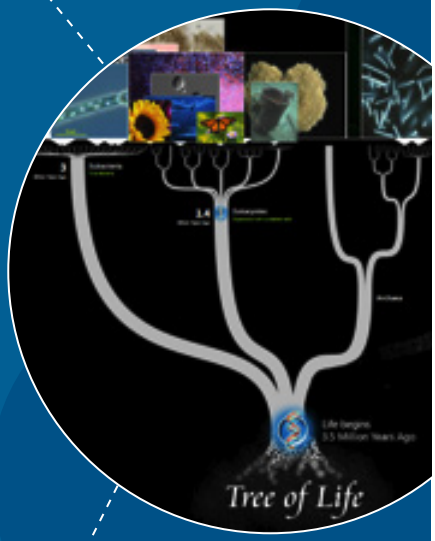


**STEM Education Evaluation Center at TERC:**

*Improving education through evaluation*

# Life on Earth

## Evaluation Report

James K.L. Hammerman, Ed.D.[1]
Amy N. Spiegel, Ph.D.[2]
Jonathan A. Christiansen[1]

[1]STEM Education Evaluation Center at TERC, Cambridge, MA
[2] Center for Instructional Innovation, University of Nebraska – Lincoln

**STEM Education Evaluation Center**
**SEEC at TERC**

TERC

*2067 Massachusetts Avenue*
*Cambridge, Massachusetts 02140*
*617.873.9600 phone*
*617.873.9601 fax*
*http://evaluation.terc.edu*

## Executive Summary

*Life on Earth* is interactive software installed as a museum touchtable exhibit that uses data about over seventy thousand (70,000) species from several databases to help visitors explore and deepen their understanding of biodiversity, evolution and common ancestry, and the history of life on earth (DeepTree/ FloTree). Some installations also include a smaller exhibit that poses puzzle challenges about evolutionary relationships among species (Build-a-Tree (BAT)).[1]

The exhibit was installed at four natural history museums across the U.S. – the Harvard Museum of Natural History (Cambridge, MA), the Field Museum (Chicago, IL), the University of Nebraska State Museum (Lincoln, NE), and the California Academy of Sciences (Cal Academy, San Francisco, CA). Evaluation took place at Cal Academy during two months in the fall, 2012. The *Life on Earth* project also conducted learning research about the impact of the exhibit (Evans et al., 2013; Evans et al., April, 2013).

The project engaged in three inter-related strands of research – Learning Research with youth using experimental methods; human computer interaction (HCI) research on group touch interactions and large data visualization; and this summative evaluation. Together, they build a range of important knowledge about the intervention and its impact. The Learning Research and HCI research are reported elsewhere (Block et al., 2012; Davis et al., 2013; Evans et al., April, 2013). This evaluation was intended to describe how visitors engage with the touch table exhibits when installed in a museum context, including the role of group interaction, and to explore whether engagement with the touch table exhibit helps visitors understand key concepts of evolution. We conducted a video- and audiotaped study of *Life on Earth* exhibit users in a museum context, as well as a naturalistic observation study of exhibit users. A total of 675 visitors were observed using both DeepTree and BAT over the course of over 40 hours during 11 days. A variety of data were collected for the evaluation from both video and naturalistic observations, including time spent, activities engaged in, characteristics of social interactions around the exhibit table, and responses to a short survey about visitors' experiences and their knowledge of evolution and common ancestry.

Based on our observations, the majority of visitors at Cal Academy were white and well educated with substantial museum and technology experience, but there is also significant diversity across age, race/ ethnicity, languages spoken, place of residence, and prior experiences.

The exhibit was designed for groups of visitors to work together with a common focus around the table at the same time, rather than working in parallel. We tried to observe the natural flow of visitors to and away from the exhibit – observing the forming and re-forming of natural groups rather than trying to establish which people came to the museum together – allowing our study to include interactions among strangers. Median group size was 2 or 3 in each exhibit and study condition, with a range from 1 to as many as 7 visitors at a time observed. Visitor groups represented a wide variety of age configurations with more fluid overlap in the naturalistic studies than in the video studies, as expected because of the way we controlled access to the video study.

[1] The *Life on Earth* project is supported by funding from the National Science Foundation (NSF) under award DRL–1010889 (Harvard University; PI: Chia Shen), and this evaluation report is a subcontract to that award. The views expressed herein are those of the authors and may or may not reflect those of the prime awardee or the Foundation.

### Interest and Enjoyment

Visitor self-reports suggest they found both the DeepTree and BAT exhibits interesting and enjoyable and that they would encourage a friend to visit the table (average ratings of 4 or more on a 5 point scale).

These self-reports were backed up by observations, which found that for nearly half of visitors in the DeepTree study, and over 70% in the BAT study, someone verbally expressed enjoyment with use of the software during their time at the exhibit table, and that less than 25% experienced anyone expressing dislike or frustration with the exhibits.

### Engagement

Observations show visitors engaged substantially with the software, spending 1 and $^{2}/_{3}$ minutes on average in the naturalistic conditions for both DeepTree and BAT, and about 6 minutes on average in the video condition, controlling for group characteristics.

For the DeepTree video study, where we were able to collect table log data, 38% of visitors engaged with 5 or more (of the 7) major exhibit activities (Top level navigation; Reel item navigation; Inspection of text/ top image zooming; Trait display; Relate; Training tree; and FloTree) and another 22% engaged with 4 of the 7 (total of 59% engaged with 4 or more), suggesting a high proportion of "Diligent Visitors" (Serrell, 1997). Although we were not able to create a reliable multi-dimensional measure of engagement through confirmatory factor analysis, we found that dwell time was the most reliable predictor of a hypothesized underlying latent engagement factor, and dwell times were moderately high.

