patterns, refraction, etc.) with water waves, possibly sound waves, and their light analogs.

We sent a survey to high school freshmen through seniors via their teachers (Sub-App. A). Selected results from the survey, which was conducted at Rochelle Township High School in Rochelle, IL, are shown in Sub-Appendix B. The responses indicated that half of the older part of our audience would still not be comfortable with the concept of different wavelengths of light and light energy, and that in order to introduce light and waves we would need additional experiments with water. Given the mobility and therefore short attention span of our intended audience, we decided we might design our station around a simpler base message than the energy of light.

Additionally, we sent surveys to 2nd and 3rd graders at Van Hise Elementary in Madison, WI (Sub-App. C). The students were allowed to take the surveys home and may have had some assistance from parents or the Internet. Nonetheless, the children surprised us with how much they knew. The survey questions were geared towards seeing where students were on our learning triangle. Questions such as: “Do you know why there are different colors of light?” and “Do you think light carries usable energy?” were at the bottom of the triangle while questions on wavelength and the wave nature of light were at the top (see Sub-App. C). The responses to these questions were varied. Some children had no idea about the wave nature of light nor about non-visible light such as x-rays and radio-waves. However, some
children got all of the questions correct and even drew diagrams of the electromagnetic spectrum and how it changes with wavelength. We feel that this type of response will be typical of our audience at Science Expeditions; some people will know all of the physics of our demos and others will learn it for the first time.

Because a portion of our audience may not yet be at a stage to understand “the usable energy of light,” we decided to simplify the message of our station and instead focus on the color of light. Since color appeals to both children and adults, and since Josh and Blakesley were already familiar with demonstrations that had to do with color, we narrowed our focus into the visible part of the spectrum. See Sub-Appendix D for our revised learning goals triangle and message compass. These goals and messages were not fully set or enacted until our formative evaluation discussed below.

Initial Testing

Our group conducted initial testing of some of our primary station ideas at the Physics Fair, which was held on February 19th, 2011 from 11am -4pm in Chamberlin Hall. Our demonstrations were:

- Color mixing of red, green, and blue lights, with white as a comparison light, viewed through diffraction glasses or a spectroscope, and optionally matching RGB light to a random color.
- Spinning tops (translucent - like mixing light, opaque - like mixing pigment)
- Prism

This balanced well with the other demonstration in the room titled “gas fingerprints,” which showed the line spectra of different gases. Anecdotally, most people seemed happy to go through “white light is all colors” and then move on to the gas fingerprints, as both of these concepts hinge on the spectrum of light. This indicates that we can use “white light is all colors” as the base of our exploration station, with time for one more related activity or a few short incidental activities. Also, we did not get as many middle school-aged students as we expected; our audience included mostly elementary-school children accompanied by their parents (34 groups) and individuals (4) or pairs of adults (4). Of 127 visitors, 62 were adults, 49 were elementary-school age or younger, 16 were middle-school age or older, with an error of about 10 missed or misidentified people. Our notes and a break-down of the demographics from the Physics Fair are found in Sub-Appendix E.

Some questions we received were “how do prisms work?” (age 10), “how do the diffraction glasses work?” (age 7), and “why does the pattern of spots change away from the center of the diffraction glasses?” (adult). These questions indicate that our audience is broadly receptive to additional treatment of the different properties of different colors, for example that some colors bend more than others through the same medium (glass/plastic), producing a rainbow. We have since decided to incorporate a short demonstration relating to the unique properties of different colors of light (e.g. energies) as well as a poster discussing refraction and diffraction.

Our initial testing caused us to alter some design aspects of our demonstrations. We found that the backs of the projectors need to be covered to prevent ancillary rainbows when using the diffraction glasses. We have since used demonstration board to block this light, as well as to hide many of the electrical cords. The projectors were too high for some of our smallest guests making it difficult for them to see the colored lights. We will change the location of the projectors relative to the viewers in order to minimize this problem, and we will have small step stools available in the future. The spectroscope more
clearly showed the difference between discrete and continuous spectra but it was difficult for guests to see through and we have now purchased two easier-to-use spectroscopes. We also bought single band diffraction glasses that produce a similar effect to spectroscopes but are less expensive. The tops did not adequately demonstrate the difference between mixing light and mixing paint/pigments, especially because we were in the dark. We have decided not to use the tops and will have a poster demonstrating the difference between the types of mixing. Our prism was heavy and difficult to use and so we have purchased a small, hand-held prism that creates better rainbows. The prism requires sunlight, so depending on the weather and our location at Science Expeditions we may or may not use it.

In summary, based on our front-end evaluation, we decided to focus on the visible spectrum. We tested our primary activity and found it to be adequate in terms of complexity, duration, and enjoyment. We began working on several ideas for secondary activities that we tested during our formative evaluation that follows. Importantly, we found that our audience is generally elementary school aged or younger and so have revised our message to aim it at this younger audience. We found some design flaws in our demonstration and have worked to fix them. Additionally, we decided to design posters on more complex topics in order to shape our station into a more coherent whole and to include levels of complexity that appeal to a broad range of people.

**Formative Evaluation**

We conducted a formative evaluation with a combined 2nd and 3rd grade class at Van Hise Elementary School, Madison, WI, on March 16, 2011. This is the same group that previously filled-out our front-end evaluation surveys. Based on our Physics Fair demographics, these students also represent the typical age of our expected audience. Because we were in a class room setting with ~20 students, we split the class into three groups and set up three demonstration stations. We opened by handing out diffraction glasses to everyone and discussing that “white light is made of all colors” as a group before sending them to the stations. In addition to the color mixing projectors we added two new demonstrations. We added a station of different types of light bulbs that demonstrates that different types of “white” bulbs emit different colors of light, and that the light from fluorescent light bulbs (compact fluorescent, neon) produce a characteristic pattern when seen through a spectroscope (similar to the “gas fingerprinting” demonstration we saw at the Physics Fair). This provides an additional ‘real life connection’ with our project, as many people will recognize compact fluorescent bulbs and neon lights from their daily life experience.

