

SHEDD AQUARIUM



**LEARNING PLANNING & EVALUATION:
GREAT LAKES TEACHER BADGING
EVALUATION REPORT**





DIGITAL LEARNING GREAT LAKES TEACHER BADGING EVALUATION REPORT

“The course changed the way I approach science and renewed my enthusiasm for it.”

Key Findings

- Great Lakes Teacher Badging grows teachers’ knowledge of science, confidence teaching science, and use of resources to do so.
 - *“I have not just increased my awareness of environmental issues, but I have also come to see science in a different light. This course made me more aware of science as inquiry and the process of observation and analysis behind it. Because of this course, I was able to add strong lessons to what I will be teaching and I was inspired by the process of inquiry based thinking that is so integral to science. So, the benefits of this course have been so much more than just learning about issues affecting the Great Lakes. They have improved the way I will approach science and teaching in general.”*
- Online badging breaks down and simplifies information to scaffold and motivate learning in enjoyable ways.
 - *“Professional development programs that offer badges are a great idea. It is a way that through the entire course, you can see the progress you are making step by step. Each accomplishment is rewarded and acknowledged. It is a very motivating way to keep interest in a self-paced program.”*
- As a means of professional development, badging provides engaging and interactive activities, valuable instructor feedback, and relevant information.
 - *“This is the first program I have been in where I actually had to participate. Most classes consist of listening to someone speak and group discussion later. I prefer this course because I had guidance from the program but I had to do the work myself. I retain things better if I participate in the learning process, not just listening to another person speak and looking at handouts. Thanks to the Shedd, Heather and Miranda for the support throughout this course, your feedback was extremely helpful.”*

Executive Summary

On February 25, 2013 the Teacher Badging pilot program was launched with a set of Great Lakes Science Certified badges. **These badges include Intro to Badging, Great Lakes Basics, Invasive Species Defined, Environmental Literacy, Science Literacy, and 21st Century Skills, all culminating in the achievement of the Great Lakes Science Certified badge.** Each badge includes 3-7 missions that teachers must complete in order to be awarded a given badge.

The pilot was launched with an invite to 221 interested participants. The invite included a link to a pre-survey that, once completed, provided program login information. As of December 31, 2013, **327 people have taken the pre-survey, with 262 people continuing on to log into the site. 16 different states and 3 foreign countries** (Egypt, Canada, and Ghana) are represented in the pre-survey. For those logging into the site, **499.75 contact hours** have been recorded with **1140 missions completed** toward the six badges.

A variety of tools were used to collect data, including pre and post surveys, work product analysis, reflection, and conversation coding. Findings from the evaluation, applied throughout the online program, demonstrate that **participants have enhanced their competence teaching about the environment and science, integrating**



21st century skills into their lessons. This outcome was reached by engaging teachers through **curiosity, investigation** and **solution developing** opportunities. As this program transitions from a pilot to an established program, next steps include enacting additional recruitment strategies, securing graduate credit options for teachers, seeking out of state continuing education credits, and continuing to foster the online learning community aspect of the program.

The concept of using badging for teacher professional development has been a successful strategy. The platform and curriculum is easily managed by Shedd staff. Relationships with teachers are developing and being maintained through online means. Experience and learnings from the Great Lakes Teacher Badging program have helped **inspire future badging programs across the Learning Group:** Early Science Learning (PNC) Teacher Badging, Teen Career Badging, Volunteer Training Badging, and Ecological Separation Online Curriculum.

Background

The Great Lakes Teacher Badging program, launched on February 25, 2013, offers a unique spin on professional development opportunities for the teacher community. This program allows Shedd to extend its reach by providing a customizable and flexible online learning environment for K-12th grade teachers to share, learn and explore using Shedd resources and expertise.

This free self-paced program features topics surrounding Great Lakes environmental literacy, science literacy, and 21st-century skills. As teachers build their skills and accomplish learning activities, they are awarded "digital badges."

Spanning across Empathy & Curiosity, Question & Investigate, and Develop Solutions levels of the Learning Framework, the program is designed to spark curiosity, investigation, and critical thinking among teachers. Activities scaffold to build teacher confidence using the online platform, get familiar with Great Lakes basics, and dive deeper into science skills and literacy. The program's learning community encourages teachers to interact with and learn alongside other teacher professionals (i.e., through teacher forums, creation of cohort groups, and Learning with Shedd's Pinterest page).

Activities include ...

- taking pictures of local habitats
- uploading a design of a simple experiment
- participating in online interactives to better understand the interconnectedness of an issue (invasive species: Asian Carp)
- practicing citizen science skills
- sharing ideas with other teachers to incorporate information into the classroom

Illinois Teachers receive 20 CPDUs after completing this program. All participants receive a "digital badge" that can be posted to their LinkedIn profiles or resumes. Participants also receive a final "principal letter" outlining accomplishments and skills built through program participation.

The goal of the program is to create a teacher badging system that will:

- foster an online community for teachers to share, learn, and explore
- follow the Learning Framework fostering learners in self-selected engagement levels



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- highlight environmental literacy, science literacy, and 21st century skill acquisition
- be accessed by teachers locally, nationally and globally, expanding Shedd's reach
- be a flexible system that allows for the input of current trends, topics and digital tools
- provide teachers with access to unique Shedd resources and expertise

The intended learner outcomes are that teachers will . . .

- enhance their competence in teaching about the environment and science while integrating 21st century skills into their lessons
- be engaged through curiosity, investigation, solution developing and leading opportunities
- actively participate in an online community sharing and learning with other teachers
- uncover relevant connection to their practice and the natural world

The pilot Teacher Badging program had four critical questions for evaluation:

Q1. Does the program platform and content foster an online learning community for teachers?

Q2. Does the program provide useful classroom connections to teachers of a variety of grade levels?

Q3. Do the program missions increase teacher competence and confidence in teaching about the environment and science and integrating 21st century skills?

Q4. What time factors, for both teachers and Shedd staff, need to be considered with a full launch of an online badge program?

