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# Touch Tank Scientists: Diving Deeper with Inquiry

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As marine science educators, we know the value of inspiring, connecting, and using inquiry to drive and deepen a visitor's learning. Conversations like the one above, peppered with wonder questions and scientific inquiry practices and skills, represent the new norm at this touch tank. Its evolution from a platform that excites, inspires, and informs, to one that promotes scientific inquiry and self-paced discovery required in-house assessment, iterative design, and an innovative and comprehensive approach to exhibit planning. The practices of thoughtful exhibit assessment, design, and interpretation can be applied at other institutions and learning environments to facilitate fun, novel hands-on inquiry investigations, and discussions.

## INFORMAL SCIENCE EDUCATION CENTERS AND THE STEM ECOSYSTEM

STEM Ecosystem is a phrase that has been gaining in popularity (Traphagen and Traill 2014; Falk et al. 2016; Tapprich et al. 2016), but what does it really mean and what is its value in practice? One may consider this concept as the combined relational effects of informal learning environments, classrooms, and home efforts working together to provide a range of experiences that help develop critical thinking and problem-solving skills. Ideally these efforts coalesce to build a student's confidence practicing and understanding STEM (Raju and Clayson 2010). A national urgency to improve STEM skills and practices illuminates the need for a varied and robust STEM Ecosystem to support and strengthen


Renovated touch tank with mounted discussion prompt signage. Courtesy of Seacoast Science Center ©2018

classroom efforts. Institutions like aquariums, museums, and science centers, can play an important role in supporting the STEM learning that occurs in classrooms. Through exhibits, live animal interactions, and interpretive programming, informal science education centers (ISECs) have the ability to generate excitement, motivation, and inspire interest and passion (Feder et al. 2009; Gutwill and Allen 2010; Kisiel, Rowe, Vartabedian, and Kopczak 2012).

ISEC professionals use programming and interactives to provide opportunities that combine content with a variety of scientific inquiry (SI) skills. NSES Content Standards (National Research Council 2000) define comfort with SI practice as the ability to:

- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.
- Employ simple equipment and tools to gather data and extend the senses.
- Use data to construct a reasonable explanation.
- Communicate investigations and explanations.

When students and visitors apply these skills, they are demonstrating a critical learning progression toward higher level reasoning, a complex skill that leads to informed decision making (Feder et al. 2009). Research indicates that there are ample opportunities for deeper-level science learning, inquiry-based activities, and discussions in informal science education centers, yet little research has been done to increase scientific literacy at live animal exhibits (Rowe and Kisiel 2012). The need exists for these types of complementary learning goals to be established in informal learning environments, if ISECs are to have a meaningful contribution to a STEM Ecosystem.

**TABLE 1.** Touch Tank Exhibit Goals and Understandings From Visitor/Exhibit Interactions

| EXHIBIT GOALS | VISITORS MAY BE ABLE TO UNDERSTAND: |
|---|---|
| Invite observation, exploration, touching, and interaction with intertidal organisms. | A wide variety of organisms live in the rocky intertidal ecosystem. The touch tank exhibit is a simulated tide pool that are similar to those outside the building and throughout the Gulf of Maine. |
| Touch tank discussion prompt signage is used to combine hands-on touching/exploration with thought-provoking discussion and investigation starters. | The touch tank is stocked with living algae and marine invertebrates. These organisms are adapted to life underwater and must be handled gently. These organisms have different adaptations, which can be observed, compared, and investigated to consider and answer questions about their feeding, defensive, behavioral, and survival characteristics. |
| Facilitate fun, novel, hands-on investigations to build visitors' confidence as science learners and practitioners. | Touch tank tools can be used to help deepen investigations. |

**TABLE 2.** Touch Tank Exhibit Goals and Understandings From Educator-facilitated Visitor/Exhibit Interactions

| WITH FACILITATION, VISITORS MAY BE ABLE TO: | EDUCATOR OBJECTIVES: |
|---|---|
| Compare and contrast feeding, defense, and motility adaptations. | To evoke scientific curiosity and empower visitors to see themselves as scientists. |
| Employ simple equipment and tools to gather data and extend the senses (in the touch tank environment). | To model the use of scientific inquiry skills and encourage visitors to practice them (e.g. observation, question development, claim making, data collection, communication). |
| Ask a question about objects, organisms, and events (in the touch tank environment) and use data to construct reasonable arguments or explanations. | To nurture and facilitate investigations and discussions to guide understanding of interconnectedness of organisms, systems, and humans. |
| See themselves as scientists. | To facilitate first person experiences that build visitor confidence asking questions and using scientific tools and processes. |