We also had a station that demonstrated that different colors of light have different properties (i.e. energies). This station involves different fluorescent plastic tubes and colored lasers as well as a fluorescent pad that guests can “draw” on with the lasers. Each group had 10-15 minutes at each station before rotating to the next station.

Because the groups were large, the projector demonstration did not end up being quite as hands-on as it had been at the Physics Fair. Instead, we controlled the lights and we asked the children interactive questions while they experimented with the full-spectrum diffraction glasses and single band diffraction glasses. They also experimented with making shadow puppets in the true white light versus the mixed white light as well as experimenting with covering different projectors to see the resulting color. A few issues we found with the demonstration were that the true white light did not appear the same color as the mixed white light. The mixed white light was significantly less bright than the true white light as well.
These issues caused some confusion for the children which made it more difficult for them to reach the learning goal; however, overall the children seemed to understand what we were demonstrating. Before Science Expeditions, we will test all the light control boards available to us to find one that more accurately mixes the colors to create white light. We also may try to find a way to dim the white projector so that it better matches the mixed white light.

The laser station was quite successful. Overall the children seemed to understand that different colors of lights behaved differently and they especially enjoyed “drawing” with the lasers. We attempted to incorporate a solar calculator into the demonstration to show that some colors of light have the energy to turn it on while others do not, but we were unable to get this demonstration to work in the dark. The laser station was so successful probably because it was very hands-on and included different colored lasers! The lasers combined with the fluorescent tubes create a spectacular light show, particularly with the diffraction glasses put on. It also very nicely demonstrates the energy in the different colors of light and makes a nice segue to explaining wavelength.

The light bulb station also seemed to work well. Although it was not as popular as the light mixing or laser drawing stations, the children still seemed very interested in the demonstration. The new spectroscopes were easier for the children to use, however there was some confusion with how to hold them. Thus, we will add TOP/BOTTOM labels and arrows to indicate how to use the spectroscopes. The fluorescent light was also overly bright and somewhat difficult to look at for very long and it was necessary to turn the lights on and off in order to prevent each bulb from washing out the light from the one next to it. To counteract these problems we will put a poster board with slits in front of the light bulbs and a divider between each bulb, as was done in the “20/20 Vision” demonstration in the Physics Fair, to allow only a fraction of the light through and to make it easier to look at only one type of light at a time.

After the demonstrations the children filled out surveys about their experience (Sub-App. F). A summary of the major results is found in Sub-Appendix G. Though we did not ask in the survey, in speaking with the children it was apparent that they understood that white light is made of all colors, our base learning goal. The children showed keen interest in asking questions about color and seemed to stay alert and involved throughout the demonstrations. Several students even stayed to ask physics questions after the demonstration. Based on our survey, all but one child found the demonstrations Easy or Somewhat Easy to understand, so we can be fairly confident that we are explaining the concepts at an appropriate level. This was true even though each group of children approached the stations in a different order. This indicates that our activities, though related, are independent enough to work well in the Science Expeditions environment, where explorers may approach our station from different sides and go through it in different orders. All of the children also found the demonstrations to be Fun or Very Fun as well as Interesting or Very Interesting. Thus, we are certain that our Exploration Station will be appealing and educational for our expected audience.

**Evaluation Summary**

Through our front-end evaluation, initial testing, and formative evaluation, our Exploration Station has become more focused and coherent and better tailored to our expected audience. Our front-end evaluation led us to shift our learning goals to the “science of color”, since the “usable energy of light” seemed like it would require a more structured and time-intensive approach than would fit the free-flowing format of Science Expeditions. Our initial testing at the Physics Fair helped us to refine the nuts
and bolts of our projector demonstration and to improve its universal design. We received a better indication of the age and education level of our expected audience, and we came up with the idea of displaying posters on more complex topics for those audience members wishing to explore light on a deeper level. We also found that our audience would be willing to move from the projector demonstration on to one or two additional, shorter demonstrations. Not only was our formative evaluation a good opportunity to practice the delivery of our message, but it also provided insight into how enjoyable our activity actually is for our audience. The children thought our demonstrations were fun and interesting, and they were able to easily understand our explanations. With a few additional refinements to our demonstrations, as well as posters displaying more complex information for the advanced audience members, our Exploration Station will be ready for successful deployment at Science Expeditions.
Sub-Appendix A: Front-End Evaluation Survey to High School Students

Salut / Hola, RTHS French / Spanish students. My name is Josh Weber, and I’m M. Weber’s / Sra Weber’s son. For a class that I am taking at the University of Wisconsin, my group is designing an exhibit about light for a science festival. Some of our audience will be around your age, so we’re trying to figure out what high schoolers know about light. Could you please answer the following questions by checking yes or no and then writing a few words if you have something to add? There are no right or wrong answers, so don’t worry about being correct. Just be honest; we just want to know what you know. Your answers will remain anonymous, and you don’t have to answer any questions you don’t want to. My group and I would really appreciate your input.

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
<th>Additional Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think most people your age would know why we see different colors?</td>
<td>Yes / No</td>
<td>If you have any ideas why this is, could you please explain in a few words?</td>
</tr>
<tr>
<td>In school, have you ever discussed how light carries energy?</td>
<td>Yes / No</td>
<td>Can you list any examples that show that light carries energy?</td>
</tr>
<tr>
<td>Do you think most high school freshman would know that there are “colors” of light that we can’t see?</td>
<td>Yes / No</td>
<td>Can you list any examples?</td>
</tr>
<tr>
<td>Extra: Is there any demonstration or experiment that you’ve seen or done involving light that was particularly interesting?</td>
<td>Do you have any questions about light?</td>
<td></td>
</tr>
</tbody>
</table>

Merci beaucoup/muchas gracias for your help! We really appreciate it! Your responses will help us to make a better exhibit.
Sub-Appendix B: Results Summary of Front-End Evaluation Survey to High School Students

Do you think most people your age would know why we see different colors?