Methods

Each critical question is matched to learning metrics to better understand the impact on the learner as well as the effectiveness of the technology and management of the program. **A variety of tools were used to collect data, including: pre and post surveys, work product analysis, reflection, and conversation coding.**

To access the badging site teachers must first complete a pre-survey to gain an access code to create a login for the program platform. **As of December 31, 2013, 327 people have taken the pre-survey for the program, and 262 people have continued to log in to the site.** Teachers are asked to complete a post-survey as their last 'mission' in the program before achieving the final badge, ensuring 100% participation in the surveys. An online focus group of program participants was also conducted to better understand how the program connects to the classroom and how to decipher between active and inactive participants.

Rubrics and coding systems are used to evaluate work product submissions from key missions and community forums posted on the site. Many of these rubrics are used to 'approve' or 'defer' a teacher's mission submission, allowing them to continue to the next activity or revise their submission to illustrate better understanding of the material. Work product submissions are a natural source of evidence to evaluate learning.

Findings

Findings from the evaluation, applied throughout this online program, demonstrate that **participants have enhanced their competence in teaching about the environment and science, integrating 21st century skills into their lessons. This outcome was reached by engaging teachers through curiosity, investigation and solution developing opportunities. The concept of using badging for teacher professional development has been a successful strategy. The platform and curriculum is easily managed by Shedd staff. Relationships are developing and being maintained with teachers through online means.**



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Evaluation findings and examples are organized below by critical questions for the program. Each critical question focused on a unique aspect of the pilot to better understand the effectiveness of the curriculum, connection to learners, and the online platform.

Q1. Does the program platform and content foster an online learning community for teachers?

There are two main ways the Great Lakes Teacher Badging program fosters an online community: through online forums and community badges. There are a total of 28 forum topics, of which 27 are optional. Of the optional forums, 11 are from missions that include an optional discussion topic for teachers to comment on, 13 are topics generated by participants*, and 4 are generated by Shedd staff on topics that emerged from participant work and interest. **There have been 337 different posts to these forums with an average of 12 posts per forum.**

***7 of these topics were from a teacher who thought she had to create a forum for each mission submitted**

The top four forum topics are:

- **Invasive Impacts**, 51 posts
 - How have you brought the topic of invasive species to your students?
- **Invasive Species Overview**, 33 posts
 - Nab the Aquatic Invader is a fun interactive game with a detective theme where the invasive species are portrayed as ‘criminals’. In your mind is this an accurate portrayal?
- **Water Quality**, 26 posts
 - How have you or could you incorporate water quality tests and data analysis with your students?
- **Sharing the Space**, 25 posts
 - What factors do we need to consider when deciding which natural spaces to preserve and which to develop for human use?

Each of these topics connects with relevant content areas for Great Lakes Teacher Badging. The top forum, Invasive Impacts: How have you brought the topic of invasive species to your students?, was coded using the Collaborative Learning Skills analysis. Collaborative Learning Skills include Conversation, Active Learning, and Creative Conflict. All comments in this forum fell under Active Learning, showcasing subskills of informing, motivating, and requesting (Table 1). The inform subskill was most prevalent in this forum, which contained attributes of rephrasing, leading, suggesting, elaborating, clarifying, justifying, and asserting information.

Collaborative Learning Subskill	Number of Posts
Inform	38
Motivate	3
Inform and Request	7
Inform and Motivate	2
Inform, Request and Motivate	1

Table 1. Collaborative Learning Skills analysis of top forum

Community badges are digital rewards and recognition for helping to build an active online community of learners and teacher professionals. Examples of these badges and the percentage of achievement can be seen in Appendix 1.1. During online focus groups, participants who self-noted that they don't actively participate on forums mentioned that they think forums will become more active as more teachers participate. As the pool of



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participants grows and completes the program, we look forward to seeing an increase in idea sharing and collaboration among badging teachers.

Q2. Does the program provide useful classroom connections to teachers of a variety of grade levels?

After each of the missions (excluding the Intro to Badging missions), there is a section called ‘Classroom Connections’ where teachers can access resources to aid in classroom lessons or expand their knowledge on how to do so. In the post survey, when asked if these sections were helpful and useful, **all teachers who completed the program responded ‘Yes.’** Teachers were also asked to rate the importance of various program components. As seen in Figure 1, 88% of participants ranked the classroom connection section as a 4 or 5 on the five point scale where 5 = very important.

Please rate how important these features were to you: (1 = NOT important, 5 = VERY important)