## INFUSING SCIENTIFIC INQUIRY AT INFORMAL SCIENCE EDUCATION CENTERS: CHALLENGES AND OPPORTUNITIES

Historically exhibit and program learning goals have focused on content delivery and exposure to new ideas, primarily due to limits around the quality and length of visitor contact time, and varied visitation motivations (Falk and Adelman 2003; Schwan, Grajal, and Lewalter 2014). While knowledge and awareness gains are beneficial and worthy of our efforts, such learning goals do not develop the critical thinking or scientific inquiry skills and practices that lead to synthesis for informed decision making. ISEC's have been addressing national efforts to increase practice and application of scientific inquiry skills by supplementing content and experiences with educator-led programs and exhibits that provoke deeper level questioning and inquiry (National Research Council 2000). Data suggests that there is also the potential for incorporating these skills and practices at touch tanks, which can be novel platforms for deepening visitor's identities as science learners and practitioners (O'Brien, Rowe, Dierking, and Farley 2014; Rowe and Kisiel 2012). Touch tank attributes such as lengthy visitor and exhibit contact time, live animals, hands-on interactions, and the presence of knowledgeable staff and volunteers, make this an ideal platform for scientific inquiry. Although previous studies have demonstrated that learning happens here, research does not indicate evidence of explicit or outlined learning goals for these popular live animal exhibits (Kisiel et al. 2012).

## ASSESSING EXHIBITS FOR THE POTENTIAL OF SCIENTIFIC INQUIRY

Objective internal assessments of popular exhibits, or those with high visitor dwell times, can help ISEC's determine if the opportunity, capacity, or interest exists to thoughtfully integrate SI into the platform in question. Staff at the Seacoast Science Center, in Rye, New Hampshire, recently explored options for SI integration at their popular touch tank exhibit, in the summer of 2017. A small marine science education center situated on the rocky coast of New Hampshire, the Center offers many tanks and exhibits showcasing Gulf of Maine species. The highlight at this location is the 250-gallon touch tank. To better assess visitor interest and openness to SI integration at the touch tank, education and exhibit staff formed an advisory group with learning scientists from the University of New Hampshire, to identify the following:

- visitor usage at the tank;
- current educator and interpretive practices at the tank;
- desired visitor outcomes and exhibit learning goals for current and re-envisioned tank; and
- financial and personnel resources available for renovation.

## Children Explore the New Inquiry-based Touch Tank Exhibit with a Center Volunteer

A volunteer interacts with children at the touch tank exhibit. Courtesy of the Seacoast Science Center ©2018

**Visitor/Exhibit Interaction:** Three children and two adults approach a 250-gallon touch tank at a marine science center. The children, ages 5, 6, and 8, scan the tank and exclaim their excitement. The adults scan the signage and pocket their phones. The children wash their hands, then begin assessing their options and reach into the tank. A volunteer welcomes them to the indoor tide pool and begins asking gentle questions and framing the experience:

***Question:*** *This indoor tide pool has animals and seaweeds just like you would see in the tide pools right out this window. Have you guys ever been out tide pooling before?*

**Visitor/Exhibit Interaction:** As the children share their prior knowledge and experiences with the volunteer and begin asking questions about the organisms, the adults are reading the question prompts on the signs.

***Question:*** *Emma, did you read this sign: It says, 'Look Closely, use your magnifying glass to find the tiny, hidden features of our tide pool creatures.' How fun!*

**Visitor/Exhibit Interaction:** The volunteer points to the Touch Tank Tools bench and invites Emma and her friends to grab a magnifying glass, or to try one of the magnifying sheets that can be immersed under water. Emma's younger brother grabs two sheets and a wet ruler and drops them in the water. The volunteer reaches in for the tools:

***Question:*** *I see you found two different tools for exploring. We can look closely at things with this one, and we can measure how long something is with this one. I wonder what we should examine. Do you or your friends have any good ideas?*


**FIGURE 1.** Touch tank discussion prompt signage is mounted directly in the touch tank. Courtesy of Kate Leavitt ©2018

In-house observations, needs assessments, and surveys captured the perspectives of education staff and visitors. The results helped uncover ways that visitors were using and perceiving the exhibit purpose and benefits, and how this aligned with the education staff's learning goals. Center staff knew they wanted to utilize the touch tank as a fun and novel platform for marine science and SI. The evaluations and assessments helped to inform an exhibit renovation plan that weighed SI potential against visitor interest and other informal education challenges, such as high visitor volume and age and development disparities. The development of a live-animal exhibit interpretation plan that was co-developed by the education and exhibit teams and informed by visitor and staff surveys was profoundly critical to the success of this renovation.