![Bar chart](chart1)

Year in High School of Respondents

<table>
<thead>
<tr>
<th>Year</th>
<th>Freshmen</th>
<th>Sophomores</th>
<th>Juniors</th>
<th>Seniors</th>
<th>Unclassified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>42</td>
<td>57</td>
<td>7</td>
<td>18</td>
<td>2</td>
<td>76</td>
</tr>
<tr>
<td>No</td>
<td>57</td>
<td>33</td>
<td>24</td>
<td>8</td>
<td>2</td>
<td>88</td>
</tr>
</tbody>
</table>

In school, have you ever discussed how light carries energy?

![Bar chart](chart2)

Year in High School of Respondents

<table>
<thead>
<tr>
<th>Year</th>
<th>Freshmen</th>
<th>Sophomores</th>
<th>Juniors</th>
<th>Seniors</th>
<th>Unclassified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>61</td>
<td>39</td>
<td>24</td>
<td>13</td>
<td>4</td>
<td>112</td>
</tr>
<tr>
<td>No</td>
<td>39</td>
<td>61</td>
<td>14</td>
<td>6</td>
<td>1</td>
<td>66</td>
</tr>
</tbody>
</table>

Do you think most high school freshman would know that there are “colors” of light that we can’t see?

![Bar chart](chart3)

Year in High School of Respondents

<table>
<thead>
<tr>
<th>Year</th>
<th>Freshmen</th>
<th>Sophomores</th>
<th>Juniors</th>
<th>Seniors</th>
<th>Unclassified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>49</td>
<td>49</td>
<td>20</td>
<td>19</td>
<td>4</td>
<td>88</td>
</tr>
<tr>
<td>No</td>
<td>49</td>
<td>49</td>
<td>10</td>
<td>8</td>
<td>1</td>
<td>34</td>
</tr>
</tbody>
</table>
Sub-Appendix C: Front-End Evaluation Survey to 2nd and 3rd Grade Students

1) Do you know why there are different colors of light? or Do you know why there are different colors?
2) Do you know that light carries usable energy?
3) Do you know that there is light that you can't see with your eyes?
4) Do you know that radio waves and X-rays are among this “light that you can't see with your eyes”?
5) Can you define what a 'wavelength' is? Can you define what 'frequency' is?
6) Do you know that light behaves like a wave?
Sub-Appendix D: Learning Goals Triangle and Message Compass

Learning Goals Triangle

- Colors of light can be mixed to create other colors. Red, blue, and green lights can mix to make almost all colors
- Colors of light have unique properties
- Light bulbs emit different colors of light

White light is made up of all colors

Message Compass

White light is made of all colors

- Tungsten light bulbs emit the entire spectrum of visible light.
- Fluorescent and neon bulbs emit only bands of color.
- The differences are due how the light is being produced, and the materials being used.
- These differences can be seen through a spectroscope.
- This is similar to how scientists identify which gases make up stars.
- Demonstrations: various types of light bulbs, spectrosopes

Light bulbs emit different colors of light.

Each color of light has unique properties.

- The colors of the rainbow are always in the same order because each color has a different energy or wavelength.
- Red has the least energy and violet has the most.
- Diffraction through rain drops or diffraction glasses demonstrate these differences.
- Demonstrations: lasers + colored tubes, refraction poster

Colors of light can be mixed to make other colors

- White light can be "created" by mixing red, blue, and green.
- These colors can be combined in different amounts to make almost all other colors.
- TVs use this method of color mixing.
- Pigment mixing is different than color mixing.
- Our perception of color is sometimes different than the true color of light.
- Demonstrations: color mixing projectors, diffraction glasses, spectrosopes, eye/color mixing posters

- Diffraction glasses and prisms affect each color of light differently.
- The amount they bend the light depends on the light’s color, so they spread out white light, allowing us to see the constituent colors.
- Demonstrations: diffraction glasses, diffraction/refraction posters
Sub-Appendix E: Notes and Demographics from Initial Testing at Physics Fair

Some observations we made were:

- The projectors needed to be covered in back because the light that they gave out created ancillary rainbows in the diffraction glasses.
  - We need to figure out a professional-looking way to cover them effectively
- The projectors were on desks, and when covered in back, our smallest audience members could not see over them to see the colored spots on the board.
  - We will experiment with setting projectors on the floor or just above, and propping them up, making sure they won’t be in danger of being stepped on, or posing a trip/touch risk.
  - Also, we need to figure out a way to make part of the WID dark in general: have color mixing booths? Some sort of drapery shelter? A darkened room (but that may reduce traffic.)
- While the spectroscope (tube-shaped) more clearly showed the difference between the discrete and continuous spectra, it was difficult to see through and therefore not useful for most of our visitors.
  - The diffraction glasses seemed to be a big hit. They were a good way to “break the ice” with arriving visitors. They appeared to be genuinely impressed by what they saw while wearing them.
  - We will experiment with different types of diffraction glasses (single in-line diffraction versus diffraction array), or buying a few easier-to-use spectrosopes.
  - Single-band diffraction glasses (from Rainbow Symphony, with a yellow paper frame) also have printing on them so people can read them when they get home.
- The tops did not adequately demonstrate the difference between mixing light and mixing paint/pigments, especially because we were in the dark.
  - The tops were ignored by almost all visitors. We didn’t do anything to draw attention to them, and visitors may have not noticed them.
  - We could try to have both a light area of our exhibit and a dark area of our exhibit.
  - Adding the white circle underneath the translucent top seemed to help make it mix to be more apparently white.
- For older kids (6th-8th grade and up), trying to match a certain colored gel by mixing R, G, B was fun even when they already knew that red, green, and blue lights can be mixed to produce white lights.
  - This “game” aspect seemed to be more appealing to older kids who were initially more reluctant to take a turn controlling the lights.
  - We will get a second mixing board/projector setup (borrow from Physics 109 lab) so that some kids can spend some time mixing colors.
- Only one person could participate in the mixing board at a time.
  - Some visitors, especially the younger ones, were drawn to this part of the station. The more visitors got physically involved, the more engaged they seemed to be.
  - We will get a second mixing board/projector setup (borrow from Physics 109 lab).
- Our prism was difficult to make a rainbow with, and rather heavy.
  - We can experiment with finer beams of light (like from a flashlight?) and/or different prisms.
  - We might figure out ahead of time the best way to make rainbows with the prisms, and then have a poster or chart.
- At least one person was confused, and many may have been and not said anything, when we asked about seeing “rainbows” in the white light through the diffraction glasses, as she was expecting a classic arc-shaped rainbow.
We need to figure out a more precise way to describe what they see (a white dot, with half of the rainbow smeared on one side, and the other half on the other side)

