A EVALUATION OF ACTIVITY SHEETS CREATED TO ENHANCE SCIENCE LEARNING DURING THE SELF-GUIDED TOUR AT THE TENNESSEE AQUARIUM

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This project evaluated activity sheets that I created for the Tennessee Aquarium based on Tennessee state science standards and the informal education model of free-choice learning. The research focused on one of the worksheets about habitats created for second through fourth grade students. Teachers from those grades who were scheduled to visit the Aquarium in the month of March were solicited to participate in the study. Two teachers agreed to participant in different capacities. Based on the lack of student enthusiasm and my evaluation of completed the activity sheets and student surveys, I determined that the activity sheet was not effective at fostering learning or interest. However, the activity sheets were effective when used by chaperones instead of individual students. Additional research should be conducted to specifically evaluate using chaperones to led activities during self-guided tours of the Tennessee Aquarium.

INTRODUCTION AND BACKGROUND

I work at the Tennessee Aquarium in downtown Chattanooga, TN within Hamilton County. The 2012 census showed the city population of Chattanooga to be 167,896 with a demographic of 34.6% African American, 59.2% White, 5.9% Hispanic or Latino, 2.1% Asian and 0.3% American Indian. The median income was $35,817 (http://quickfacts.census.gov/qfd/states/47/4714000lk.html). As a private non-profit, the mission of the Tennessee Aquarium is to inspire wonder, appreciation, and protection of water and all the life it sustains (http://www.tnaqua.org/about-us/). The education department plays an important role in implementing that mission, as well as working toward a departmental mission to create a future generation of science-literate and environmentally knowledgeable citizens. Our hands-on, informal programming falls under the umbrella of museum education, since the Aquarium displays a living collection.

Seventy to ninety thousand children visit the Tennessee Aquarium on field trips every year from Tennessee, Alabama, Georgia, and North Carolina at a price that is 56% less than a regular child admission. We provide free admission to students who qualify for free or reduced lunch eight months out of the year and give over $40,000 in bus reimbursements to Title I schools every school year. We also provide free outreach programs to Title I schools in Hamilton County and give family passes, called Aquarium Passports, to students at an intercity Environmental Science magnet school. The bus reimbursement, complimentary admission, and passport programs, as well as the generous education discount, are all testaments to the institution's commitment to reaching as many children as possible within a school year.

The Tennessee Aquarium opened in 1992 with one building, River Journey. A typical field trip at the aquarium included a one-hour tour of the exhibits, a one-hour education program, and lunch. In 2006, a second exhibit building, Ocean Journey, and an IMAX theater were added. Extra time on field trips became much more limited with the addition of a second one-hour long exhibits tour and the option to add a 45-minute IMAX film. As such, the number of groups that schedule education programs with their exhibits tour has dropped significantly since 2006. On the Teacher Survey sent out to teachers in December 2014 and April 2015 (N=144), only 37% of teachers indicated that they participated in some kind of classroom program during their field trip (Appendix A).

In December 2014, I was promoted from Education Coordinator to Group Programs Manager. In this role, I supervise a staff of four full-time educators, three part-time naturalists, and eight summer camp seasonal workers. I manage all group programming at the Aquarium including field trips, overnights, summer camp, outreach, and daily Tennessee River gorge cruises. Since I am the first new manager since the building of Ocean Journey and the IMAX Theater, the Education Director assigned me the task of increasing our influence on students on field trips. This is especially challenging since students are not in a classroom setting.

Several options are currently in place for classroom teachers to aid in student learning during the self-guided exhibits tour. One that is frequently used is the AquaQuest (Appendix B). It is a scavenger hunt that teachers can print and give to students to complete during their tour. There are four AquaQuests available to download on the Tennessee Aquarium website based on the grade of students

(http://www.tnaqua.org/teachers/teacher-resources/). The AquaQuests are light on content and mostly involve looking for specific animals or facts from the graphic panels.

My change in role at the Aquarium, the challenge of assisting classroom teachers and their students and our organization's mission lead to the focus question of this study, Will the creation of new *activity sheets that fulfill teacher learning goals be effective to motivate a future generation of science-literate citizens?*

CONCEPTUAL FRAMEWORK

There is a national crisis of not enough people entering the science workforce. Both the Obama and the Bush administrations have focused on the goal of increasing the number of students pursuing high-level science and math. Globalization requires the understanding of science and technology for most fields of work (Griffin & Ramachandran, 2010). Improved science literacy will aid basic understanding about what citizens read on the internet and other media, allowing the identification of errors and design flaws as well as differentiating between claims and evidence (National Research Council, 2012). It will help people solve meaningful problems in their lives and might affect how they live their lives (Feinstein, 2010). Thus, improving science literacy will help boost U.S. participation in the global scientific workforce as well as benefiting the layperson.