## REDESIGNING THE TOUCH TANK

Informed by our assessments, the team began the redesign process by defining exhibit learning goals, a process that was similar to how we define goals and learning objectives for a lesson. Tables 1 and 2 show the two new sets of desired outcomes for visitor interactions at the renovated touch tank exhibit: one with educator-facilitated tank interpretation and another with exhibit signage only. To achieve the desired learning goals, we developed exhibit signage and exhibit interactives (scientific tools) to complement the existing tank. The goal of the signs was to provide inquiry prompts that would:

- Spark conversation and curiosity.
- Invite participants to try the touch tank tools (magnifying glasses, magnifying sheets, calipers, wet rulers, stopwatch, dive slate/pencil).
- Allow visitors to engage at will, with prompts that interest them, or not at all.
- Deepen visitor engagement, conversation, and learning at the touch tank.
- Promote the use of scientific inquiry skills and practices.
- Provide caregivers with language and information to help deepen learning and conversation.

The new signage was developed and mounted directly in the touch tank. Double-sided signs with species identifications and inquiry prompts were designed to spark observation, exploration, and discussion (Figure 1).

The prompts (Figure 2) are interchangeable so that educators staffing the tank may display the prompts they feel most comfortable with while they are working. By selecting the signage, educators are empowered to guide visitor interactions that they feel most confident facilitating. In addition to promoting discussion and exploration, the inquiry prompt signs direct visitors to the Touch Tank Tool Bench (Figure 3), stocked with scientific tools which visitors are encouraged to use in their touch tank explorations:

- Small quadrats (8 by 8 inches)
- Submersible magnifying sheets
- Wet rulers
- Dive slates/pencils
- Magnifying glasses
- Stop watch
- Laminated data sheets and markers
- Child-safe calipers

## ADDITIONAL REMARKS

This case study shares the story of how a popular touch tank exhibit evolved into a hands-on platform for scientific inquiry, marine science, and discovery. Prior to these changes, a dwell time study revealed that visitors were spending over six times as much time at our touch tank than at any other exhibit in the building. When the dwell time numbers were coupled with observations of positive, engaging visitor touch tank experiences, we were prompted to question our approach:

> *Were we recognizing the exhibit's full potential as a learning platform? If the opportunity for more exists, what do we want to provide?*

Internal exhibit assessments revealed important information about our visitors' motivations and interests, and SSC staff's teaching challenges relative to touch tank learning goals. The new touch tank inquiry prompts and tools met the learning goals and scaffolding challenges presented by staff, while still meeting visitor needs and interests. Visitors and groups are now able to select their entry-points for learning. They can determine their own investigations based on personal knowledge or experience, current interests, and time constraints. The prompts provide parents and caregivers the tools they need to guide and deepen conversation. Parents and caregivers, although armed with some knowledge of their children's prior experiences, may not always know what types of questions to ask to link these to the contents of an exhibit. These prompts can help facilitate that connection.


**FIGURE 2.** Inquiry prompt signs at new touch tank exhibit. Courtesy of Seacoast Science Center ©2018


**FIGURE 3.** Inquiry tool bench at the newly renovated touch tank. Courtesy of Seacoast Science Center ©2018

Observations and assessments suggested that the touch tank had the potential to be a powerful platform for building visitor confidence and understanding through using the principles of scientific inquiry. By collecting data, making observations, and asking questions, participants are given the opportunity to become more comfortable with scientific tools and, more importantly, to interact with a simulated intertidal environment in a different and deeper way. As deeper learning opportunities are offered and utilized, and visitor confidence increases, we predict that visitor questions will be less about species names and facts, and more about how species behave and interact with their environment. Now that the exhibit is open, evaluation is underway to measure accomplishment of learning goals and intended outcomes.

We hope this case study will inspire readers to consider the potential that exists to infuse scientific inquiry and deepen visitor engagement at their own institutions and learning environments. ISECs play a crucial role in the STEM Ecosystem, offering fun, novel, and self-directed learning opportunities. It is incumbent on us to leverage these experiences by infusing them with meaningful inquiry activities and practices whenever possible. As educators and exhibit designers, we can provide these opportunities through encouraging visitors to design their own inquiry investigations, participate in experimentation, and grow their confidence in scientific inquiry.

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