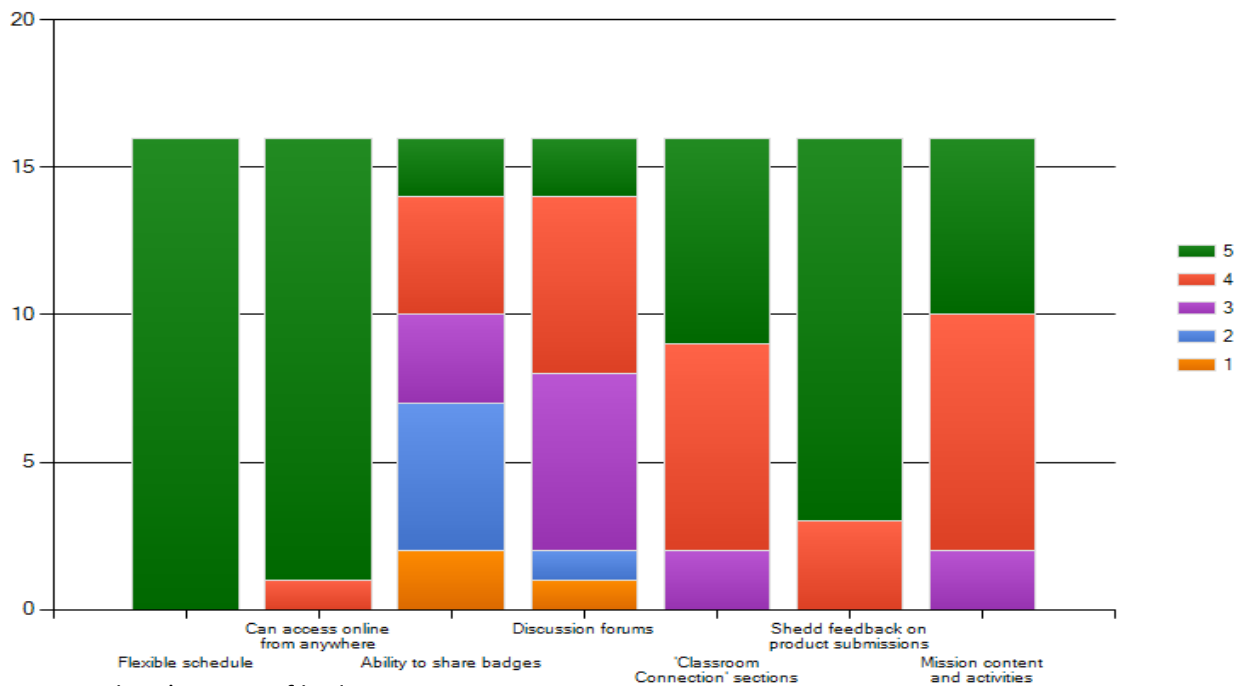


Figure 1. Teachers’ ratings of badging program components

Teachers who complete the program are asked to reflect on the following question: How do you think you have professionally grown over the course of this program? Coded responses showed that the Great Lakes Teacher Badging program fostered growth in teachers’ science content, increased their confidence teaching science, and **provided science teaching resources.**

In the last mission of the 21st Century Skills badge, Share Your Voice, participants are asked to share ideas for connecting their students to the knowledge and resources in the Great Lakes Teacher Badging program. Many participants choose to design a newsletter for parents explaining what their class is doing. These newsletters can be seen on Learning with Shedd’s Pinterest page on the [Action Plans K-5](#) and [Action Plans 6-12](#) boards. In these newsletters, many of the resources from the missions and ‘classroom connection’ area are integrated in the teacher’s lessons. Appendix 2.1 provides an email from a teacher who put her lesson into action.



Q3. Do the program missions increase teacher competence and confidence teaching about the environment and science and integrating 21st century skills?

This critical question directly connects with the program's learner outcomes. Three data sources have been evaluated to see if learning is taking place in the Great Lakes Teacher badging program: the post survey, final reflection, and work product analysis.

The post survey and final reflection are the two final missions participants must complete to finish the program and receive the Great Lakes Science Certified badge. During the retrospective post survey, participants are asked to rate how they feel about the statements listed below, comparing after the program to before they started. On a scale of 1-5 where 5 = very strong, **participants ranked themselves 1-3 points higher on each of the statements after completing the program** (if they ranked themselves a 5 before they started, this stayed the same after the program). The group's collective ratings can be seen in Appendix 3.1. The full results of the post survey can be found [here](#).

- Apply your knowledge of Great Lakes science to further investigate related topics
- Integrate science curriculum and activities into the classroom
- Use science thinking and skills to better understand the environment
- Understand the different human and environmental factors interacting in an environmental issue
- Think creatively to propose ways to solve environmental challenges
- Apply what you know about science to make cross-curricular connections
- Consider the wants and needs of all people affected by an environmental issue and possible solutions
- Use technology to teach/learn about the environment and science concepts
- Use technology to connect with other teaching professionals

Each reflection question was emergently coded, with the following themes appearing:

How do you think you have professionally grown over the course of this program?

- **The Great Lakes Teacher Badging program fostered growth in teacher science content, science teaching confidence, and science teaching resources.**

What are your feelings about an online professional development program that offers badges?

- **Online professional development that offers badges can help break down and simplify information, scaffold learning, and motivate learning in enjoyable ways.**

How does your growth in this program compare to other professional development programs you have participated in?

- **Compared to other professional develop programs, this program provided engaging and interactive activities, valuable instructor feedback, and informative material on topics. Teachers would participate again in the future and/or recommend the program to other teachers.**

The culminating mission in each of the main badges (Environmental Literacy, Science Literacy, and 21st Century Skills) asks participants to provide evidence of their skill and knowledge development on the topic. Each mission is thoroughly reviewed and checked against a work product rubric before being approved. Results support participant advancement in each of the areas by either meeting or exceeding mission outcomes.



Environmental Literacy – 27 teachers achieved

- Completing this Badge successfully means: teachers have combined environmental information, including food webs, habitats, invasive species, water quality, and human impacts, to propose a solution to an ecological challenge.
 - Final Mission: Site Selection
 - You have used the knowledge and skills from the previous missions to determine a site that's a good fit for rainbow darter reintroduction.
 - Work Product Analysis Findings
 - A rubric was developed to evaluate if teachers meet, exceed or do not meet the mission requirements. They are given a 0-2 score for each component needed to complete the mission (0=not meet, 1=meet, 2=exceeds). **Participants must get a total of 5 points to be approved. Of the 27 participants who have achieved this badge, the average received 7.3 points, supporting successful understanding of ecosystem interconnectedness and the impact of issues on the system.**
 - A description and key for the rubric can be found in Appendix 3.2.

Science Literacy – 15 teachers achieved

- Completing this Badge successfully means teachers have combined science information and thinking, including science practices, understanding, and application in real world ecological connections.
 - Final Mission: Pitching Solutions
 - You combined information on the issue to pitch a solution that works towards solving the issue.
 - Work Product Analysis Findings
 - A rubric was developed to evaluate if teachers meet, exceed or do not meet the mission requirements. They are given a 0-2 score for each component needed to complete the mission (0=not meet, 1=meet, 2=exceeds). **Participants must get a total of 5 points to be approved. Of the 15 participants who have achieved this badge the average points received (6.9), support successful critical thinking about solutions to solve an ecological problem, along with impacts to resources and stakeholders.**
 - A description and key for the rubric can be found in Appendix 3.3.
 - Two examples of complete work product submissions can be found in Appendix 3.4 and 3.5.

21st Century Skills – 14 teachers achieved

- Completing this Badge successfully means teachers extended learning that occurred with the Environmental Literacy and Science Literacy Badges. Teachers connect directly to doing science, bring experiences to their students, and share ideas with fellow teachers.
 - Final Mission: Classroom Connections
 - You have a plan for connecting this professional development program directly to your class.
 - Work Product Analysis Findings
 - In general all the work product submissions showcase examples and resources found in previous Great Lakes Teacher Badging missions. An example of a newsletter submission can be seen below.