- It is difficult to talk to multiple groups of people at the same time
- Posters for grownups to read while we do elementary explanations with their kids.
- Overlap with other areas: 20/20 vision demonstration
  - This same group, from the Synchrotron Radiation Center, will also be at Science Expeditions.
  - This uses fluorescent, incandescent, and mercury lights. We may want to go in a slightly different direction (e.g. refraction of light, or difference between additive and subtractive mixing of color.)
  - We met with the people running the 20/20 demonstration. They were very willing to discuss presentation techniques and to share resources. We agreed to be in contact to plan so that our Science Expeditions stations don’t overlap too much.

Ideas for additions we might make:

- Fluorescent lamp (spectral lines) and incandescent lamp (full spectrum) comparison
- Hydrogen, Neon fluorescent gas lights
- Small LCD with magnifying glass, and maybe a poster, to show the RGB pixels in LCD displays.
- Different colored lasers fluorescing different plastics (does this still work with our “white light is all colors” message? This will still work for “different colors of light have different properties”)
- Color pencil mixing / some explanation of subtractive color mixing?
- Large diffraction grating to demonstrate what the diffraction glasses look like and how they work (in response to question about how diffraction glasses work)
- Some display or activity about refraction (in response to questions about how prisms work, and why diffraction pattern is not just a simple repeat, but the blue, red, and green dots are shifted relative to each other)
- Solar cell with different colors of lights - which make the solar cell light up a light bulb? (energy has to be > bandgap energy; this may not work with our new “white light is all colors” primary message, but may work for “different colors of light have different properties”)
- Plants grown under different lights (different colors of light have different properties), and under white light (white light is made of all colors)

A typical script (it changed by person) went like this:

What do you see when you look at a white light through diffraction glasses? (Rainbow)
That’s because white light is made up of many different colors of light, and your glasses separate the colors.

Blakesley: The diffraction glasses split color to the way droplets of water in the air split color to make a rainbow (grownup immediately added something like, yes, like when we use the sprinkler.)
What do you see when you look at just the red light? (Just red light.) Repeat for green.
What color do you think you will get if you mix red and green light? (Brown?)
(Actually get yellow) -> Light mixing is different from paint mixing. (No elaboration was given, and no questions were asked about this.)
What color do you get when you add blue light to the red and green light?
What color is in the middle? (White. They have to take off their glasses sometimes to see this clearly.)
How is this white different when viewed through your glasses, compared to the first white? (Dots versus smeared rainbow.)
This is because the white you created is made up of just red, green, and blue light, while the other white light is made up of many different wavelengths.

Josh: Through your eye, your brain perceives the red plus green plus blue as close to white even though it is not made up of as many different colors as “true” white light.

Then we generally sent them on to the next group with, “scientists use tools like your diffraction glasses in order to find out things like what stars are made of.”

Interesting comments / questions we many want to address:

- Why does the [white] light get yellow when it is dimmer? Is it because of the [tungsten] filament? (Age: approx middle school)
  - We looked at this and it seems like the blue wavelengths get dimmer before the red and green ones; the blackbody curve may be shifting back down away from blue, leaving yellow (and red and green = yellow) behind.
- How do the diffraction glasses work? (Age 7)
- Why (when looking at red, green, and blue dots through diffraction glasses) do they not repeat in the same pattern? (This is because the red, green, and blue lights refract differently) (Adult)
- Interesting to look at fireworks through diffraction glasses - Rhythm and Booms does this.
- Mixing red, green, and blue, and more different colors to get white is like what they do to try to create a fluorescent light that is softer, more like a real [incandescent light bulb] white.
- How do prisms work? (Age 10?)

Demographic breakdown:
34 apparent family units (parent(s)/guardian(s) with a child/children)
4 individuals (adults)
4 adults in pairs
1 pair of 8th grade boys
1 school group (5 adults, 7 children - but this was a hectic time, so my notes may not be accurate)
(Tam also missed seeing 1 or 2 groups but was otherwise present.)

One pair of women, one unit of a woman and two girls, and one unit of a woman with one girl, one man, and two middle-school boys stopped briefly but did not interact.

Total recorded representation of participants (non-ignores) was:
35 men
27 women
24 young boys
25 young girls
5 middle school boys
2 middle school girls
7 older teenage boys
2 older teenage girls
The age breakdown was based on Tam’s estimate; the divide between middle school and older may include some error, and around 5 or 10 middle school boys and girls may have been mis-categorized as “young”.

Total visitors = 127
Total ignores who hovered near the doorway or just inside the room = 10
Total groups visiting = 44
Total groups ignoring = 4

Visiting groups / total groups = 44/48 so our exhibit seems to be adequately appealing, although part of that may be because it was advertised (due to the other group in the room) as “gas fingerprints.” Most people engaged with us once they entered the room.

Teens and middle-school students had slightly better representation in the late afternoon, possibly corresponding with the 4pm Wonders of Physics show.