In addition to these intended types of interactions, evaluators observed visitors engaging in a range of invented behaviors that they used to explore and play with the content of the exhibit. These included "encyclopedic" scanning of species across the canopy of the DeepTree (observing pictures and reading text about one species, then going on to another species); use of manual navigation to back up from the canopy to a common ancestor, then forward down a branch to a related descendant; group attempts to "kill off" one branch in FloTree; and even simultaneous use of an iPad by one teenager to look up information about species while his parents explored the exhibit software, among others.

### Social Interaction

Social interaction around the exhibit table was important. Visitors in all study conditions reported that the presence of others at the table had a somewhat positive impact on their learning and experience at the exhibit, on average.

Between 65% and 90% of visitors in groups of two or more in all software and study conditions experienced verbal negotiation about social interactions. Groups also used a mixture of physical approaches to social interaction, with 85% or more of visitors in the DeepTree video study experiencing turn-taking, two or more people manipulating the exhibit table simultaneously, and visitors pointing to the table without touching it to suggest things to look at or do. (These proportions were somewhat smaller in the DeepTree naturalistic study – 78% experiencing two or more manipulating the table; 50% experiencing pointing; 40% experiencing turn-taking – and similar but slightly larger percentages in the BAT naturalistic study.)

As expected, group configurations were more fluid in the naturalistic study conditions than in the video studies because of increased access control to the exhibit in the video studies. In all study conditions, we found that larger groups tended to spend longer than smaller ones, controlling for other group characteristics, though these effects were only statistically significant for the naturalistic studies – it seems the exhibit design encourages and builds upon positive

group interactions. Interestingly, this effect was somewhat tempered in the DeepTree studies if the additional people were "strangers" (i.e., didn't come and go together), suggesting that comfort with social interaction may make an important contribution to this effect.

For the most part, the presence of children and teens did not have a statistically significant impact on exhibit dwell time, though groups containing children or especially younger children tended to spend less time in the DeepTree naturalistic study than did groups containing only adults or those with teens. DeepTree was designed for ages 10 and up, and this dwell time evidence suggests that, as intended, some of the content of DeepTree may be more interesting and engaging for teen and adult learners than for younger children.

The presence of 6-12 year old children (and to a lesser extent, teens) was associated with *increased* time in the BAT studies, though the difference is not statistically significant in the naturalistic study and, though statistically significant in the video study, is based on just 3 groups so may be partially an artifact. Still, it seems the BAT software tended to engage groups with children somewhat more than groups with just adults.

### Biology Content

The content of the exhibits was also important. Visitors reported that they learned moderate amounts from the exhibits (ratings in the mid-3 range on a 5 point scale).

More importantly, analysis of learning outcomes on a subset of the total sample (N=123) suggests that time at the DeepTree exhibit had a statistically significant association with ratings of agreement on the common ancestry questions of the survey and a marginally significant association with agreement ratings on the evolution questions, controlling for visitors' level of education (which is also associated with these scores), and group membership. Engagement in specific activities at the table such as use of the Relate function, use of the FloTree function, or extent of biology talk within the group were *not* associated with differences in these scores. For the BAT exhibit (N=18), educational level is associated with common ancestry scores, but there were no other statistically significant associations.

A similar result was found with the project's own learning research studies – a controlled experiment that used the same questions about common ancestry and evolution. In that study, youth who experienced the DeepTree exhibit were more likely than a control group to agree with the common ancestry questions. In the learning research studies, there was also a positive association between use of the Relate function and increased agreement with common descent. This result was stronger for the younger, 8-11 year-olds, which may be why it was not replicated in the current evaluation, which included adult as well as youth participants in the sample.

Observations show that majorities of visitors in both the DeepTree and BAT naturalistic studies (50% and 65% respectively), and *substantial* majorities in the video studies (over 80%) experienced some talk about biology content while at the exhibit table. This included questions about whether species were related, comments about characteristics of varied species and/ or reading information displayed in the exhibit, and hypotheses about what was going on in the FloTree "Experiment," among others.

In addition, a substantial minority of visitors were able to connect their exhibit experiences to other experiences at the museum and elsewhere in their lives – e.g., learning from classes they had taken, or diseases they had experienced – with about 15% in all study and software conditions expressing one or more such connections during their time at the exhibit, suggesting some integration and meaning-making of the *Life on Earth* experience.

## Conclusions

These findings suggest that the *Life on Earth* exhibit software was successful at engaging a wide range of visitors with a variety of activities to learn about diversity of species, common ancestry, and evolutionary processes. Visitors expressed enjoyment with their experience at the exhibit, and engaged in discussions about biology content and, sometimes, how it related to other experiences in their lives.

Social interactions among visitors around the table were common and larger group sizes at the exhibit were associated with increased dwell time, moreso for groups who came and went together than for those that included "strangers" in the DeepTree studies. Increased dwell time, in turn, was associated with increased common ancestry and evolution scores in the DeepTree exhibit after controlling for visitors' level of education. This observational study could not make causal inferences directly linking engagement with the DeepTree software with higher scores on important learning outcomes/ goals in the naturalistic setting. However, the evaluation findings align with results from the project's more controlled experimental learning research which indicates a causal connection for youth between experience with DeepTree and learning results. Together, these findings suggest that exposure to the exhibit software in the museum context may increase scores on important learning outcomes. This is an important set of findings.