This newsletter submission highlights resources and concepts found in the Science Literacy badge. Scientific inquiry is a key concept that helps spark critical thought among students. Science journals, observing, questioning and investigating are elements teachers practiced in this badge.

The teacher who submitted this newsletter implemented the lessons described in the beginning of the 2013-14 school year and sent this newsletter to parents. In an email to Shedd (Appendix 2.1), the teacher reflects on the success and challenges of implementing science inquiry and remarks that she will continue to foster science thinking as she is off to a “solid start.”

Q4. What time factors, for both teachers and Shedd staff, need to be considered with a full launch of an online badge program?

Teachers: The Great Lakes Teacher badging program is estimated to take teachers about 20 hours to complete and achieve all available badges. Completing teachers report that it took 20-30 hours to complete all the missions and activities. One teacher mentioned spending 40+ hours due to interest and curiosity to learn even more. Based on these results, Shedd will continue to offer Illinois teachers 20 hours of CPDUs and will use the 20-30 hour self-report as a basis for graduate credit hours, which roughly translates into 1 graduate credit.

It is important to point out that the estimated time frame to complete the program is 20-30 nonconsecutive hours. Since this is a self-paced program, it is tricky to label the program as ‘it will take you one week to complete.’ In the pre-survey (N=332), teachers were asked to provide an idea of when they will interact with the program. The top three responses were on the weekends, in the evenings, and on days off (Figure 2).

John G. Shedd Aquarium
Learning Planning and Evaluation
Prepared by: Heather Schneider

Science News
AUGUST, 2013

“Questioning is a lifelong learning skill that is critical for success in the 21st century.”
-Carol Koechlin and Sandi Zwaan

WAYS YOU CAN PROMOTE SCIENTIFIC INQUIRY:

- Encourage your child to keep a Science Journal.
- Encourage your child to ask and answer questions, and make inferences about his or her observations.
- Play games like “20 Questions.”
- Play games that encourage thinking like “I’m thinking of…”
- Explore and create riddles.
- Explore your outdoor environment.
- Visit a museum.

Question Trek

What is a scientist and how do scientists use the scientific method?

Exploring the world scientifically requires developing strong questioning skills. As questioning plays a key part in the inquiry process, the focus of our activities in science this week will be on these three skills:

- **Observing**
- **Describing**
- **Questioning**

Students will find an object that they are curious about, sketch the object, write what they know, and questions they have about the object. Then they will write how they could find the answers to their questions.

One thing students will be doing to practice these skills, is to go on a “Question Trek” outdoors in front of our school.

These three important skills will be practiced and developed throughout the year in all of our science units, as well as in other curricular areas.

Ice Balloons

Another one of our activities of scientific inquiry this week is “Ice Balloons.” Students will conduct a variety of experiments with frozen water balloons.

They will then use their investigation to learn how to ask and answer their own questions.

It is going to be an exciting year of science!



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The completion schedule of this program is flexible and based on your own timeline. It is estimated that this program will take at least 20 non-consecutive hours of your time. What is your plan** for completing this program? (check all that apply)**You are by no means held to your selection once you start the program. This question helps us get a sense of schedule intentions. We will ask you more specifically about time spent on the program during a post survey.

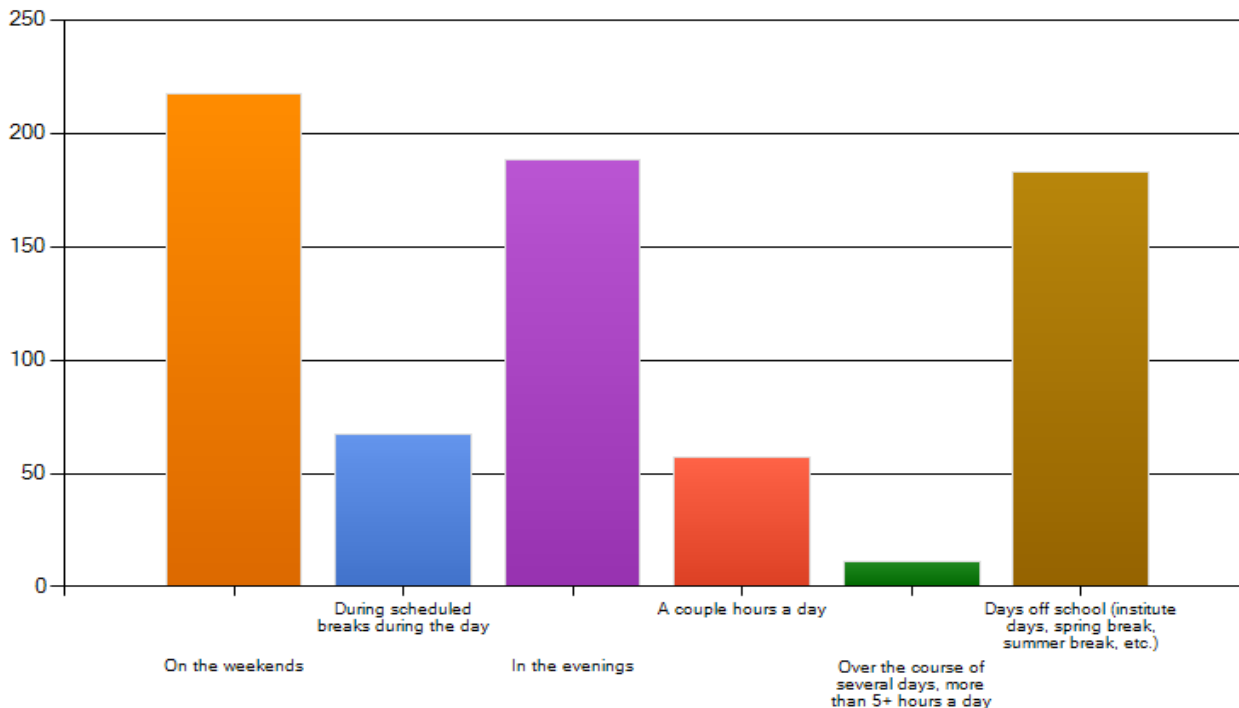


Figure 2. Teachers' intended schedule for completion of the badging program

To motivate teachers to continue on their badging path, teachers in the online focus groups recommended that Shedd send out regularly scheduled emails for updates. This suggestion has been incorporated via the addition of a 'Badging Highlights' section in Learning with Shedd's teacher e-newsletter, Fish Tales.