Science literacy endeavors can start at a young age by exposing guiding children to answer their natural questions about the world (Bell, Lewenstein, Shouse & Feder, 2009). The National Research Council outlines in *Learning Science in Informal Environments* that developing motivation to learn science can be achieved by fostering interest and emotional engagement among students. Hobby or interest groups, museum

exhibits, and after school programs support science learning by fostering interest and excitement (Bell et al., 2009), which can lead to cognitive gains (DeWhitt & Hohenstien, 2009). Falk (2005) refers to these out-of-school learning places such as zoos, aquariums, science centers, and museums as institutions of "free-choice learning," since visitors often make the choice to learn in these environments. He suggests that part of what motivates students to learn in these environments is their empowerment to make choice about what they learn. Griffin (2004) also found that museum learning is best facilitated by giving students freedom of choice in how they spend their time.

Alternatively, Bamberger and Tal found in their 2006 study of 750 students in four Isreali museums that "limited choice" learning environments created the best outcome of learning over "free choice" and "no choice." In their study, free choice situations allowed the students unstructured reign of their environment. Limited choice included times when the students had worksheets to complete and when they had a problem or task to solve with their peers. No choice situations were guided museum tours with little to no inquiry included. The depth of interactions between students was the greatest with guidance in the limited choice situations, as opposed to mostly expressions of excitement in the free choice situations (Bamberger & Tal, 2006).

In addition to choice, inquiry is also important tool in formal and informal science education. One of the basic premises of science literacy is that "critical thought and the ability to explore questions are more important than learning answers by rote" (Roush, 1996, p. 1356). Informal learning centers can be a place to explore those student questions. Classroom teachers and museum educators can impede that process by

mimicking the formal environment in the informal (Griffin, 2004), although some use of formal questioning and reminders to focus can aid in student learning. DeWhitt and Hohenstein (2009) found that museum learning is best when students are guided in their learning, but not over-programmed. They concluded that students benefited from a combination of student-directed questioning and teacher-directed questioning, based on their findings that student-directed questioning led to increased cognition and that teacher-directed questioning led a deeper understand of content.

In selecting content for informal learning experiences, teachers should link the visit to current classroom curriculum and have adults with some content knowledge accompanying the students (Gilbert & Prest, 1997). In general, Griffin and Ramachandran (2010) suggest that teachers should cover fewer topics in greater depth to create lifelong learners of science. They support their research with the approach of studying broader topics, like conservation and energy, which can be broken down into more specific topics to help understand the ideas more thoroughly.

While there is not a consensus on best practices for informal learning experiences, there is a large body of research supporting that they are an important tool in the overall science learning of students and adults. It is clear that field trips should be based on previous learning the classroom and answer big questions, they should be guided by structured inquiry, and they give students more freedom to explore than they are allowed in a classroom.

METHODOLOGY

Background Research and Worksheet Creation

Based on my research of best practices for learning in informal environments, last spring I created several standards-driven activities, including the Habitat Activity Sheet used in this research, which were less rigid than the AquaQuests and more closely followed the museum model of free-choice learning (Appendix C). In additional to habitats, these covered the content of biomes and adaptations. They were created to meet teacher learning goals and focus students to learn more deeply at exhibits of their choosing. They were also intended to have students connecting more with nature by creating a sustained interaction and closer observation at those exhibits.

After creating the Habitat Activity Sheet and other activity sheets, I observed a free-choice self-guided tour of a fourth-grade group from a neighboring county who were not guided by adults using inquiry, had not been given tasks for touring, and did not have worksheets to complete. I was not wearing a uniform that day and did not interact with the group in any way. I took notes about the length of time they spent at exhibits, the number of related and unrelated questions they asked their peers and chaperones, and the number of related and unrelated comments they made to their peers and chaperones. I counted each window as an exhibit stop. I used the Exhibit Ethogram to tally these interactions at each exhibit (Appendix D). For background information, I also examined the data collected by the marketing department from this school year's Teacher Survey (Appendix A).

Group Solicitation

I solicited groups to participate in the study using the reservations system to collect email addresses of teachers planning to visit the Aquarium in March, 2015 and sent the Teacher Email to prospective teachers (Appendix E). Of 45 emails sent, two teachers responded stating they would participate. For the purposes of this paper, the teachers and their students are referred to as Group A and Group B. Group A was 24 second grade students from a rural county in Tennessee. Group B was a fourth grade group of 32 students from north Georgia who were scheduled to participate in an educator-led classroom program about plankton before their self-guided tour. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix F).