One consequence of our demographic breakdown is that we may want to include additional material for accompanying adults to read as posters. We should be ready to shift our talk and activities accordingly for visitors with more advanced knowledge. Also, our idea of focusing on middle-school/8th grade may need some revision, as most of our audience was either elementary school or younger (with several preschool-K-1 children), or adults. While we were not able to convey our whole message to this younger audience, they did seem to enjoy seeing the rainbows and being able to control the lights.
Sub-Appendix F: Formative Evaluation Survey of 2nd and 3rd Grade Students

1. How interesting were the activities?
   - [ ] Very interesting
   - [ ] Interesting
   - [ ] Somewhat interesting
   - [ ] Not interesting

2. How fun were the activities?
   - [ ] Very fun
   - [ ] Fun
   - [ ] Somewhat fun
   - [ ] Not fun

2a. Why did you think it was fun or not fun?

3. How easy was it to understand the activities?
   - [ ] Easy
   - [ ] Somewhat easy
   - [ ] Somewhat difficult
   - [ ] Difficult

3a. What did you find hard to understand?

Over
4. Do you have any questions about what you saw or did?

5. What did you learn from these activities?

6. What was your favorite activity? Why?

Tell us a little bit about yourself so we can better serve our audience.

7. How much do you like science on a scale of 1 to 10 if 1 is “I hate science” and 10 is “I love science”? (Circle only one number)

   1   2   3   4   5   6   7   8   9   10

8. What is your age? ______

9. Are you... □ Male □ Female

Thank you!
Sub-Appendix G: Results of Formative Evaluation Survey of 2nd and 3rd Grade Students

The average age of the participants was just over 8 years old. On a scale from 1-10, with 1 being “I hate science” and 10 being “I love science!”, the average self-ranking of the participants was just above 9.8. There were 18 participants, roughly two-thirds of whom were male.
Appendix III: Summative Report on the Lakeshore Video Walk

Abstract

A group of UW-Madison researchers would like to educate the public about water issues and research in the Yahara Watershed. To achieve this goal, I created a prototype video guided walk along the Lakeshore Path that allows users to learn about the watershed using their personal mobile devices while walking along the trail. The pilot version of the Lakeshore Video Walk (LVW) consisted of seven educational videos. I evaluated the LVW with a group of adults at UW-Parents’ Weekend using pre- and post-LVW questionnaires. My teaching-as-research questions were: (1) Is the LVW enjoyable and is the technology easy to use? (2) Does the LVW increase knowledge of water issues within the Yahara watershed? (3) How can the LVW be improved? All participants agreed with statements indicating they enjoyed the LVW and participant comments supported this. Generally the mobile devices were easy to use though sometimes difficult to hear. All participants preferred captions. On average, participants increased their knowledge score by 30% on the post-LVW questionnaire. These results indicate that the LVW was enjoyable, easy-to-use, and successfully met the learning objective. Recommended improvements to the LVW include: giving potential solutions to water issues in all videos, captioning all videos, addressing major misconceptions about water issues, and improved testing of the LVW with larger audiences.

Introduction

A group of UW-Madison researchers on the Water Sustainability and Climate (WSC) project led by Chris Kucharik and funded by the National Science Foundation need to educate the public about water issues and research in the Yahara watershed. These issues and research not only impact the plants and wildlife dependent upon the lakes and streams, but also the people who live near the water, recreate on the lakes and rivers, and drink the groundwater. The Temin Lakeshore Path along Lake Mendota on the UW-Madison campus provides an excellent conduit for teaching the public about these watershed issues. The Lakeshore Path, a popular recreational trail among members of the university as well as the broader community, offers users an opportunity to interact with nature within an otherwise urban setting. The path also offers users direct interaction with Lake Mendota, a major component of the Yahara watershed.

Currently there is no way for users of the path to learn about the Yahara watershed while on the path. The Lakeshore Nature Preserve (LNP), an organization that manages the path and its surroundings, wishes to maintain the natural beauty of the trail and will not allow large educational signs to be posted.

The LNP has made efforts to educate path users via an audio trail in which participants use their cell phones to access educational audio recordings about aspects of the preserve. Though the Audio Trail incorporates place-based, mobile learning, it is inaccessible to participants with hearing impairments and reaches out only to audio learners. The Audio Trail focuses primarily on aspects of the preserve such as historic land-use, as opposed to ecological issues in the Yahara watershed. Furthermore, the success of the Audio Trail at educating users is unknown.

Mobile learning, such as the LNP’s Audio Trail, is becoming increasingly prevalent in environmental outreach. Mobile learning allows people to learn outside traditional educational settings and often utilizes devices that are ubiquitous in the lives of people today. By moving learners out of the classroom, mobile devices “can help pair the benefits of computer-mediated learning with direct nature
experience” (Ruchter, Klar, & Geiger, 2010). This form of place-based learning allows learners to engage with educational content in real world contexts, fostering a deeper understanding of the information (Herrington et al., 2009).

Others have created and tested mobile guides in environmental education settings. Naismith, et al. (2005) evaluated the usability and effect on learning of CAERUS, a context aware mobile guide, at a botanical garden. A handheld PC device with GPS capability automatically played audio content as the user entered a particular region of interest. Although there were difficulties in GPS accuracy, overall, participants enjoyed the experience and showed evidence of learning. Ruchter et al. (2010) compared the impact of a mobile guide system and traditional instruments (real-person guide and paper guide) on environmental education and found that the mobile, digital guide achieved similar results in environmental knowledge as the traditional methods.

To meet the needs of the WSC and the LNP, I created the Lakeshore Video Walk (LVW), a video guided walk along the Lakeshore Path that allows users to learn about the watershed while walking along the trail using their personal mobile devices (e.g. smartphone, tablet PC). My learning objective for the LVW was to increase public understanding of Yahara Watershed issues. I pilot tested the LVW with a group of adults at UW-Parents’ Weekend and used pre- and post-questionnaires to answer the following questions: (1) Is the LVW enjoyable and is the technology easy to use? (2) Does the LVW increase knowledge of water issues within the Yahara watershed? (3) How can the LVW be improved?