Shedd Staff: The second part of this time question is to identify how much time the program takes staff to implement. Since the program's launch in late February of 2013, the Learning Programs Digital Learning team has spent a total of 504 hours approving missions, promoting, recruiting, evaluating, building relationships, and maintaining the program platform. This equates to about 13% of the Digital Learning Manager's time and about 11% of work time for the Digital Learning Specialist (specialist was on maternity leave for over two months during this reporting timeframe).

Thus far, summer has been the busiest time where the team has seen the most submissions come through the program, which is consistent with the data reported in Figure 2. Overall, the daily percentage of staff time ebbs and flows with the amount of missions completed by participants.

Staff time continues to be documented and has been a helpful tool in projecting staff time for other badging projects, such as the Early Science Learning badge program that is currently under development. As we shift from a third party hosted site to one hosted by Shedd, other staff time factors will be considered and recorded.



Conclusions

Through implementation of the multiple data collection methods described, findings show that:

- **The Great Lakes Teacher Badging program fostered growth in teacher science content, science teaching confidence, and access to science teaching resources.**
- **Online professional development that offers badges can help break down and simplify information, scaffold learning, and motivate learning in enjoyable ways.**
- **Compared to other professional development programs teachers have participated in, this program provides engaging and interactive activities, valuable instructor feedback, and instructive information on the topic. Teachers would participate again in the future and/or recommend this program to other teachers.**

Results also support the growth of an online community where teachers can share ideas and learn from their colleagues. In general, the concept of using badging for teacher professional development has been a successful strategy. The platform and curriculum is easily managed by Shedd staff and relationships are developing and being maintained with teachers through online means.

Recommendations for the future and what to expect in 2014

As this resource is an on-going program for teachers, focus areas for the future include recruitment strategies, graduate credit, out-of-state continuing education credits, online community, and storytelling. In 2014, the Great Lakes Science badging program will work with PR and Marketing to plan and enact a recruitment strategy to increase the amount of teachers participating and completing the program. **The goal is to have at least 100 teachers complete the program at the end of 2014.** Additional extrinsic motivators for teachers will also be included in this year. **Final paperwork has been submitted to offer one graduate credit hour through National Louis University.** Discussions are also taking place with NOAA on how Shedd can offer continuing education credits for other states. These additional pieces may aid in moving participants to completion. Lastly, **teacher resources will be created to help teachers keep pace in this self-paced program.**

Experience and learnings (i.e., staff time, community needs, and curriculum structure) from the Great Lakes Teacher Badging program have helped to inspire and will inform future badging programs across the Learning Group: Early Science Learning (PNC) Teacher Badging, Teen Career Badging, Volunteer Training Badging and Ecological Separation Online Curriculum.



Appendix 1.1: Community Badge Examples



4% of participants earned the Beyond Badge! by sharing out one of his/her badges on Facebook or LinkedIn.



36% of participants earned the Idea Sharer badge by sharing their two cents on at least one discussion forum.



11% of participants earned Share Superstar badge by commenting on the discussion forums at least four times.



7% of participants earned Friendliest Friender badge by sending at least three friend requests.



Appendix 2.1: Participant Email Highlighting Classroom Connections in Action

-----Original Message-----

From: [REDACTED]
Sent: Thursday, August 29, 2013 6:17 PM
To: Schneider, Heather
Subject: RE: Mission 3 Newsletter

Hi Heather,

I used the bird observation lesson and answer key with my fourth graders, along with other lessons on observation and it went well! The kids seemed to like it!

They are doing the ice balloon and question trek activities next week, so we'll see how those go.

I am really trying to bring out their natural curiosity and focus on having them practice asking questions. I've done so many lessons this week focusing on that. I don't think they are used to it because I was surprised at how hard it is for them to ask deeper questions. We will be working on it all year. I also sent home the science newsletter I created for the class to the parents.

Interestingly enough, as we played 20 Questions with the topic of "animals," one boy thought of "sea lamprey." He knew all about it! I used that as a springboard to talk about the sea lamprey as an invasive species and what I studied in the class. They were interested in it! I tried to go back to the course to show the page from the detective game we played, but it wouldn't let me access it. So, I showed a video clip that I found on it instead.

I am off to a solid start, thanks to everything I learned this summer!

Thanks!

[REDACTED]

Note: The resource the teacher mentions that cannot be accessed was sent to them in response to this message along with pictures of Shedd's sea lamprey habitat.



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Appendix 3.1: Post Survey Response to Before and After Self-ranking

Before	1 Very Limited	2	3	4	5 Very Strong	Response Count
Apply your knowledge of Great Lakes science to further investigate related topics	47.1% (8)	35.3% (6)	11.8% (2)	5.9% (1)	0.0% (0)	17
Integrate science curriculum and activities into the classroom	5.9% (1)	23.5% (4)	29.4% (5)	23.5% (4)	17.6% (3)	17
Use science thinking and skills to better understand the environment	5.9% (1)	17.6% (3)	29.4% (5)	29.4% (5)	17.6% (3)	17
Understand the different human and environmental factors interacting in an environmental issue	23.5% (4)	5.9% (1)	47.1% (8)	11.8% (2)	11.8% (2)	17
Think creatively to propose ways to solve environmental challenges	17.6% (3)	23.5% (4)	41.2% (7)	11.8% (2)	5.9% (1)	17
Apply what you know about science to make cross-curricular connections	0.0% (0)	41.2% (7)	29.4% (5)	23.5% (4)	5.9% (1)	17
Consider the wants and needs of all people affected by an environmental issue and possible solutions	18.8% (3)	25.0% (4)	37.5% (6)	18.8% (3)	0.0% (0)	16
Use technology to teach/learn about the environment and science concepts	11.8% (2)	23.5% (4)	35.3% (6)	17.6% (3)	11.8% (2)	17
Use technology to connect with other teaching professionals	0.0% (0)	17.6% (3)	58.8% (10)	23.5% (4)	0.0% (0)	17