Data Collection Instruments

I used three main instruments for collecting data in this project. These included the Habitat Activity Sheet (Appendix C), Habitat Pre and Post-Tests (Appendix H), and the Student Survey (Appendix I). I tallied data in Google Sheets and used R statistical software to test for statistical significance. I chose non-parametric tests due to the small, non-random sample size of this study.

The Habitat Activity Sheet was selected as the appropriate activity sheet for the participating second and fourth grade groups. On the Habitat Activity Sheet from Groups A and B, I calculated the number of observations listed per habitat on completed

worksheetsand compared those data sets using a Mann-Whitney test. I also tallied who did and did not complete the activity sheet when given the option.

The Habitat Pre and Post-Tests were administered to Group B. Answers were coded as relevant or non-relevant. I calculated the percent of correct answers on each test and compared the averages on both tests using a Barnard's Exact Test.

Both Group A and Group B completed the Student Survey. I also administered the Student Survey to non-participating students chosen randomly as they ended their self-guided exhibits tour. I focused my analysis of the Student Survey on two questions: "Name something cool you learned at the Aquarium today," and "Do you have any questions about what you saw today?" I coded the survey answers from the general student population and Group B as relevant or non-relevant/no answer. For each of the two questions, I compared the students who had completed the Habitat Activity Sheet or a teacher-created scavenger hunt to those who had completed no written activity using Barnard's exact test for 2x2 contingency tables.

Implementation

The teacher of Group A agreed to have her 24 students use the Habitat Activity Sheet during their self-guided tour, fill out the attached Student Survey, and then mail the materials to me. This teacher did not agree to have her students complete the Habitat Pre and Post-Test. After receiving the worksheets and surveys in the mail, I clarified with the teacher by phone why there were only eight worksheets returned for the group's 24 students. The teacher told me that chaperones conducted the Habitat Activity Sheet with small groups of students. The chaperones also filled out the Student Survey instead of

the students, so the survey data was not useful to compare to the other groups. For her efforts, I mailed her classroom an otter poster and a set of animal cards.

I agreed to meet Group B in the morning to issue the Habitat Pre-Test. I requested that only half of this class complete the Habitat Activity Sheet so that I could evaluate differences in the group that did the activities and the group that did not. She did not facilitate this and many of the students were unwilling to participate without a teacher mandate. Therefore, only ten students in Group B took a Habitat Activity Sheet and clipboard. Before the Group B's IMAX film at the end of the day, I was able to administer the student survey and post-test to these students. Only four of the ten students returned a completed activity sheet, some stating that they lost it and others stating that they forgot. I conducted the Habitat Post-Test and Student Survey in a classroom after they ate lunch and before their IMAX movie.

I collected 16 additional Student Surveys from students from random groups visiting in the same month by standing at the exit of River Journey for an hour one day and at the exit of Ocean Journey for an hour another day. I asked students to take a survey while they waited for their group to finish their tour. I was unable to identify which groups the students were touring, so asked for their grade level and whether or not they had completed a worksheet or scavenger hunt that day at the top of these surveys. Table 1 highlights the triangulation of data for the study.

Table 1
Data Triangulation Matrix

Focus Question	1	2
1. What are teachers and students currently getting out of field trips?	Teacher Survey	Ethogram
2. Do new standards-focused written activities help teachers meet learning goals?	Habitat Pre and Post-Test	Habitat Activity Sheet
3. Do new standards-focused written activities help the aquarium meet its science literacy goals?	Habitat Activity Sheet	Student Survey

DATA AND ANALYSIS

On the Exhibit Ethogram used to study student behavior on field trips, I recorded 23 exhibit stops, which had an average length of 30 seconds. Students stayed for 4.5 minutes at an exhibit in which a scuba diver was cleaning and stayed an average of three minutes at each touch tank. The most content related questions I heard were at the tank with the scuba diver, such as "How did he get in there?" The most content related comments I heard were at the touch tanks, including many observations on how they fish felt. The students asked more content related questions in the freshwater building, but made more excited comments in the saltwater building, such as exclamations of "Shark!" and "Sea Turtle!"

On the Teacher Survey (N=144), 61% of respondents indicated that their visit to the Aquarium supplemented a specific classroom lesson. Of the teachers who comments on what concepts were covered (N=80), the most common concept mentioned was

habitats/biomes, followed by lesson about specific animals or groups of animals and taxonomy or classification lessons (*Figure 1*).