Methods

Description of the Lakeshore Video Walk

The LVW consists of a series of seven, 3-5 min videos: “What is the Yahara Watershed”, “Urbanization: The effects of impervious surface”, “Groundwater quantity in the Yahara Watershed”, “Urbanization: What can you do?”, “Groundwater quality in the Yahara Watershed”, “Agriculture in the Yahara Watershed”, and “Biofuels in the Yahara Watershed”. Each video is aimed at the general public and consists of photos, videos, interviews with scientists, and narrative. At the time of this study, half of the videos were captioned. Many of the videos utilize place-based learning by linking the content of the video to the location it should be viewed along the Lakeshore Path. Each video ends with a “Let’s Talk” segment consisting of a set of discussion questions to create a learning community among viewers.

These videos were designed to be viewed on personal mobile devices including smartphones and tablet PCs. In this study and other instances in which participants do not have access to a data plan, the videos may be downloaded onto the device in advance. If the participant’s device has a data plan, QR (Quick Response) codes may also be used. A QR code is a square barcode that can be scanned by the device’s camera and directly links to the web address of the appropriate video. For this pilot study, seven small signs were placed along the Lakeshore Path at the locations each video should be viewed. Each sign indicated the title and sequential number of the video as well as a QR code. These signs and a map allowed the LVW to be self-led. Participants went on the LVW in pairs in small family groups each pair or group sharing a single iPad on which the videos were pre-loaded.

Pilot study population and survey design

The LVW was pilot tested in September 2012 with a group of adults who were participating in UW-Parents’ Weekend. IRB approval was obtained prior to working with this group. The study consisted
of paper pre- and post- LVW questionnaires. Pre-and post-LVW questionnaires were linked via a participant chosen identification code to maintain anonymity. The pre- LVW questionnaire consisted of eight, true/false and multiple choice knowledge questions about Yahara Watershed concepts and issues. Each knowledge question included a confidence scale where a participant could indicate her confidence in each answer. This method allowed for an assessment learning gains even when a participant correctly answered a question in both the pre- and post-questionnaire. Demographic questions were also included in the pre- LVW questionnaire. Participants received this questionnaire prior to watching any of the videos. After a participant completed the LVW, she received the post-questionnaire. Post-questionnaires consisted of the same knowledge questions and confidence scales as pre-questionnaires so knowledge gains could be assessed. The post-questionnaire also included multiple-choice, Yes/No, open-ended, and Likert scale questions to assess participant satisfaction with the LVW and the usability of the technology.

**Data Analysis**

Pre- and post-LVW questionnaires were matched using the participant chosen identification code. In cases where a participant did not answer a question, the matching question on the pre- or post- LVW questionnaire was dropped from the analysis. Open-ended answers were categorized based on whether they contained similar concepts or opinions (Table 1). Answers could be placed into multiple categories. To determine overall knowledge gain, differences between pre- and post-questionnaire scores were averaged. For specific knowledge questions, the percentages of correct and incorrect responses for each question were used. Due to a low study population, no statistical analysis was used.

**Results**

**Participant Demographics**

Eleven individuals participated in the LVW and 9 of these also participated fully in the study. Of these 9, one was under the age of 25 and all others were age 50-69. There were 5 females and 4 males. Participants resided in Wisconsin, Minnesota, or Texas and no participants resided in Madison or Dane County. Participant residences ranged from small cities to urban areas. There was one current undergrad in the study population and the remainder had completed at least some college. All participants had an annual household income greater than $75,000.

**Satisfaction**

Participants were prompted with a series of statements regarding the enjoyability of the LVW including “I enjoyed the video guided Walk,” “The videos enhanced my experience on the Temin Lakeshore Path,” “I found the videos interesting,” and “I would go on a video Walk like this again.” To all these statements, all participants either strongly agreed or agreed. Participants also indicated their favorite and least favorite videos (more than one answer was allowed for each). All videos were named at least once to be a favorite. In particular, 5 of 9 participants liked the “Urbanization: What can you do?” video best, 4 of 9 indicated the “Agriculture in the Yahara Watershed” video, 3 of 9 chose the “Groundwater Quality in the Yahara Watershed” video and 3 of 9 chose the “Biofuels in the Yahara Watershed” video as their favorite. The top two reasons for choosing a video as a favorite were that the video was interesting and that the video used real-world examples. For instance, one participant, who
chose the “Urbanization: What can you do?” video as her favorite, stated, “That’s the one I remember the most of any of them, the tips were good, because learning all of this isn’t helpful otherwise.” Four of the videos, “Agriculture in the Yahara Watershed”, “Biofuels in the Yahara Watershed”, “Urbanization in the Yahara Watershed”, and “Urbanization: What can you do?”, were indicated as least favorites. The reasons for this included that the video was too long, too technical, or provided tips that involved city structure and would be difficult for an ordinary citizen to change. Six of nine participants did not dislike any of the videos. At the end of the post-LVW questionnaire, participants were able to provide other comments. Many of these also indicated enjoyment. Two example comments were, “Nice job! I enjoyed the learning experience and will put some of my learnings (sp) to use in my home and neighborhood” and “So glad I took the time to do it. Learned so much and really appreciate the opportunity. Thank you!”

**Usability of the technology**

Participants were asked to indicate their agreement or disagreement with several topics related to how easy their mobile device was to use in the context of the LVW. Eight of nine participants strongly agreed and one participant agreed with the statements, “The mobile device was easy to use with the format of this Walk” and “The video guided Walk was easy to follow”. When prompted with the statement, “The videos were easy to see on my device,” 5 of 9 participants strongly agreed, 2/9 agreed, and 2/9 neither agreed nor disagreed. To the statement, “The videos were easy to hear,” 2 of 9 participants strongly agreed, 5/9 agreed, and 2/9 neither agreed nor disagreed. Half of the videos included captions, so we asked participants whether they found the captions helpful and why or why not. All participants found the captions helpful. Three of nine participants explained the captions helped with learning and comprehension and 4/9 thought the captions were helpful because the audio was sometimes difficult to hear.