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After	1 Very Limited	2	3	4	5 Very Strong	Response Count
Apply your knowledge of Great Lakes science to further investigate related topics	0.0% (0)	0.0% (0)	0.0% (0)	64.7% (11)	35.3% (6)	17
Integrate science curriculum and activities into the classroom	0.0% (0)	0.0% (0)	5.9% (1)	17.6% (3)	76.5% (13)	17
Use science thinking and skills to better understand the environment	0.0% (0)	0.0% (0)	5.9% (1)	35.3% (6)	58.8% (10)	17
Understand the different human and environmental factors interacting in an environmental issue	0.0% (0)	0.0% (0)	5.9% (1)	47.1% (8)	47.1% (8)	17
Think creatively to propose ways to solve environmental challenges	0.0% (0)	0.0% (0)	5.9% (1)	47.1% (8)	47.1% (8)	17
Apply what you know about science to make cross-curricular connections	0.0% (0)	0.0% (0)	11.8% (2)	52.9% (9)	35.3% (6)	17
Consider the wants and needs of all people affected by an environmental issue and possible solutions	0.0% (0)	0.0% (0)	6.3% (1)	62.5% (10)	31.3% (5)	16
Use technology to teach/learn about the environment and science concepts	0.0% (0)	0.0% (0)	11.8% (2)	47.1% (8)	41.2% (7)	17
Use technology to connect with other teaching professionals	0.0% (0)	0.0% (0)	11.8% (2)	35.3% (6)	52.9% (9)	17



Appendix 3.2: Rubric Description and Key for Environmental Literacy Site Selection Mission Rubric for Site Selection Mission Submission

Completed Mission Description

“State which site you would recommend for rainbow darter reintroduction and support this choice by explaining why this site is a good match for rainbow darters in 3 or more of these categories:

- Rainbow darter biology (diet, predators, life history)
- Rainbow darter habitat
- Invasive species present or not present
- Water quality data
- Surrounding area, including natural or man-made features”

Approval

Participants must receive a total of 5 or higher for this mission to be considered complete.

Mission Components

- A specific site must be stated (number or name of location)
 - 0 – Does not meet
 - 1 - Meet
- Number of categories addressed
 - 0 - Does not meet: 0-2 categories
 - 1 - Meets: 3 categories
 - 2 - Exceeds 4 or more categories
 - Categories are:
 - Rainbow darter biology (diet, predators, life history)
 - Rainbow darter habitat
 - Invasive species present or not present
 - Water quality data
 - Surrounding area, including natural or man-made features
- Rainbow darter biology (diet, predators, life history)
 - 0 - Does not meet: Simply states the rainbow darter biology would be a good match for the site, with no explanation.
 - 1 - Meets: discusses at least one aspect of rainbow darter biology (diet, predators, life history) and how it relates to the site.
 - Example— “The rainbow darters diet consists of aquatic insect larvae, fish eggs and crayfish. There are 19 different species of fish, specialized plants to attract insects and rusty crayfish present in the creek to feed the Rainbow darter.”
 - Example—“This site does not contain any predators such as burbot, stonecats and smallmouth bass. So Rainbow darter fish should be able to survive.”
 - 2 - Exceeds: discusses multiple aspects of rainbow darter biology and how it relates to the site.
 - Example—“This site is home to 41 different species of plants and animals including many fish. I presume that the eggs of these fish would prove a desirable food source or



the rainbow darters... The information did not note specifically any predators of the rainbow darter that I am aware of; however, I assume some of the more than 41 species present could be predators. I wonder if the large number of present species would contain enough predators/preys of one another to keep every population in balance??”

- Habitat
 - 0 - Does not meet: Labels an answer as “habitat” but does not discuss any aspects of the habitat or describes the habitat, but does not relate it rainbow darter.
 - 1 - Meets: Description of habitat and a reason why it is a good fit for rainbow darter.
 - Example—“Habitat- This site lists that it has 2 riffles which are known to be the preferred habitat of Rainbow Darters.”
 - Example—“Habitat - gravel/small rock, slow moving with many riffles good for laying eggs”
 - Example—“The habitat provides shelter for both young and adult rainbow darters with shallow and deep riffles present.”
 - 2 - Exceeds: Discusses how at least 2 aspects of the habitat are a good fit for the rainbow darter.
 - Example—“There are 2 riffles for the rainbow darters to lay their own eggs in. The substrate of the site is gravel and sand, which the rainbow darters prefer.”
 - Example—“The Rainbow darter habitat can be a creek over gravel and rubble with riffles. Site # 6 is a creek that has two riffles that are 10-15 inches deep and a substrate that is mostly rocky with some gravel.”
 - Example—“The site had four large riffles, from 3" (shallow for young) to 15" (deeper for adults). The dam removal should increase the depth of the water and form some pools (for adult fish).”
- Invasive species present or not present
 - 0 - Does not meet: Just mentions invasive species are present, and/or incorrectly states the roll of the invasive species.
 - Example—“There are invasive species within the area, but all the sites had some listed.”
 - Example—“ Invasive species- only Eurasian Milfoil”
 - 1 - Meets: Names the invasive species at the site selected (or calls out which are not present at the site) and provides some indication of how it would impact the rainbow darter population.
 - Example—“No Asian carp or invasive plant pictures were listed to impede the growth of the rainbow darter.”
 - Example—“The site lists the Rusty Crayfish as being the only recorded invasive species in this area. However, Rainbow Darters are known to eat crayfish, so this is not necessarily a threat to their species.”
 - Example—“Invasive crayfish were found to be present. Yet other predators of the crayfish such as burbot and stonecat were also present”
 - 2 - Exceeds: Names more than one invasive species present (or not present) and specifically addresses how they would impact rainbow darter, possibly beyond the resources provided (?)