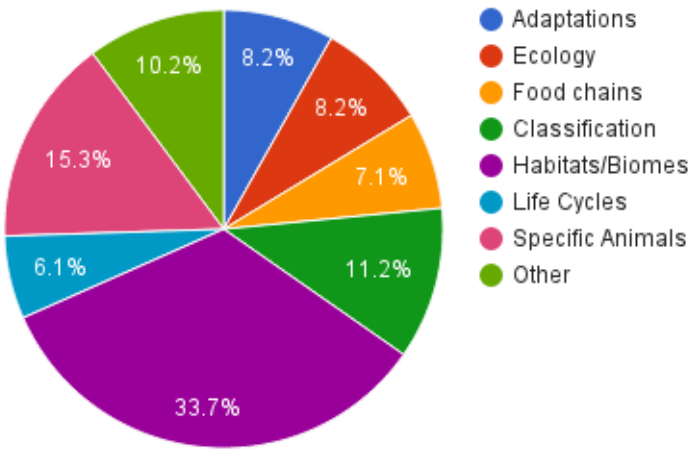

Figure 1.Percentage of responses (*N*=80) to survey query, "If yes, please list what concepts were covered."

On the Habitat Pre-Test from Group B, 96% of students demonstrated that they understood the definition of a habitat (*N*=24). On the post-test from Group B, 74% of students were able to make connections about why a seahorse could not live in freshwater or the desert (*N*=24). There was no significant difference (*p*=0.50, Barnard's Exact Test) in performance on the post-test for the students doing the habitat activity (*N*=4) compared to the group not completing the activity (*N*=20).

Of the students who completed a worksheet (*N*=8), 88% had a relevant response to the query, "Name something you learned at the Aquarium today," compared to 72% of the students who had not completed a worksheet (*N*=32). No significant difference was found between these two groups (*p*=0.22). Of the worksheet students (*N*=8), 50% generated a relevant question when prompted, "Do you have any questions about what

you saw today?" and of the no worksheet students (*N*=32), 37.5% generated a relevant question. This was not a statistically significant difference in answers.

On the Habitat Activity Sheets, the chaperone-led worksheets from Group A (*N*=8) had an average of three observations per habitat and the students-directed worksheets from Group B (*N*=4) had an average of one observation per worksheet (*Figure 3).* The distribution of this data was found to be significant at an alpha level of 0.05 using the Mann-Whitney test for non-normally distributed data (*p*=0.02).

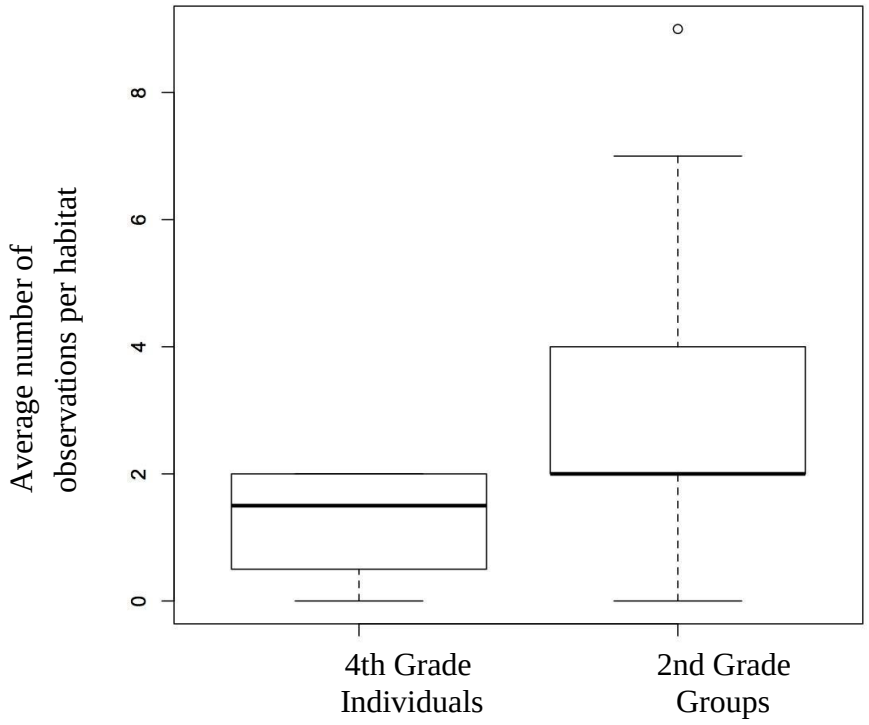

*Figure 2.*Distribution of observations listed on Habitat Activity Sheets (Appendix C) completed by 4th grade individuals (*N*=4) versus 2nd grade chaperone-led groups (*N*=8).