**Knowledge gains**

All but one participant had an increased score on the post-LVW questionnaire versus the pre-LVW questionnaire knowledge questions. The participant showing no increase had the same score on both the pre- and post-questionnaire. On average, participants increased their knowledge score by 30% on the post-LVW questionnaire (Fig. 1). All participants indicated that they spoke with someone else about the “Let’s Talk!” questions presented at the end of each video.

The three questions with the lowest number of correct answers on the pre-LVW questionnaire are shown in Fig. 2. The percentage of participants with correct responses on these questions increased from 22-25% to 67-89% on the post-LVW questionnaire. On “Question 5”, 5 of 7 participants who answered incorrectly on the pre-LVW questionnaire were Mostly Confident or Very Confident in their answers. Not only did many participants answer incorrectly, they also felt they had the correct answer. On “Question 6” and “Question 7” of the pre-LVW questionnaire, 5/8 and 5/9 of participants, respectively, had incorrect answers and were Mostly or Very Unconfident in their answers. Though many participants answered incorrectly, they recognized that they did not know the answer.

“Question 2” (Fig. 3) was answered correctly by all participants on both the pre- and the post-LVW questionnaire. On the pre-LVW questionnaire all participants were Mostly Confident or Very Confident in their answer to this question and all participants were Very Confident in their answer on the post-LVW questionnaire. “Question 3” (Fig. 4) was the only question to show no increase in correct
answers on the post-LVW questionnaire. Participants giving incorrect answers to this question on the post-LVW questionnaire were Mostly Confident or Very Confident in their answers.

Statements of self-evaluated learning gains were grouped by similar concepts (Table 1). The most commonly discussed concept regarded ways an individual can reduce water quantity or quality problems. For example, one participant stated that, “I learned about green space between sidewalks and [the] street. I learned about capturing rainwater for the yard.” Other commonly learned concepts included: the definition of a watershed, effects of agriculture, and biofuels.

Discussion

Overall, participants found the Lakeshore Video Walk to be enjoyable indicating continued development of the LVW and creation of other similar educational activities would be favorably accepted by the public. Many participants liked the “Urbanization: What can you do?” video. This video was unique in that it gave tips for actions the participants could take in their own homes or neighborhoods to reduce the impacts of urbanization on the watershed. This result and the reasoning given by some participants indicate that the public appreciates being given concrete steps towards solving an environmental problem. It will be important in the future to include possible solutions in each video or to create more solutions-centered videos. The Agriculture and Biofuels videos were also participant favorites. These related videos may have been particularly well received by our audience because agriculture is an important part of the Midwestern identity and the majority of participants reside in the Midwest. Agricultural effects on waterways and the increase in biofuel production are also more widely discussed in the media than some of the other video topics and so participants may have had some prior knowledge and interest in these subjects. Based on the data collected here, it is difficult to discern whether participants liked a video because of its content, its presentation, or both. Further study might help to clarify why participants did or did not like particular videos.

In general, participants did not dislike any of the videos. For those videos that were disliked, participants’ reasons were informative. Specifically, videos need to be kept short or participants will lose interest and videos need to avoid technical jargon. Although the LVW was designed to take these points into consideration, continued effort to keep videos brief and at the proper technical level will be needed. One participant also felt that solutions given in the Urbanization videos were not steps an individual could take but were city structural concerns. Though it is important to address actions that the broader community can take to solve environmental issues, this comment indicates that outreach content should be careful to frame them as such.

Overall, participants felt the mobile devices were easy to use. Given that no participant used his/her own device (all participants used iPads with the videos pre-loaded), this indicates that the technology is relatively easy to learn even for those with limited experience with the device. Using the QR codes may have been somewhat more difficult for participants because QR codes require the use of an app and the device camera, with which some participants may have less experience. Further investigation into the ease of use of smartphones and QR codes would be informative. For the most part, participants felt the videos were easy to see on the device; however, smaller devices, such as smartphones, may make the videos more difficult to see. Though most participants felt the videos were easy to hear, they did not
feel as strongly about this statement compared with how easy the videos were to see. This is supported by the finding that all participants found the captions helpful and 4 of 9 participants felt so because the audio was sometimes difficult to hear. Background noise from wind, waves, construction machinery, and people likely affected audio clarity especially in instances where the audio was already less clear (e.g. sound quality was reduced due to microphone issues during filming of some interviews). Headphones would help alleviate this problem but would make it difficult for participants to share a single device. Captions seem to have been a successful solution. Additionally, others felt captions helped with their understanding of the video content. This shows that universal design concepts, such as captioning, can assist even those without disabilities and can increase learning as well as ease of use.

The LVW effectively increased participant knowledge of Yahara watershed issues (Fig. 1). Nearly all participants improved their scores on the post- LVW questionnaire. This signifies the LVW was an effective learning activity. However, because the study population was small and non-representative of the general public, wider-scale evaluations are necessary. A few concepts were commonly given by participant as self-assessed learning gains, in particular an improved understanding of the ways an individual can reduce water quantity or quality issues. This indicated that this concept may have been best taught, most memorable, or most interesting to participants.

A low percentage of correct responses on Questions 5, 6, and 7 indicated that these topics – groundwater conservation, agricultural pollution, biofuels carbon dioxide emissions – may be least understood by the public (Fig. 2). In particular, “Question 5”, addressing the reason for groundwater conservation, identifies an important misconception as the majority of participants with incorrect answers on the pre- LVW questionnaire were Mostly/Very Confident in their responses. Because post- LVW scores on these three questions improved across the board, the LVW seems to be effectively addressing these misunderstandings.