- Water Quality Data
 - 0 - Does not meet: just states water quality works
 - 1 - Meets: States how at least 2 parameters are 'good' or within the needs of rainbow darter or makes strong connection between one aspect and rainbow darter
 - Example—"The water quality numbers of pH 7.6, dissolved oxygen 8, and turbidity 14 were all in a good range."
 - Example—"It contains clear water (quality 14, which is in between the 0 and 25 needed for fish to survive and spawn in)."
 - 2 - Exceeds: mentions all 3 parameters (dissolved oxygen, turbidity, and pH) and/or ties water quality values directly to rainbow darter needs.
 - Example—"Rainbow darter are very sensitive to water pollution. The turbidity at this site is low and the oxygen and pH level is good"
 - Example—"Tests show that the the pH, Dissolved Oxygen and Turbidity are good: 7.5, 9 and 11, respectively. Rainbow darters are extremely sensitive to turbidity (<10 NTU?)..."
 - Example—"The water quality data, the pH is 8 which is close to optimal for most organisms, the dissolved oxygen is 9.5 which supports life and activity and can support abundant populations and the turbidity is 8 which clear water fish can tolerate and thrive."

- Surrounding area, including natural or man-made features
 - 0 - Does not meet: Offers information about the surrounding area, but does not make the connection to rainbow darter (or the connection is only inferred)
 - Example—"The site has been established there since 1970, so it has been there a while."
 - Example—" surrounding habitat - surrounded by a chemical free, USDA certified organic farm
 - 1 - Meets: Includes one aspect of the surrounding area and how that would impact rainbow darter
 - Example—"This site is a nature preserve with hardwood forest along both sides that attract many animals. I think that the preserve will be kept in its natural state for many years to come thus insuring the survival of the Rainbow darter and many other species."
 - Example—" Also, the site is a nature preserve that is protected from some sources of pollution and human interventions. Also, there are many other endangered species present at the site, so humans will be extra vigilant about protecting it."
 - 2 - Exceeds: Explains more than one aspect of the surrounding area, makes a detailed explanation of how it would impact the rainbow darter.
 - Example—"The surrounding area of the study site (from the given photo) looks to be wooded. There is a lot of data on the internet on improving Fox River Watershed quality, including Ferson Creek. I think that the rainbow darter would have a better chance of being introduced properly in an area that is being closely monitored and valued by humans."



Appendix 3.3: Rubric Description and Key for Science Literacy Pitching Solutions Mission Rubric for Pitching Solutions Mission Submission

Completed Mission Description

“You combined information on the issue to pitch a solution that works towards solving the issue.

Your mission is to create a pitch on how you would go about solving the Asian Carp issue.

Be sure to include:

- your solution idea
- how it would work
- resources needed
- how it would impact stakeholders
- why it would be the best choice to pursue.

You may choose a unique solution or build on one you have heard about while completing previous missions.”

Approval

Participants must receive a total of 5 or higher for this mission to be considered complete.

Mission Components

- Description of solution idea
 - 0 – does not pose a solution
 - 1 – poses a solution
 - Example: “A physical barrier separating the Mississippi River and The Great Lakes is the only way to truly control invasive species.”
 - 2 – poses multiple solutions
 - Example: “I believe the most realistic course of action would be a combination of poisoning the asian carp, continuing to use the electrical barriers and pursuing the concept of building a lock that would use electrical currents to kill invasive species before releasing ships out into the water.:
- Explanation of idea
 - 0 – does not explain their posed solution
 - 1 – explains details of how their solution would work
 - Example: “My idea would work by providing a physical barrier (the locks) and then the electrical pulse that would kill anything that came in with each boat. This would keep non-native species from spreading.”
 - 2 – explains how their solution works and connects it with other potential solutions or existing solutions
 - Example: “If a PR firm could develop a good marketing campaign for the Asian Carp in the Mid West people would begin to purchase them, creating a demand for them. The state could offer fisherman a financial incentive to fish for and process them, helping to eliminate the number of Asian Carp. The less Asian Carp in our rivers and waterways the less chance for them to make it past the electric barriers and to the Great Lakes.”
 - Example: “My solution to this problem would be to get behind efforts by the U.S. Geological Society to develop an Asian carp-specific poison. Their research has already



discovered an enzyme in the body of the Asian carp that breaks down poisonous microparticles and kills them. They are testing the effects of this poison to be sure it is safe for the environment, including other fish and for birds who would eat the dead carp. If found effective it could be used on Asian Carp eggs before they hatch. Researchers could continue developing other poisons that affect other invasive species as well. This idea is supported by “carp czar” John Goss.”

- Resources needed to accomplish solution
 - 0 – does not include resources
 - 1 – provides list of resources that will be needed to carry out their posed solution
 - Example: “The resource needed above all would be money. Supplies would need to be purchased, and it would become a large public works project. Once completed, money would need to be provided for its ongoing operation and maintenance.”
 - 2 – provides list of resources and explains how they will be obtained
 - Example: “There would be resources needed to solve this problem. There would need to be money invested by companies interested in catching and packaging the Asian carp. There would need to be famous chefs to promote easy and healthy recipes. There would need to be an advertising agency hired to do the promotions/campaign.”
- Impact on stakeholders
 - 0 – does not include the impact of their solution on stakeholders
 - 1 – includes a statement on how stakeholders will be impacted by their posed solution
 - Example: “It would impact stakeholders in a few ways. For recreational boaters and the fishing industry, this would provide one more step they needed to endure to be able to do what they want. These people would need to safeguard their boats and people on their boats to pass safely through the locks system. It would affect the general public by needing money to operate and requiring land.”
 - Example: “It would create jobs, reduce business costs and improve tourism. It could help the Chicago area to become more globally competitive.”
 - 2 – includes a statement and elaborates on how stakeholders will be impacted by their posed solution
 - Example: “The impact this solution will have on stakeholders may seem negative at first, as the reversal is being constructed. However, once the project is complete, I feel most stakeholders will see positive benefits. Commercial fishermen could rely on getting the resources they need to continue their businesses. The MWRDGC would continue to protect the water quality, prevent flooding and monitor sewers; although the layout of their plant may be different. The Great Lakes Legislators will still promote restoration and protection of the Great Lakes, but hopefully, with less anxiety to act quickly to study and educate the general public about the Great Lakes, but again, on a more relaxed level, as the eminent danger of the Asian Carp will no longer be a huge threat. The boaters will be able to continue recreating on the Great Lakes. The Asian Carp and other species. With current technology and water cleansing procedures, the citizens using the water involved in this enormous project should feel confident that the water they use is safe.”
- Why is it the best choice to pursue
 - 0 – does not include why their solution would be the best choice to pursue
 - 1 – explains why their choice would be the best choice to pursue



