

Evaluation Report

Signing Glossaries for Science Exhibits (SGSE) Exploratory Pathways project

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TERC

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PROJECT DESCRIPTION

With this 2-year *Signing Glossaries for Science Exhibits (SGSE)* Exploratory Pathways project, TERC is studying potential effectiveness of use of venue-specific signing glossaries to enhance access of visitor groups with at least one member, ages 5-12+, who is deaf or hard of hearing to STEM learning during visits to informal STEM learning environments.

Research and development involved: 1) Preparing six separate signing glossaries, delivered as apps, to provide the target audience with an assistive tool that enables access to STEM vocabulary during visits to aquariums, botanical gardens, natural history museums, nature centers, science museums, and zoos; 2) Conducting a formative evaluation that incorporates a mixed-methods design at six sites in the Northeast to find out about use of the glossaries, to begin to establish effectiveness in providing the target audience with the visual language its members need to access and explain STEM exhibit content, and to discover how the glossaries might be improved; 3) Conducting field research to identify dissemination strategies and new terms to add; 4) Making the glossaries available at no cost and completing a report of findings. Outcomes rendered new knowledge that will be used to inform subsequent research and development of the glossaries.

Terms included in each prototype glossary were drawn from the standards-based science terms included in one or more of the video versions of the signing dictionaries for grades K-12+, developed previously by TERC and Vcom3D (<https://signsci.terc.edu/video/index.html>). Terms selected for the glossaries represent those that visitors might encounter during a visit to a particular informal science education institution. For example, the Signing Zoo Glossary (SZG) includes only those terms that might be encountered during a visit to a zoo. Additional development included adapting the Principles of Universal Design for Learning (UDL)¹, developed by David Rose et al., that were incorporated into the signing dictionaries, into the glossaries to meet the needs of a very varied audience. Specifically, content is presented in multiple ways, allowing visitors to select the method of presentation that best matches the way they comprehend information. Access to terms is available from alphabetical lists, key terms lists, categories, or clicking on a magnifying glass and typing into a search box. Individual components can be selected and viewed in sign, as English text, or both and can be played and replayed as often as needed. Audio is also available. Illustrations can be accessed with a single click. The images below are examples of pages from the SZG that incorporate these “universally designed” features.



¹ Rose, D., & Meyer, A. (2006). *A practical reader in universal design for learning*. Cambridge, MA: Harvard Education Press.

OBJECTIVES and GOALS

The objectives of the research component of the project were to study: 1) how visitors integrate mobile app versions of the glossaries into their visit experience; 2) the impact of the glossaries on what deaf or hard of hearing visitors are able to learn from exhibits; and 3) how the glossaries might be improved and disseminated. The goals of the evaluation were to collect data to answer our four primary research questions: 1) How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments? 2) What kinds of learning outcomes are made possible with use of the glossaries? 3) What terms need to be changed or added to the glossaries? 4) What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit? Answers to these questions were intended to generate new knowledge about what happens with use of the signing glossaries, how it happens, and under what circumstances and to provide insight into components to incorporate into subsequent versions.

METHODOLOGY

The Prototype Glossary Test used a mixed-methods design that integrated qualitative and quantitative methods and built on the designs used for testing of the signing dictionaries at the Museum of Science, Boston and Harvard Museum of Natural History. The research team collected data from groups of family and school visitors before, during, and after their visit. These data included observations and exit interviews and post-visit surveys with fixed and open-response items. Additional data collection included using an online feedback survey to gather information from venue staff from test sites and partner sites about the terms included in the glossary, additional terms and features to include in a subsequent version, and internal and external dissemination of the glossary for use prior to and during a visit. These data sources were designed to provide a robust data set to support an analysis that was intended to answer our research questions.

FAMILY GROUPS

Pre-visit Protocols — Prior to visiting a particular institution, requirements for working with human subjects were finalized and groups completed a Participant Data Form. The form provided demographic information about factors such as age, reading level, hearing level, interests, and times available for a visit. The Lead Researcher used this information to schedule visits.

Visit Protocols — The Lead Researcher met participants at the site at a designated time and place. Plans called for morning and afternoon sessions, with the researcher working with one group at a time for approximately 1.5 to 2 hours. After a short “get acquainted” conversation that included looking at a map of the exhibit areas available for exploration and determining which areas the group was interested in visiting, the researcher gave each group member an iPod with the glossary installed and a lanyard for hanging it around the neck. This was followed by demonstration and practice of how to use the alphabetical look up, search feature and category look up and how to use the interactive features of a glossary term page. The group then proceeded to the first exhibit area that was in closest proximity to the meeting place.

Using an Observation Guide, the researcher observed group members as they visited the area using the glossary, recorded data, and sometimes asked them to explain or clarify their behaviors and conversations. As time allowed, the group proceeded to a second exhibit area where group members and the researcher repeated the same process as for the first exhibit area. This included engaging in the exhibit while the researcher observed behaviors and conversations, recorded data, and asked questions to obtain more in-depth information about what the visitors' thinking and reasons for particular actions. The group was then invited to continue to explore other exhibits areas of interest using the glossary until approximately twenty minutes before the testing session was scheduled to end. At a scheduled time and place, the researcher collected the iPods and conducted a short post visit exit interview.

Post-visit Protocols — Following the exit interview, the researcher explained that she would email them a link to an Online Survey to complete and return within a week. Groups were free to stay at the venue as long as they wished after the formal testing session had ended and explore the exhibits on their own.