INTERPRETATION AND CONCLUSION

During my observation of a self-guided tour, I found that students were on-task for the majority of their tour. Their interest peaked at the scuba diver, which they might

not have been expecting, and waned after 45 minutes of touring. They also stayed longer and talked more at the touch tanks where they got to interact with live animals.

Even though a majority of teachers who completed the Teacher Survey stated that they were supplementing a specific classroom lesson, the standards-driven activity that I created was a difficult sell to teachers. From informal conversations with teachers during this research, I found that they mostly use scavenger hunts as an activity to focus students, but preferred not to make them so challenging that they are not having fun that day. I had one teacher from a prestigious private school in Chattanooga tell me that she used the middle school AquaQuest for high school honors chemistry class because the high school scavenger hunt was too challenging for a field trip day.

Even though it was not my intention, I found that the Habitat Activity Sheet worked better as a chaperone led activity instead of asking students to remember to do the activity themselves. The content produced when chaperone-led was of higher quality than what the students produced independently. This hopefully led to a greater understanding of the connection between animals and the habitats, although this statement cannot be evaluated conclusively since the teacher opted out of pre and post-tests for this group.

The California Academy of Sciences experimented with chaperone-led activities, but whether or not it was helpful to aid learning was inconclusive (Burtnykn& Combs, 2005). In introducing her research on the role of chaperones in museum visits, Wood (2010) noted that most research on student cognition in museums ignored the role of chaperones, even though it supported the importance of social interaction. She found that

many external factors affected the role of chaperone on field trips, such as level of education, comfort with the museum space, and perceptions about museums.

Overall, research on learning in informal science education facilities is conclusive that teacher involvement and fostering student interest is crucial to student learning on field trips (Fenichel & Schweingruber, 2010). Dohn (2011) published research on situational interest of high school students on an aquarium visit. He found that hands-on activities using live animals, surprising or novel events, social involvement, and support for learning were the main influences to situational interest. Instead of just focusing on free-choice, future activities created to enhance the self-guided exhibit tour need incorporate research-backed suggestions such as these for driving interest. More work should also be done to create teacher buy-in for future activities.

VALUE

While my undergraduate capstone work focused on the importance of informal science education and the role of the educator, this research focused more specifically on the role of an education department at an informal institution. This was in-line with my recent promotion to Group Programs Manager. While this study looked specifically at improving the AquaQuest, the background research and data collected also has implications for all group programming. It reminded me that it is important to keep activities and programming fun, not just to please teachers and parents, but also because that is the most effective way for us to utilize our unique role as an informal facility to inspire children to want to learn while on their field trip and when they get back to the

classroom. I would like to explore the possibility of using my conceptual framework as a starting point to develop a teacher workshop on field trip best practices.

I intended to create an activity in which children would choose galleries to complete the open-ended task. When given free-choice, the students mostly choose to not complete the activity. If I had chance to redo my research project, I would create a more visually appealing worksheet and use marketing tools such as the teacher e-newsletter and social media to promote it. However, I had no conclusive data from the Habitat Pre and Post-Tests or Student Survey that supported enhanced student learning or interest when using the activity sheets on their own.

Because of this, I have adapted the activity sheets that I created as student-led activities to be chaperone-led activities and have posted them on the Tennessee Aquarium's "Teacher Resources" webpage (Appendix J, http://www.tnaqua.org/teachers/teacher-resources/). I have discussed the possibility of field trip use for the Tennessee Aquarium mobile app. The technology team hopes to develop mobile chaperone guides using the aquarium's beacon system, which ping smartphones with exhibit-specific information as guests walk past those exhibits. I have also taken over the role of coordinating our partnership with a local museum magnet school in hopes that I can use the chaperone-driven, small group work that the school does in specific exhibits as a model for other groups.

The exhibit ethogram that I created was an excellent tool for keeping track of student interactions at exhibits. I plan to use interns in the fall to collect data about student interactions at exhibits. Hopefully this additional data will help me draw

conclusions about the best timing for educator interactions, as well as the importance of education interactions and the usefulness of worksheets and chaperone guides. Once I determine the best way for groups to foster learning on their field trips, I will hopefully be able to offer incentives to education groups for participation. I continue to work on improving the reservation process for teachers, which will hopefully leave them with more time to plan their content. We are a mission-driven organization that already offers many programs to aid groups in providing field trips for all students, so I feel that the administration will be on-board with research-backed suggestions from the education department.