“Question 2”, regarding the effect of impervious surface on flooding, was answered correctly by all participants on both the pre- and post- LVW questionnaires (Fig. 3). This suggests that the topic may already be well understood by the public and it may be of less importance for future outreach. On the post-LVW questionnaire, “Question 3” showed no increase in correct answers and participants who gave incorrect answers were Mostly Confident/Very Confident in their answers (Fig. 4). This indicates participants maintained misconceptions about the amount of urban land cover in the Yahara Watershed. Because the majority of the videos focused on urban water issues, the LVW may have inadvertently supported this misconception. It may be important, in future videos, to emphasize the relatively small area of urban land cover in the Yahara Watershed, especially if the videos continue to focus on urban issues.

Because post- LVW questionnaires were taken only one to two hours after the pre- LVW questionnaires, it is possible that participant scores on the post- LVW questionnaires were higher than might be expected because the questions were known in advance. To better determine knowledge gains, it may be important to give a follow-up knowledge questionnaire several weeks after the LVW. This would provide information on longer-term knowledge gains.

Creating a learning community within an outreach situation that involves a transient population and no leader is difficult. Learners are not required to engage in the community and group size can be small. I attempted to create a learning community through the “Let’s Talk” segment at the end of each video. By asking participants interesting questions, it was hoped that learners would engage with one another and learn through their discussions. This seemed to have been a successful tactic. All participants
noted that they spoke with someone else about the “Let’s Talk” questions. In further studies, it would be useful to determine whether participants learned something new from these discussions and what they learned. Additionally, all participants in our study went on the LVW in groups of 2 or more. In the future, it is likely that learners will go on the LVW alone. In this case, it may be more difficult to create a learning community. One possible option may be to create an online learning community that a participant can engage with during the LVW via her personal mobile device. For example, an additional QR code could link participants to a discussion board where they could post their thoughts and opinions and read previously posted participant comments.

The sample size for this study was small (n=9 full participants). This is largely because registrants were not required to show up for the LVW and bad weather turned many people away. In the future, it may be useful to test the LVW with undergraduate classes. By making the LVW a requirement, participation could be greatly increased. Because the sample size was small, my results may not be broadly applicable to the general population. This is especially an issue because the participants did not span a diversity of ages or backgrounds. However, based on responses from my study population, the LVW was both well received and of educational value. The devices were generally easy to use and all participants preferred the videos to be captioned. The “Let’s Talk” questions successfully engaged participants in discussion. Based on the positive results of this study, further development of the Lakeshore Video Walk is recommended though testing with other groups may be necessary.

Since the completion of the pilot testing, the Lakeshore Video Walk has been edited so that all videos include captions and has been uploaded to YouTube where the videos have over 700 total views. They can be viewed at http://tinyurl.com/cyqqkly. It is expected these videos will be incorporated into a long-term outreach activity along the Lakeshore Path through a collaboration between the Water Sustainability and Climate project and the Lakeshore Nature Preserve. These videos are free to use for educational purposes by individuals, groups, and organizations.

References


Table 1: Categories used in analysis of answers to open-ended questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which video did you like best? Why?</td>
<td>• Interesting</td>
</tr>
<tr>
<td></td>
<td>• Gave examples</td>
</tr>
<tr>
<td></td>
<td>• Other</td>
</tr>
<tr>
<td>Did you find captions helpful? Why or why not?</td>
<td>• Improved understanding</td>
</tr>
<tr>
<td></td>
<td>• Audio difficult to hear</td>
</tr>
<tr>
<td>List 2-3 things you learned by participating in the Lakeshore Video Walk.</td>
<td>• Definition of a watershed</td>
</tr>
<tr>
<td></td>
<td>• Biofuels</td>
</tr>
<tr>
<td></td>
<td>• Agriculture issues</td>
</tr>
<tr>
<td></td>
<td>• Things participant can do</td>
</tr>
<tr>
<td></td>
<td>• Viruses in groundwater</td>
</tr>
</tbody>
</table>

Figure 1: Participant scores on knowledge questions on Pre- and Post- Lakeshore Video Walk (LVW) questionnaires.
Figure 2: Questions with lowest number of correct answers on Pre- Lakeshore Video Walk questionnaires.

5) Residents of the Yahara Watershed should conserve groundwater primarily because:
   a) There is not very much groundwater water available in the Yahara Watershed and it may run out soon if people don’t conserve
   b) High water use can cause groundwater springs to run dry which affects lakes and the plants and animals living in them
   c) Both a) and b)

How confident are you in this answer?
Very Unconfident    Mostly Unconfident    Mostly Confident    Very Confident

6) The largest agricultural pollutant to the Yahara lakes is:
   a) nitrate
   b) potassium
   c) phosphorus

How confident are you in this answer?
Very Unconfident    Mostly Unconfident    Mostly Confident    Very Confident

7) Biofuels may reduce carbon dioxide emissions compared with fossil fuels because:
   a) biofuels do not emit carbon dioxide when used in cars, but fossil fuels do
   b) biofuel crops use carbon dioxide from the atmosphere to grow
   c) Both a) and b)

How confident are you in this answer?
Very Unconfident    Mostly Unconfident    Mostly Confident    Very Confident

Figure 3: Question 2 from pre- and post-LVW questionnaires. Answered correctly on pre-LVW questionnaire by all participants.

2) True / False: An increased amount of impervious surface (e.g. asphalt, concrete, etc.) in an urban area can increase the risk for flooding.

How confident are you in this answer?
Very Unconfident    Mostly Unconfident    Mostly Confident    Very Confident
Figure 4: Question 3 from pre- and post- LVW questionnaires. No increase in the number of participants giving a correct answer to this question on the post- vs. pre- LVW questionnaire.

3) **True / False**: The Yahara Watershed is composed of primarily urban land cover.

How confident are you in this answer?

- Very Unconfident
- Mostly Unconfident
- Mostly Confident
- Very Confident