SCHOOL GROUPS

Visit Protocols — Prior to the visit, the researcher worked with staff from the institution and the school group administrative staff to determine the schedule and plan of activities and to complete requirements for working with human subjects. Careful consideration was given to the nature of the institution and the needs of the group. School group visits included: exploration of exhibit areas in small groups; whole group presentations and hands-on interactive activities led by venue staff members and educators; a combination of large and small group activities. Upon arrival, the Lead Researcher met the school group participants and reviewed the plan for the visit. Next, the researcher gave each group member an iPod with the glossary installed and a lanyard for hanging it around the neck. This was followed by demonstration and practice of how to use the glossary features. The group then proceeded to the first exhibit area that was in closest proximity to the meeting place, or to the location where the programs or presentations began.

Using an Observation Guide, the researcher observed group members use of the glossary. She recorded data, and often asked teachers and students to explain or clarify their behaviors and conversations.

Post-visit Protocols for School Groups — At the conclusion of the visit, participants met at a scheduled time and place. The researcher collected the iPods. She also gave a teacher chaperone an envelope with copies of a Post-Visit Survey, one for Teachers and another for Students. She explained that they were to complete the surveys as soon as possible and return them to her in the self-addressed envelope provided.

VENUE STAFF FEEDBACK

Test and partner site staff from each of the six informal STEM learning environments were provided with two lists of terms. One list included all of the terms that were taken from the Signing Science Dictionaries (signsci.terc.edu) and are currently included in the glossary for use by visitors to their particular venue. The other was a list of suggested terms assembled from relevant Web sites to include in a subsequent version. Staff were asked to review the lists and suggest additional terms to include.

INSTRUMENTATION

The Observation Guide, Exit Interview (used with families only), Post-Visit Survey, and Venue Staff Feedback Form were designed to provide information that could be used to answer our research questions. Appendix A provides the questions included in each instrument and their alignment with the research questions.

RESULTS

We organized our results for each of the informal learning environments around each of our four research questions: 1) How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments? 2) What kinds of learning outcomes are made possible with use of the glossaries? 3) What terms need to be changed or added to the glossaries? 4) What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit? Summaries are provided as Key Findings for the first two questions.

The table numbering scheme that is used to present these results, identifies both environment type (zoo, nature center, aquarium, science museum, natural history museum, botanical garden) and testing order. For example, all of the tables that show results for zoo testing are designated with the number 1, for nature centers with a 2 etc. Appendix B provides pictures of visitors using the glossaries.

1: ZOO

Zoo testing was done at the Stone Zoo, Stoneham, MA— operated by Zoo New England. It included two families and seven family members as described in Table 1a.

Table 1a. Zoo Visitor Demographics

Group	N	Members	Age	Gender	Hearing Status	Hearing Loss	Communication Methods	Signing Proficiency
A	4	Mother	--	Female	Deaf	Profound	English, ASL	Superior
		Father	--	Male	Deaf	Profound	English, ASL	Superior
		Child 1	8	Female	HH* with	Severe	English, ASL	Intermediate
		Child 2	5	Male	HA HH with HA	Severe/Profound	English, ASL	Intermediate
B	3	Mother	--	Female	Hearing	N/A	English/ASL	Advanced
		Father	--	Male	Hearing	N/A	English	Survival
		Child	11	Female	Deaf	Profound	ASL	Advanced

*HH=hard of hearing

Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

The Observation Guide provided data for the results presented in Table 1b. The Exit Interview and Post Visit Survey provided data for the results presented in Tables 1c and 1d.

Table 1b. Use and Integration of Terms

Zoo

Exhibit	Group	Terms Looked Up	Features Used	Integration
Reindeer	A	Reindeer	Alphabet List, Search*, English text, ASL**, Illustration	Parent uses sign to ask about the number of remaining reindeer. Child answers
Barnyard	A	Goat; Pig	Alphabet List, Search, English text, ASL; Illustration	Animal observation.
Gibbon	A	Monkey	Alphabet List, Search, English text, ASL, Illustration	Child comments about the gibbon's long arms and tail.
Flamingos	A	Flamingo	Alphabet List, Search, English text and ASL	Animal observation
Eagle	B	Eagle, Bird	ASL	Animal observation
Arctic Fox	B	Fox	Search, ASL	Child observes animal and uses sign to comment about it as her favorite animal.
Snow Leopard	B	Leopard	Search, ASL	Animal observation. Parent comments the sign combines "cat" and "spot"
Markhor	B	Herd	Search, ASL, Illustration	Child explains a herd as "a group of 3 or more animals together."
Wolf	B	Wolf	Search, ASL, Illustration	Mother asks child to tell about the animal. Child answers by pointing to the exhibit sign.
Gibbon	B	Monkey	Search, ASL, Illustration	Discuss importance of "long arms" for moving from place to place.
River Otter	B	Otter	Search, ASL, Illustration	Discuss term being finger spelled.
Discovery Center	B	Lizard, Frog	Search, ASL	Animal observation.
*-The older children often used the Search feature. Some children went to the category they were in and then searched. **-The language noted was used for both the terms and its definition.				

Table 1c. Perceived Value Added

Zoo		
Group	Parent/Child	Group Member's Perception
A	Child	It was helping me a lot and it was very fun using it. My brother was fascinated with the stuff [what he saw in the glossary].
A	Parent	They were hooked. I guarantee they are leaving with more in their heads than if we were just looking at everything. My children were engaged and did it on their own.
B	Child	I liked that it helped me so that I could look up words and learn the sign and a little bit more about the animals.
B	Parent	My daughter usually looks for a second and then moves on. I noticed today with the technology she wanted to look everything up. She's definitely more engaged with the animals and with the displays than before. This enhanced her zoo experience.
A & B	Parents	Using the glossary made Our visit easier and more fun (4/4), Exhibits more accessible (4/4), Enhanced our visit (4/4), Enabled children's independence (4/4). Children particularly liked Using the technology (2/4), Reading about the different animals (2/4), Independently learning (2/4), Looking at the images to be sure the animal looked was the same as the one displayed (2/4). Having the categories available helped children find the animal for a particular area (4/4).