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APPENDICES

APPENDIX A

TEACHER SURVEY

Teacher Survey (some questions included at imperative of marketing)

1. Please rate your overall field trip experience.
   5 - Excellent, 4 - Good, 3 - Neutral, 2 - Fair, 1 – Poor

2. What month do you typically plan your field trip?

3. What month do you start the planning process?

4. Did you access the Tennessee Aquarium website prior to booking your reservation?

   Yes, No

   If yes, please let us know what we can do to improve the user-friendliness of our website.

5. Did you download and of the following educational resources from our website?

   Check all that apply:

   Aqua Quest, Aqua Guide, Food Webs, IMAX Resource Guide, Dichotomous Keys, Biome or Habitat Tour

6. Did your Aquarium visit supplement a specific classroom lesson?

   Yes, No

   If yes, please list what concepts were covered.

7. Did you take advantage of any of the following free educational programs?

   Lunch and Learn, Classroom Program, Auditorium Program

   If yes, please comment on your program experience.

8. Please tell us what we can do to improve the reservation process.

9. What grade do you teach? (Check all that apply)

   Preschool, Elementary, Middle School, High School, College

10. Where do you teach?

    Public school, private school, home school

APPENDIX B

AQUAQUEST

AQUA QUEST

Welcome to the Tennessee Aquarium!

While enjoying your visit today, look closely at the animals, the graphics and the exhibits as you search for answers to the following questions.

Grades 3 - 5

Good luck and have fun exploring the Tennessee Aquarium!

Ocean Journey

Tropical Cove

1. The hyacinth macaws have very specialized beaks and feet. Observe them and describe how they move from limb to limb.

_____

_____

2. Touch a ray or shark at Stingray Bay. How did it feel?

_____

Fun Fact: A shark has tiny teeth all over its skin called dermal denticles.

Butterfly Garden

3. Butterflies are very colorful. One butterfly, the blue morpho, has a bright blue pattern with wings open and a brown pattern with wings closed. Why do you think this is helpful for this butterfly to have two different colors?

_____

_____

Penguins' Rock

4 What materials do Gentoo penguins use to build their nests?

_____

5. Where do Emperor penguins keep their young after they hatch?

a. in their pouch b. under their wings

c. on their feet d. in the nest

Fun Fact: Adult penguins are able to identify their young by the chick's distinctive call.

Secret Reef

6. The sand tiger sharks in the Secret Reef exhibit have lots of sharp teeth. Why do you think sharks have so many rows of teeth?

AQUA QUEST

Grades 3 – 5

Page 2

Boneless Beauties

8. The giant Pacific octopus is a very intelligent animal. The aquarists give them things to play with to keep them active. Write the name of one of their toys. _____

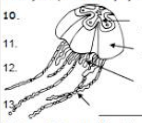
9. The Live Coral tank is full of life. Is live coral a plant or an animal?

a. plant b. animal

Fun Fact: The Giant Pacific Octopus has the learning ability of a three year old child!

Jellies: Living Art

Identify the parts of the jellyfish with the following words: tentacles, stomach, bell, arms



10. _____

11. _____

12. _____

13. _____

14. On which part of the jelly are the stinging cells located? _____

15. What are the stinging cells, or nematocysts, purpose? _____

16. How does a comb jelly snare its prey? _____

17. How does the upside-down jelly acquire most of its food? _____

Fun Fact: The Lion's Mane jelly is the largest jelly in the world with a bell of 8 feet across and tentacles 150 feet long. It thrives in the frigid Arctic waters.

Undersea Cavern

Coral reefs provide food and shelter for many species of fish. Look for one among the coral and draw it.

Fun Fact: Every full moon of August, the coral reefs of the Flower Garden Banks National Marine Sanctuary spawn at the same time.

This is how they reproduce.

AQUA QUEST

River Journey

Grades 3 – 5

Page 3

Seahorse Gallery

Seahorses, pipefish and seadragons are all fish but they sure do look different! Stop by our interactive area to learn what makes seahorses special.

18. Take a close look at a seahorse. How many fins do you see?

a. 5 b. 3

c. 0 d. 4

19. Which is the smallest species of seahorse at the Aquarium?

_____

Fun Fact: Seahorses have very unique eyes that can move in two directions at one time. This

Cove Forest

Live trees and cool, fast-moving streams make you feel like you are in a forest high in the mountains. Look closely and you might see a bird flying overhead or singing on a branch.