- Example: “I believe it would be the best option because it provides a combination of physical and electrical barriers. It also does not require any chemicals to be introduced to the water system.”
- Example: “It is the best choice to pursue because it can close the highway for invasive species, it would enhance Chicago's transportation system, create jobs, reduce business costs across the region and it would improve water quality, tourism and recreation.”
- 2 – explains why their choice would be the best choice to pursue and compares it to alternative routes
 - Example: “I believe that while reversing the Chicago River makes a lot of sense in the long run, we simply don't have the infrastructure needed to take on a project of that proportion at this time. It seems to me that more needs to be done right now than planning billion dollar projects. I believe that the best use of our resources right now would be to continue with the electrical barriers, poison areas where high populations of Asian Carp are known to be located, and work toward construction locks where currents can be sent through to kill invasive species before ships move out into open water.”
 - Example: “It would take a great deal of money and time but this would be a permanent solution. Instead of spending piles of money every year to research, build and maintain ways to keep invasive species out, that money could be used elsewhere because it wouldn't the current amount would not be needed on a yearly basis. The best way to keep invasive species out of the Lake? Don't let them get close.”



Appendix 3.4: Example 1 - Science Literacy Pitching Solutions Mission Work Product Submission

ATTENTION!

Fishermen, Boaters, Sports Enthusiasts!
Cooks and Diners!
Great Lakes Ecologists, Biologists, and Citizens All!

Asian carp are now moving northward through the Mississippi River basin and are threatening to enter the Great Lakes through the Chicago Waterway System.

THEREFORE:

Come join the Army Corps of Engineers, the Lake Michigan Yachting Association, Food Network and the Shedd Aquarium at Starved Rock State Park (?) as they host the first ever

Illinois River
Jumping Asian silver Carp Catch-and-Cook Contest!
Bring the entire family!



Fishermen! This is your team's chance to not only win large cash prizes* for catching the most silver carp, but help keep the Great Lakes free of this ecologically harmful invasive species. (*Asian carp harvested will be sold to local processing plants and money used toward cash prizes and donation to the fight against the Asian carp.)

HOWEVER, BOATERS AND FISHERMEN BEWARE:

Disturbed by watercraft, silver carp can jump 10 feet out of the water, resulting in thousands of leaping fish around the boat. This behavior has resulted in injuries to boaters and damage to their boats! Teams must attend safety workshops prior to contest day. Other informational workshops will also be scheduled. What boat will you use? How will you catch the jumping carp? Our experts will help you decide! Dates for these workshops will be forthcoming.

Families! Spectators! When not watching the excitement on the river, please visit the various informational and activity booths offered by our many stakeholders. Learn about how:

- the Asian carp entered the Illinois and Des Plaines Rivers and is threatening Lake Michigan and other Great Lakes;
- why the Asian carp is harmful to our freshwater ecosystems;
- what is being done (besides our Catch-and-Cook Contest!) to reduce or eradicate the Asian carp;
- and much more!



There will be special activities for children, young and old!

LATER....

Whether you are a fisherman or a spectator, stay for the evening...

to enjoy a wide variety of delicious silver carp dinners.* Booths will also feature cooking demonstrations, recipes and Asian carp processing industry information. Don't miss or sign-up for our first annual Asian carp cooking contest!

Competing cooks, here is your chance to prepare creative, tasty and beautifully presented silver carp dishes for our Food Network Judges!

* Proceeds from the dinners will be donated to some worthy action group or Shedd Aquarium). Keeping the Asian Carp from Lake Michigan waters carries a high price tag!

I think this would be a great idea because it involves all or most of the various stakeholders. It helps decrease the silver carp in the Illinois River, educates families, brings stakeholders together in one place. Could hold contests as how to use the Asian carp economically, eg what is already in place such as cat food companies, export to china, besides having these industries inform citizens what they are doing to use carp economically. Computer with the Asian Czar game could be there for children, by the way. Musicians (invasive species songs!)

Resources Needed; Organizers, place to hold the event (I chose Starved Rock just because it is on the Illinois River and perhaps a good meeting place); booth participants (including those canvassing for legislative support); fishermen; cooking contestants; judges; public relations; workshop instructors, and so forth.

I'm not sure if it IS the best course to pursue, but educating the public is important. The event would serve to get stakeholders together; maybe there could also be meetings before or after the event among the industrial stakeholders, people interested in becoming involved or starting related businesses. Shedd could increase its membership.....



Appendix 3.5: Example 2 - Science Literacy Pitching Solutions Mission Work Product Submission

STOP THE CARP!

A physical barrier separating the Mississippi River and The Great Lakes is the only way to truly control invasive species. This multi-agency, multi-billion dollar project is not slated for completion until 2030. Until then:

IDENTIFY THE PROBLEM		
Coordinated, multi-agency ongoing research into the problem of Asian Carp and all other invasive species. Identify- Methods of irradiation – safe chemical sterilization of adults and eggs Methods of control both physical and biological Methods of capture through various methods Continual assessment and study of the current invasive species numbers and locations		
IMPLEMENTATION		
Implement the most effective control methods until The Great Lakes and the Mississippi River can be physically separated. Continued use of electronic barriers and – implement effective herding measures to promote industry – Administer new DNA specific sterilization control through Asian carp specific food pellets.		
STAKEHOLDERS		
Fishermen	Industry	Boaters
Eradication means the continual availability of native species. With improvements of pet food industry needs, market prices rise and the Asian carp becomes a viable cash crop.	The pet food industry booms with the readily available Asian Carp. Market prices become competitive. Fishing increases. The public backs businesses promoting their use of Asian Carp.	Boaters on Illinois waterways are now safer because of the control of Asian Carp. Fewer physical and property injuries will be reported. Some areas are safer than others because of barriers. Boaters support and use these.