Table 1d. Use and Usability

Zoo		
Group	Parent/Child	Group Member's Perception of Usability

A	Child 1	It was easy to find the words. It popped up right when I typed it in.
A	Child 2	I would just look at the list (abc).
A	Parent	I bypassed my device and just focused on theirs – it was easier to do that.
B	Child	I went right to the magnifying glass and typed in the letters
B	Parent	I used the alphabetical list the most...because of my big fingers that was just easier.
A & B	Parents	Easy to Use 4/4 Informative 4/4 Usefulness of Glossary 4/4 (Useful), Alphabet List 4/4 (Useful), Categories 2/4 (Never used), 2/4 (Useful), Search 4/4 (Useful), Illustrations 4/4 (Useful) Most Useful for You Terms in ASL (4/4), Terms in English (2/4), Definitions in English (4/4) Most Useful for Deaf/HH Children Terms in English (2/4), Definitions in English (2/4) Terms in ASL (2/4), Definitions in English (2/4) Reason for Use Learn signs (2/4), Learn Meaning of Terms (4/4), Learn About Animals (4/4) Using the Glossary throughout the entire zoo would be beneficial (4/4)

Key Findings for Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

Groups used the dictionaries during their visits to the exhibits in ways that met the individual needs of family members. Specifically, they used the Alphabet List and Search, using the magnifying glass and/or category lists, to look up terms. They used ASL and/or English text to learn signs and find out about the animals they had looked up. They looked at illustrations to see that they had found the correct animal. Use of the glossary resulted in observation and discussion about animal structures and behaviors. Children and parents alike found the glossary useful, fun, and easy to use. Parents found that it slowed children down so that they spent time at each exhibit and that it enabled them to engage with the exhibits independently.

Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

To help us answer this question, we organized our results around impact categories from the Framework for Evaluating Impacts of Informal Science Education Projects². The Observation Guide, Exit Interview and Post Visit Survey provided data for the results presented in Table 1e.

Table 1e. Learning Outcomes

Zoo			
Impact Category	Group	Parent/Child	Evidence of Impact

²Allen, S., Campbell, P. B., Dierking, L. D., Flagg, B. N., Friedman, A. J., Garibay, C., & Ucko, D. A. (2008). Framework for evaluating impacts of informal science education projects. In *Report from a National Science Foundation Workshop. The National Science Foundation, Division of Research on Learning in Formal and Informal Settings*.

Awareness, Knowledge or Understanding*	A	Child	<ul style="list-style-type: none"> • I looked up Pig and they are supposed to be the cleanest animals! But when I looked, it wasn't very clean. It smelled really bad! • I learned a lot about Goats. They have little beards. I learned that from the sign. In the glossary, it said that goats butt heads a lot. We saw them doing that. They kicked up their heels on top of each other and butted heads!
	B	Child	<ul style="list-style-type: none"> • I could see the otter playing in the water. I looked at the picture. I liked that I could see a picture of the animal so that I knew I had the right one. If the picture matched, that helped me learn. • The monkey had the long arms that helped him to climb. That's what I learned from the glossary!
	A	Parent	<ul style="list-style-type: none"> • My son was able to learn a little bit about each animal through the glossary and this allowed him to really interact with the exhibits. Otherwise, he would just be walking through without much reason to stop and observe each animal. They used the glossary more to learn information about each animal more than just the sign.
	B	Parent	<ul style="list-style-type: none"> • It was wonderful to have my daughter watch the definition and then be able to communicate back to me what she learned. It definitely expands our sign vocabulary which in turn expands what we can discuss on our visit. • While I cannot recall all the signs my children learned. The ones I do remember are <i>cage, flamingo, leopard</i>.
Engagement**	A	Parent	<ul style="list-style-type: none"> • I would love to use this at other places, I really would. Today I didn't have to do as much as I normally would. Normally I have to be THE teacher and I can't. With this my son had the free will to go through on his own and I didn't have to pull my daughter back to wait while I helped him. That's the goal of this, right? to let them have that independence. Where was this when I was little? We didn't have anything like this!
	B	Parent	<ul style="list-style-type: none"> • I definitely will be getting this app! We recently were members at Roger Williams Zoo and she hated going to the zoo, so we gave it up. I used to really love going to the zoo. Now we'll probably get another membership. • This definitely slowed her down and that's the biggest thing about it for me anyway. She takes time to look and learn. Now she moves on so that she can look up the next animal that she sees. • Independence to learn on her own. That's what this makes possible. The technology absolutely makes a difference in [our daughter's] science experience.

			<ul style="list-style-type: none"> • Several times she asked: <i>Can we go back to the science museum?</i> She wants to go because she knows she could use the glossary there. • When I used to go to the zoo, I had to bring an ASL sign book and it was huge. I used to have to flip through everything. With this I can just hit a few buttons and say to her <i>Look that's what this is.</i> It's so much easier.
Skills***	A & B	Child	Observation of animals prior to and after looking up terms and in their comments and responses to parents' questions (See Table 2).
	A & B	Child	Learning of new signs and information used to further observation and discussion (See Awareness, Knowledge or Understanding).