20. List two adaptations that help the otter swim.

Fun Fact: The word Tennessee originates from the Native American word for river, Tanasi.

Discovery Hall

Explore wetlands, estuaries and other watery habitats in Discovery Hall.

21. Female alligators have great parenting skills. (Circle one) *TRUE* or *FALSE*

22. Treefrogs are excellent climbers. Look closely at their feet. How might their feet help them climb?

23. In 1989 the last golden toad was seen in the jungles of Costa Rica. It is now extinct. (Circle one) *TRUE* or *FALSE*

24. Touch one of the sturgeon carefully. What does it feel like?

_____

AQUA QUEST

Grades 3 – 5

Page 4

Delta Country

A cypress swamp makes a great home for many unusual plants and animals. Swamps act as nature's sponges by absorbing excess water and preventing floods.

25. Look at an alligator closely. List two adaptations that help it to hunt when it is in the water.

_____

_____

26. Many animals rely on each other for survival. Find two animals that use the burrow of the gopher tortoise as its shelter in the longleaf pine forest.

_____

_____

Fun Fact: Alligator snapping turtles lure their prey into their mouths using a part of their tongue that looks like a worm.

River Giants

From chilly Eurasian waters to tropical Australian rivers, river giants from around the world require clean water to survive. Pollution, habitat destruction, dams, and overfishing are some of the human impacts threatening these amazing animals.

27. Arapaima are considered to be the largest freshwater fish in the world. Find and observe the arapaima. Where in the water column do you think the arapaima eats? Why?

_____

28. How long can the arapaima grow? _____

29. Write the name of two different fish native to the United States.

_____

_____

Fun Fact: Lake sturgeon are considered to be the largest freshwater fish in North America. It spends its entire life in the river system. Since 1998, the Tennessee Aquarium Conservation Institute has released more than 115,000 lake sturgeon into the Tennessee River system where the fish had almost gone extinct.

APPENDIX C

HABITAT ACTIVITY SHEET

Tennessee Aquarium Habitat Tour

What is a habitat?

Many of the exhibits at the Tennessee Aquarium are made to look and feel just like certain habitats. Make a list of the habitats you experience while you tour the Aquarium. For each habitat, list two animals that live there and any adaptations that you notice that help it live there.

Habitat:	
Animal:	Animal:
Observations:	Observations:

APPENDIX D

EXHIBIT ETHOGRAM

All answers counts except first. Comment define as words or phrases combined in a single thought.

Length of interaction	
Student asks a related question to adult	
Student asks an unrelated question to adult	
Student asks a related question to a peer	
Student asks an unrelated question to a peer	
Student makes a related comment to adult	
Student makes an unrelated comment to adult	
Student makes a related comment to peer	
Student makes an unrelated comment to peer	

Length of interaction	
Student asks a related question to adult	
Student asks an unrelated question to adult	
Student asks a related question to a peer	
Student makes a related comment to adult	
Student makes an unrelated comment to adult	
Student makes a related comment to peer	
Student makes an unrelated comment to peer	

APPENDIX E

TEACHER EMAIL

At the Tennessee Aquarium, we're working hard to make sure that children are learning while they are on field trips to our facility. We fund $40,000 a year worth of bus reimbursement out of our operating budget and get many grants from the community to bring economically disadvantaged children to the Aquarium because we believe that the enthusiasm about science and appreciation of nature learned at Tennessee Aquarium is important. I would greatly appreciate it if you would take the time to use the attached activity sheet while you tour the Aquarium. If you leave them for me at the exit or mail them to me after you grade them, I will be happy to mail a set of animal trading cards and several otter posters to your classroom as a thank you. This tool is one of several ways that we are evaluating to enhance the learning experience of the self-guided tour at the Tennessee Aquarium. If you have ideas or examples of things that work for your class, please let me know!

Thanks for helping us better serve your students in the future.

Carrie Howell Shaw
Group Programs Manager
Tennessee Aquarium
(423) 785-4050
201 Broad Street, Suite 200
Chattanooga, Tennessee 37402

The Tennessee Aquarium inspires wonder, appreciation and protection of water and all life that it sustains.