*-Impact Category 1: Awareness, Knowledge or Understanding

**-Impact Category 2: Engagement or Interest

***-Impact Category 5: Skills

Key Findings for Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

Evidence indicates that families liked and welcomed having the glossary available to learn about the animals. Its use supported children's independent learning of signs and information about the animal's name, characteristic structures, and behaviors that resulted in their taking time to observe the animals rather than run from exhibit to exhibit. This is reflected in children's comments and in those of their parents and in observations made during the visit. Such evidence is also indicative of glossary use leading to engagement, involvement, and interest in the exhibits and to the application of skills of science process.

Research Question 3: *What terms need to be changed or added to the glossaries?*

Group members were observed looking up the following terms and not finding them: *Salamander, Poison, Tarantula, Jaguar, Cougar, Porcupine, Lynx, Yak, Lichen, Crane, Stork, Markhor, Gibbon, Hermit crab, Vernal pool.* *Lichen* is included in the signing dictionaries and has been added to the Signing Zoo Glossary (SZG).

Review of online exhibits at the New England Zoo, San Diego Zoo, National Zoo, and Miami Zoo resulted in a list of terms to consider adding to a subsequent version of the SZG. Zoo New England staff reviewed the SZG terms and categories and the list of terms to consider. *Flea* was the only term they suggested not including. They also suggested terms to include in the subsequent version. This review resulted in identification of an additional 37 terms that are included in the signing dictionaries. These have been added to the prototype SZG. It also resulted in a list of additional terms to consider incorporating into a subsequent version. Many of these were for kinds of animals that are often included in zoo exhibits.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

Evidence provided by Zoo New England staff and gathered from the exit interviews and post surveys were used to help us answer this question.

Table 1f. Suggested Changes and Dissemination Strategies

Source	Suggestion
Group A	<ul style="list-style-type: none"> • Make a button that you press to have a kid signing with captions explaining what the app does and showing what each of the buttons does. If you weren't here we wouldn't know how to use it. It should be a little introduction to how to use it. • Ensure that the animals on exhibit are also in the glossary.
Group B	<p>If there was a way to search by picture that would be good. He (my son) can't read very well so I have to help him type all of those words in.</p> <ul style="list-style-type: none"> • It is an amazing product, we are so excited to be a part of testing it. It will be exciting to watch this project evolve.
Zoo New England Staff	<ul style="list-style-type: none"> • For dissemination we could have the app logo and instructions for download on our Zoo map at the entry to our nature centers. We can also promote it on our website and share the link for download so visitors planning their trip can download it ahead of time. • If, in addition, the interface was a tool for teaching biological terms then a breakdown of suggested vocabulary for different age groups would help break down the large amount of terms by reading age.

2: NATURE CENTER

Nature Center testing was done at Mass Audubon's Joppa Flats Education Center, Newburyport, MA with a school group (Group A) and at the Ecotarium in Worcester, MA with a family group (Group B). Group A included 8 Deaf high school students, 2 teachers and 2 paraprofessionals from a suburban specialized school for the Deaf. The students had a range of developmental, physical, and/or cognitive delays, Autism Spectrum Disorders, Pervasive Developmental Disorders, Cerebral Palsy, and/or other communication disorders. All of them were Deaf. Two used ASL to communicate. Several utilized devices, including eye-gaze tracking technology that converted speech to text on a mobile device and that they used to help them interpret material. To accommodate their communication and learning challenges, nature center staff were advised to use simple words and not to exceed a grade 5/6 vocabulary level. Group B included two hearing parents and one Deaf child. Participants in each group are described in Table 2a.

Table 2a. Nature Center Visitor Demographics

Group	N	Members	Age/Grade	Gender	Hearing Status	Hearing Loss	Communication Methods	Signing Proficiency
A	8	Students	17-22/9-11	6-Female 2-Male	Deaf	Moderate/ Severe	2-ASL 6-Other*	N/A
B	3	Mother	--	Female	Hearing	N/A	English/ASL	Advanced

	Father Child	-- 11	Male Female	Hearing Deaf	N/A Profound	English ASL	Survival Advanced
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*Included students that used an assistive device or technology to communicate.

Upon arrival, after being given the iPods and shown how to use the glossaries, students were split into two groups. Each group was assigned to one of two concurrent interactive sessions delivered by nature center staff. One was about “sand sampling”. The other was about “wrack-line” examination. After about 20-30 minutes they switched from one session to the other. These small group activities were followed by a whole group activity that involved viewing a narrated Power point presentation about the eagles, owls and hawks of Plumb Island. Nature center staff members then instructed students on the use of binoculars and field guides. Afterwards, they were led to a spot from which they could view the Merrimack River and salt marsh through a window. They used the binoculars to find birds and the guides to identify them.

The family group identified several exhibit areas that they wanted to visit and proceeded to explore each area. They stopped at exhibits that interested them and used the glossaries to look up terms. Results of this testing are shown in Tables 2b-f.

Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

The Observation Guide provided data for the results presented in Table 2b. The Exit Interview (Families only) and Post Visit Survey provided data for the results presented in Tables 2c and 2d.

Table 2b. Use and Integration of Terms

Nature Center				
Activity	Group	Terms Looked Up	Features Used	Integration
Wrack-Line Presentation	A	Shell, Oyster Mollusk, Wood	Alphabet List, ASL*, Illustration	Students looked up these terms as they came up as part of the presentation - or as students identified each object in the wrack-line and learned what it was.
Bird Viewing	A	Bird, Animal, Eagle	English Term and Definition	One Student reported learning the signs for “animal” and “bird” and the meaning of “bird” and “eagle” on his/her survey.
Barred Owl	B	Owl	Search, ASL, Illustration	Animal Observation. Wanted to check to see if sign was the same as the one they know/use.
Introduction	B	Nature	Search, ASL	Mother wanted to learn sign to explain which signing glossary to use.
Secrets of the Forest – Log	B	Fungus, Beetle, Bark	Search, ASL, Illustration	Identified terms on text descriptions included in the exhibit. Father and child discussed information in the glossary and what they were observing.
Secrets of the Forest - Bear	B	Larva	Search, ASL	Child learned the meaning of the term and was able to explain to her parents that the bear eats the larva.
Turtle Live Animal Display	B	Worm	Search, ASL	Practiced the sign. Discussed that turtles eat earthworms.

The Arctic Next Door: Mount Washington (Weather)	B	Wind, Hurricane	Search, ASL	Child uses information learned to answer her parents' questions as she interacts with the exhibit.
Bald Eagle	B	Eagle	Search, ASL, Illustration	Animal Observation.

*-The language noted was used for terms and definitions.

Table 2c. Perceived Value Added

Nature Center	Group	Parent/Child Teacher/Student	Group Member's Perception
	A	Student	Student looked up "shell" watched the signed term and definition and then signed to her teacher, "I like it" (pointing to the iPod).
	A	Teacher	Students could look up new words and access information via both ASL and English.
	A	Teacher	They (students) are able to access the info they want and view it again if they didn't understand.
	A	Teachers	Using the glossary made Our visit easier and more fun (3/4), Exhibits more accessible (3/4), Enhanced our visit (3/4), Enabled children's independence (1/4).
	A	Students	Using the glossary made Our visit easier and more fun (3/3), Exhibits more accessible (3/3), Enhanced our visit (N/A), Enabled independence (0/3).
	B	Child	I can see animal signs and pictures. I can see them and sign them, so it helped me. When I look up (words) and watch it (signed term and def) it helps me remember better.
	B	Parent	It helped hold my daughters interest. Last time (without the glossary) we went so quickly through the exhibit areas. My child is limited in her intellectual ability and often doesn't absorb. The glossary helps her stay, focus and learn since it is interactive.
	B	Parent	I love this because it is so much better than carrying around that big ASL book and having to turn through all of the pages to find a word!
	B	Parents	Using the glossary made Our visit easier and more fun (2/2), Exhibits more accessible (2/2), Enhanced our visit (2/2), Enabled children's independence (2/2). Children particularly liked Using the technology (2/2), Independently learning (2/2), Interactivity (2/2)

Table 2d. Use and Usability

Nature Center	Group	Parent/Child Teacher/Student	Group Member's Perception of Usability
	A	Teacher	The app relied more on English. My students are stronger in ASL than English.
	A	Teacher	For several of the students - the screen of the iPod is way too small for their fine motor skills and vision. This makes it unusable for them. They would be able to use it on a larger device like an iPad.
	A	Teachers	Easy to Use 1/4 Informative 3/4 Most Useful for Deaf/HH Children Terms in ASL (4/4), Terms in English (1/4), Definitions in ASL (2/4), Definitions in English (2/4), Voiced Definitions (1/4) Reasons for Use

		Learn signs or see terms signed (3/4), To help understand the instructions or info presented in writing (1/4) Would like to use the Glossary again during a field trip (3/4)
A	Students	Easy to Use 2/3 Informative 2/3 Most Useful for You Terms in ASL (1/3), Terms in English (1/3) Would like to use the Glossary again during a field trip (2/3)
B	Child	I used the search...[sometimes parents would help fingerspell the term while child typed in the letters to the search field].
B	Parent	I used alphabetical list (small icons were hard to click with large fingers).
B	Parents	Easy to Use 2/2 Informative 2/2 Usefulness of Glossary 2/2 (Useful), Alphabet List 2/2 (Useful), Categories 2/2 (Useful), Search 2/2 (Useful), Illustrations 2/2 (Useful) Most Useful for You Terms in ASL (2/2), Definitions in English (2/2) Most Useful for Deaf/HH Children Terms in ASL (2/2), Definitions in ASL (2/2) Reason for Use Learn signs (2/2), Learn Meaning of Terms (2/2), Learn more about what more about what the family is observing/doing (2/2) Using the Glossary throughout the entire nature center would be beneficial (2/2)

Key Findings for Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

Groups used the glossary during their visits to the exhibits in ways that met the individual needs. Those students in the school group who were able to use the glossary, used it to look up terms during presentations. They used the ASL to learn signs or see terms signed. Children in family groups used the glossary to learn more about what they were observing. Children and parents as well as students and teachers found the glossary useful, fun, and easy to use.

Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

To help us answer this question, as for the zoo, we organized our results around impact categories from the Framework for Evaluating Impacts of Informal Science Education Projects. The Observation Guide, Exit Interview and Post Visit Survey provided data for the results presented in Table 2e.