APPENDIX F

INSTITUTIONAL BOARD APPROVAL

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

960 Technology Blvd. Room 127
c/o Immunology & Infectious Diseases
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4303
Email: cherylj@montana.edu

Chair: Mark Quinn
406-994-5721
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-6783
cherylj@montana.edu

MEMORANDUM

TO: Carrie Howell Shaw and John Graves

FROM: Mark Quinn Mark Quinn CH

DATE: February 25, 2015

RE: *"How to Enhance Learning during Self-Guided Field Trips to the Tennessee Aquarium" [CHS022515-EX]*

The above research, described in your submission of **February 20, 2015**, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX H

PRE AND POST TEST

Pre-test:

1. What is a habitat?

Post-test:

Imagine a seahorse living in a saltwater habitat where there is lots of seaweed. Name two reasons why that seahorse would not be able to survive if you moved it to a rocky lake.

1.

2.

Name two reasons why that seahorse would not be able to survive life in a desert.

1.

2.

APPENDIX I

STUDENT SURVEY

1. Name something cool you learned at the Aquarium today.

2. What's one more thing you learned?

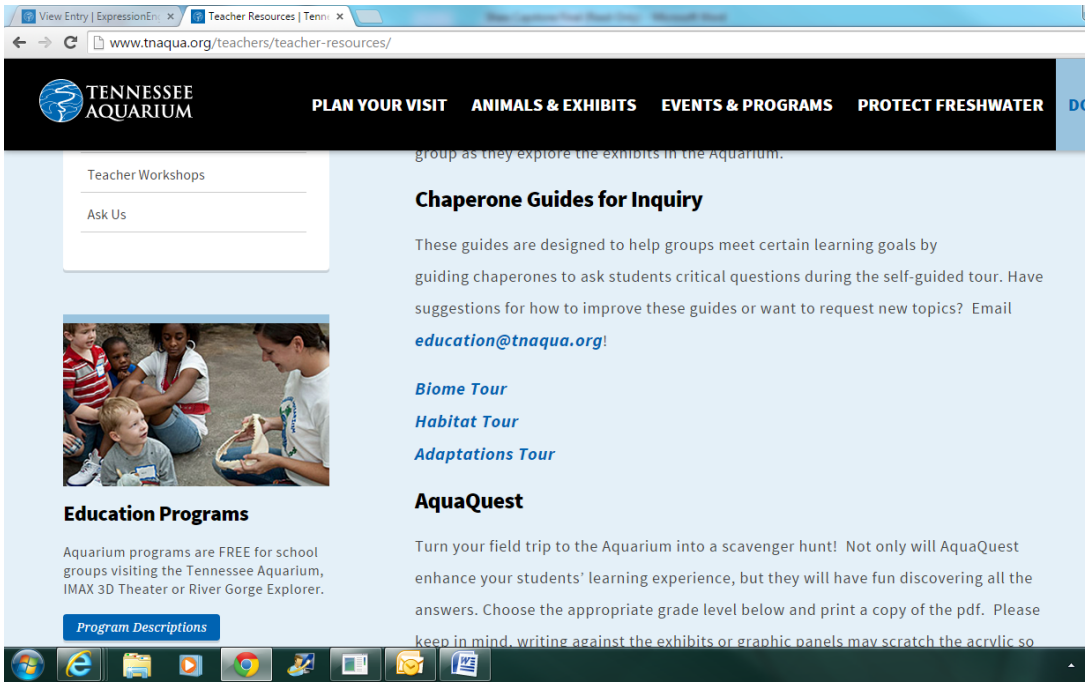
3. If the Aquarium was a classroom, what subject would it be?

4. List what kind of jobs that you think people have at the Aquarium.

Name one thing you can do to help the earth.

APPENDIX J

TEACHER TOOLS SCREENSHOT


View Entry | ExpressionEn
Teacher Resources | Tenn
www.tnaqua.org/teachers/teacher-resources/
TENNESSEE AQUARIUM
PLAN YOUR VISIT
ANIMALS & EXHIBITS
EVENTS & PROGRAMS
PROTECT FRESHWATER
Teacher Workshops
Ask Us
Education Programs
Aquarium programs are FREE for school groups visiting the Tennessee Aquarium, IMAX 3D Theater or River Gorge Explorer.
Program Descriptions
group as they explore the exhibits in the Aquarium.
Chaperone Guides for Inquiry
These guides are designed to help groups meet certain learning goals by guiding chaperones to ask students critical questions during the self-guided tour. Have suggestions for how to improve these guides or want to request new topics? Email education@tnaqua.org!
Biome Tour
Habitat Tour
Adaptations Tour
AquaQuest
Turn your field trip to the Aquarium into a scavenger hunt! Not only will AquaQuest enhance your students' learning experience, but they will have fun discovering all the answers. Choose the appropriate grade level below and print a copy of the pdf. Please keep in mind, writing against the exhibits or graphic panels may scratch the acrylic so