Table 2e. Learning Outcomes

Nature Center			
Impact Category	Group	Parent/Child Teacher/Student	Evidence of Impact

Awareness, Knowledge or Understanding	A	Students	<ul style="list-style-type: none"> • Use of the glossary resulted in students being able to access information in ASL and view it over and over again if they didn't understand.
		Students	<ul style="list-style-type: none"> • It helped them (students) connect ASL vocabulary with English words.
	B	Parent	<ul style="list-style-type: none"> • After we all watched the signed definition of the terms we were able to ask our child questions and better discuss what we were seeing.
		Parent	<ul style="list-style-type: none"> • Discovering the sign for current and learning about all of the different types of currents (wind, electrical, water, etc.) was interesting.
		Child	<ul style="list-style-type: none"> • I learned that in the season the bear looks for and eats the bug (larva).
Engagement	A	Students	<ul style="list-style-type: none"> • Students were excited to see their first language.
	B	Child	<ul style="list-style-type: none"> • The glossary helps child stay longer, focus and learn since it is interactive.
Skills	A	Students	<ul style="list-style-type: none"> • Observation of animals/objects (shown in the presentation) prior to and after looking up terms.
	A	Students	<ul style="list-style-type: none"> • Learning of new signs and information used to further observation and discussion (See Awareness, Knowledge or Understanding).
	B	Parents & Child	<ul style="list-style-type: none"> • Observation of animals/objects prior to and after looking up terms. • Learning of new signs and information used to further observation and discussion (See Awareness, Knowledge or Understanding).

Key Findings for Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

Evidence indicates that families and students in the school group liked and welcomed having the glossary available to learn about what they were seeing as they attended a series of staff led presentations and/or observed animals and objects that were part of the exhibits. Its use supported children’s independent learning of signs and information about specimens, artifacts and animals that they were learning about in the context of the presentations and activities, or as part of exploring exhibit areas. For the school group, it helped students who primarily communicate in ASL to “connect” ASL vocabulary with English words. For the child in the family group, it helped her to stay longer and focus as she learned more about what she was observing. It also enabled the family to have discussions about what they were learning. Those students who are unable to access information in English were excited to be able to use the glossary and see information delivered in their first language, ASL. This is reflected in children’s comments and in those of their parents and teachers and in observations made during the visit. Such evidence is also indicative of glossary use leading to engagement, involvement, and interest in the exhibits and to the application of skills of science process.

Research Question 3: *What terms need to be changed or added to the glossaries?*

Group members were observed looking up the following terms and not finding them: *Driftwood* (one student searched for and found the term *wood*), *tracks*, *carbon dioxide*, *scorpion*, *sap*, *finch*, *cardinal*, *fog*.

Review of online accessible trail guides from several Massachusetts Audubon Nature Center locations, and content from Audubon websites nationwide resulted in a list of terms to consider adding to a subsequent version of the SNCG. Additionally, staff from Joppa Flats, the Education Director from Massachusetts Audubon, and the Director of the Litzinger Road Ecology Center in St. Louis, MO reviewed the SNCG terms and categories and the list of terms to consider. They suggested terms to include in the subsequent version. This review resulted in identification of an additional 49 terms that are included in the signing dictionaries. These have been added to the prototype SNCG. It also resulted in a list of additional terms to consider incorporating into a subsequent version. Many of these were for terms likely to be encountered during a visit to a nature center while exploring trails and indoor or outdoor exhibits, as well as terms related to programs delivered by nature center staff.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

Evidence provided by those who reviewed the terms, as well as information gathered from the exit interviews and post surveys were used to help us answer this question.

Table 2f. Suggested Changes and Dissemination Strategies

Source	Suggestion
Group A	<p>Changes</p> <ul style="list-style-type: none"> • It would have been more valuable if it used QR codes to scan and see signs or if students could search by the ASL sign. • There needs to be a way to find terms other than English search. • It would be helpful if students could sign a word to look up the meaning. Some students may know the sign but not the English word, so finding the definition could be difficult. • Only use the glossaries for 1 or 2 activities because they can be distracting. • For several of the students - the screen of the iPod is way too small for their fine motor skills and vision. This makes it unusable for them. They would be able to use it on a larger device like an iPad. • Add a “zoom in” feature for low vision kids. <p>Dissemination</p> <p>Teachers</p> <ul style="list-style-type: none"> • Advertise the app in museums, schools, etc. • Advertise in Deaf Facebook groups (like ASL that!) • Social media ads, distributing flyers/info to schools and other organizations.

	<p>Massachusetts Audubon/Joppa Flats Staff</p> <ul style="list-style-type: none"> • We'll need to figure out a way to make sure our visitor services personnel know about this resource and offer it to nature center visitors who may find it useful. We could think about a placard or notice posted for visitors. • We'll need to figure out a way to make sure our visitor services personnel know about this resource and offer it to nature center visitors who may find it useful. We could think about a placard or notice posted for visitors. <p>Litzinger Road Ecology Center Staff</p> <ul style="list-style-type: none"> • From the Supply side -- Make ecology centers aware of it, perhaps promote it on their web site. From the Demand side – Be sure the deaf community knows of it, and how to ask for it. <p>Changes</p> <ul style="list-style-type: none"> • Sometimes the search feature was not functioning- screen would “freeze” - and that was frustrating having to start over and type the term in multiple times.
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3: AQUARIUM

Aquarium testing was done at the New England Aquarium Boston, MA— It included 2 families and 8 family members as described in Table 3a.

Table 3a. Aquarium Visitor Demographics

Group	N	Members	Age	Gender	Hearing Status	Hearing Loss	Communication Methods	Signing Proficiency
A	4	Mother Father Child 1 Child 2	-- -- 7 5	Female Male Male Female	Hearing Hearing Hearing Deaf with CI* and HA	N/A N/A N/A Profound	English, ASL English, ASL English, ASL English, ASL	Survival Survival Advanced Novice
B	4	Mother Father Child 1 Child 2	-- -- 9 12	Female Male Female Female	Hearing Hearing Hearing Deaf with CI* and HA	N/A N/A N/A Moderate-Severe	English English English English, ASL	No Skills Novice No Skills Superior

*CI=Cochlear Implant

Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

The Observation Guide provided data for the results presented in Table 3b. The Exit Interview and Post Visit Survey provided data for the results presented in Tables 3c and 3d.

Table 3b. Use and Integration of Terms

Aquarium				
Exhibit	Group	Terms Looked Up	Features Used	Integration
Lobby	A	Dolphin	Search, ASL, Illustration	Used as a demonstration of the App features. Family members practiced sign.
Penguins	A	Penguin, Egg	Alphabet List, ASL, English text	Penguin -parent uses sign and signed information to ask whether or not penguins can fly. Child answers. Egg- Hearing child saw a penguin egg as part of the display and wanted to look up the term.
Temperate Waters Gallery	A	Aquarium, Shellfish	Alphabet List, Search, English text, ASL; Illustration	Aquarium – Hearing child looked up the term while walking between exhibit areas. Shellfish - Animal observation. Father noticed child observing two shrimp at the bottom of the tank. Child was able to identify parts of the animal that she was observing that were described in the definition and illustration.
Staff Presentation	A	Jellyfish	Search, English text, ASL; Illustration	Animal Observation. Staff member was displaying a tube with small jellyfish in it. Father looked up the term to learn sign.
Giant Ocean Tank	A	Shark	Alphabet List, ASL, Illustration	Animal Observation.
Freshwater Gallery	A	Turtle	Alphabet List, ASL, Illustration	Animal Observation.
Top of the Giant Ocean Tank	A	Coral	Alphabet List, Search, English text, ASL; Illustration	Animal Observation. Mom signs (fingerspelled) coral and points to the coral in the tank.
Shark and Ray Touch Tank	B	Shark	Search, ASL	Animal Observation. Father looked up the term and showed the signed term and definition to the child.
Penguins	B	Penguin, Antarctic, Beach, Beak, Backbone	Alphabet List, ASL, Illustration	Father and child look up <i>penguin</i> . Child was prompted to look up the other terms based on the definition and information displayed on text panels.
Pacific Reef	B	Sand	Alphabet List, ASL	Child explains, “it is found on the sea floor” pointing to the sand in the tank that she is observing, and practices sign.
Marine Mammal Center	B	Seal, Salt Water, Ice	Alphabet List, ASL	Sitting looking at the seals in the enclosure, child looked up several terms. Some of the terms were terms within the definition of other terms that she was curious about.
Sea Jellies	B	Jellyfish	Alphabet List, ASL, Illustration	Animal observation.
Dolphin/Whale Call Interactive	B	Dolphin	Alphabet List, ASL	Used the signed term - Pointing to exhibit: “this is the sound that dolphins make”.
Yawkey Coral Reef Center	B	Coral	Alphabet List, ASL	Child saw the term <i>coral</i> on a text info panel. Animal observation – then commented that it was fingerspelled.
Outside of Touch Tank area	B	Shell	Alphabet List, ASL	Child noticed a cluster of muscles in the tank and looked up the term <i>shell</i> - she

				showed the sign to family, everyone practiced the sign
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Table 3c. Perceived Value Added

Aquarium		
Group	Parent/Child	Group Member's Perception
A	Child 2	I liked watching it.
A	Parent	Our daughter is much more engaged with fluid, thorough signing because that is her language. It's hard for us with our limited signing vocabulary to define or explain something accurately. So that's where this is helpful in a place like this. I am in this experience a lot (visiting museums, etc) and I always feel limited and it definitely helped me feel like I could help her so much more.
B	Child 2	I liked this because I know sign language and I love to learn things.
B	Parent	My daughter loves technology and it kept her focused and engaged. She could do it on her own. It's easier for my daughter to understand through sign. I thought this was very beneficial.
A&B	Parents	Using the glossary made Our visit easier and more fun (4/4), Exhibits more accessible (4/4), Enhanced our visit (4/4), Enabled children's independence (4/4). Children particularly liked Using the technology (4/4), Seeing fluid signing (2/4), Learning about the different animals (4/4), Independently learning (4/4)

Table 3d. Use and Usability

Aquarium		
Group	Parent/Child	Group Member's Perception of Usability
A	Child 2	[Parents said] child was looking mostly at the signed definitions. She really enjoyed getting that explanation. [Child said] I used Alphabet List to find terms.
A	Parent	I was either using the first letter (alphabet listing) or typing them in. A couple times I looked up terms because I wasn't sure of what the signs were. Other times I wanted to read the definition so that I could explain something.
B	Child 2	I used the ABC list. I watched signed terms and definitions. [Researcher noted that the child was watching the signing to also see how the signs that she had learned in school compare to the signing in the glossary].
B	Parent	We looked up words to learn new signs or see terms signed. We looked at terms in ASL to see what signs went with which animal.
A & B	Parents	Easy to Use 4/4 Informative 4/4 Usefulness of Glossary 4/4 (Useful), Alphabet List 2/2 (Not Sure) 2/2 (Useful), Categories 4/4 (Useful), Search 4/4 (Useful), Illustrations 4/4 (Useful) Most Useful for You Definitions in English (2/2) Terms in ASL (2/2) Most Useful for Deaf/HH Children Definitions in ASL (1/1) Terms in ASL (1/1) Most Useful for Hearing Children Definitions in English (1/1) Terms in ASL (1/1) – [Comment: to get to see the signs for each animal] Reason for Use Learn signs (4/2), Learn Meaning of Terms (2/4), Learn About Animals (4/4) Using the Glossary throughout the entire aquarium would be beneficial (4/4)

Key Findings for Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

Groups used the dictionaries during their visits to the exhibits in ways that met their individual needs. Specifically, they used the Alphabet List and Search feature to look up terms. They used ASL and/or English text to learn signs and find out about the animals they had looked up. They looked at illustrations to see that they had found the correct animal. Use of the glossary resulted in observation and discussion about animal structures and behaviors. Children and parents alike found the glossary useful, fun, and easy to use. Parents found that it provided a way for their child to learn independently, especially in situations where they were not able to sign terms or provide complete and accurate signed explanations.

Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

To help us answer this question, as for the zoo and nature center visits, we organized our results around impact categories from the Framework for Evaluating Impacts of Informal Science Education Projects³. The Observation Guide, Exit Interview and Post Visit Survey provided data for the results presented in Table 3e.

Table 3e. Learning Outcomes

Aquarium			
Impact Category	Group	Parent/Child	Evidence of Impact
Awareness, Knowledge or Understanding*	A	Child	<ul style="list-style-type: none"> • I learned about the penguin (that it doesn't fly). • The "shellfish" has claws.
	A	Parent	<ul style="list-style-type: none"> • Using the glossary gave my daughter a more in depth understanding of what we were seeing instead of relying on the sign that I know.
	A	Child	<ul style="list-style-type: none"> • I learned signs and learned about fish, shark, turtle, ocean/beach, jelly fish. • Learned that penguins "swim and live where it's cold" and sand is "found on the sea floor."
	A	Parent	<ul style="list-style-type: none"> • I learned signs for shark, shell, crab, fish, and other things.
Engagement**	A	Parent	<ul style="list-style-type: none"> • My child was much more engaged with the fluid, thorough signing [that the App provided] because that is her language. • Having it available for my child to watch was helpful so that I could engage her after and ask specific questions/discuss etc.
	B	Parent	<ul style="list-style-type: none"> • My daughter used it to learn on her own. She loves technology and it kept her focused and engaged.

Skills	A & B	Child	Observation of animals prior to and after looking up terms and/or in their comments and responses to parents' questions (See Table 3).
	A & B	Child & Parents	Learning of new signs and information used to further observation and discussion (See Awareness, Knowledge or Understanding).

Key Findings for Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

Evidence indicates that families liked and welcomed having the glossary available to learn about the animals. Its use supported children's independent learning of signs and information about the animal's name, characteristic structures, and behaviors. It was engaging for children in that it delivered information to them in their own language. It was especially helpful in decreasing the burden on parents to sign information that they may not know how to sign. This is reflected in children's comments and in those of their parents and in observations made during the visit. Such evidence is also indicative of glossary use leading to engagement, involvement, and interest in the exhibits and to the application of skills of science process.

Research Question 3: *What terms need to be changed or added to the glossaries?*

Group members were observed looking up the following terms and not finding them: *stingray, skeleton, shrimp, poison, starfish, sea turtle, scuba diver, solid, seahorse, hermit crab, and eel*. They mentioned that *aquarium* has several definitions all of which should be included.

Review of online exhibits at the New England Aquarium, Mystic Aquarium, Florida Aquarium, Monterey Bay Aquarium, and the Tennessee Aquarium resulted in a list of terms to consider adding to a subsequent version of the SAG. New England Aquarium and Mystic Aquarium staff reviewed the SAG terms and categories and the list of terms to consider. They also suggested terms to include in the subsequent version. This review resulted in identification of an additional 41 terms that are included in the signing dictionaries. These have been added to the prototype SAG. It also resulted in a list of additional terms to consider incorporating into a subsequent version. Many of these were for kinds of animals that are often included in aquarium exhibits.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

Evidence provided by New England Aquarium and Mystic Aquarium staff and information gathered from the exit interviews and post surveys were used to help us answer this question.

Table 3f. Suggested Changes and Dissemination Strategies

Source	Suggestion
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Group B included two hearing parents and one Deaf child. Group C included one hearing parent, one hearing child, and one Deaf child. Participants in each group are described in Table 2a.

Table 4a. Botanical Garden Visitor Demographics

Group	N	Members	Age	Gender	Hearing Status	Hearing Loss	Communication Methods	Signing Proficiency
A	3	Students	13-14	6-Female 2-Male	Deaf	Moderate-Severe	3-ASL	N/A
B	3	Mother Father Child	-- -- 11	Female Male Female	Hearing Hearing Deaf	N/A N/A Profound	English/ASL English ASL	Advanced Survival Advanced
C	3	Mother Child Child	-- 9 5	Female Male Male	Hearing Deaf Hearing	N/A Moderate-Severe N/A	English/ASL English/ASL English/ASL	Advanced Superior Novice

Upon arrival, after being given the iPods and shown how to use the glossaries, both the student and family groups used the garden map to identify a trail through the garden that they were interested in exploring. Each group then proceeded along the path, stopping to observe various plants, trees, animals, and other features of the garden that interested them, and used the glossaries to look up terms. Results of this testing are shown in Tables 4b-f.

Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

The Observation Guide provided data for the results presented in Table 4b. The Exit Interview (Families only) and Post Visit Survey provided data for the results presented in Tables 4c and 4d.

Table 4b. Use and Integration of Terms

Botanical Garden				
Area	Group	Terms Looked Up	Features Used	Integration
Benches at Trail Entrance/Shop	A	Caterpillar	Search, ASL*, Illustration	Student was proud that he was able to find caterpillar and see the signing. Showed the teachers/staff.
Beginning of Garden Trail	A	Fern, Spore	Search, ASL, Illustration	Teacher pointed out the fern to the student and prompted her to look up the term. Teacher turned the fern over to show spores on underside. Students also looked up the term spore.
Garden Trail	A	Squirrel	Search, ASL, Illustration	Animal Observation. Student showed researcher the screen showing the illustration of the squirrel while pointing to the area where she saw it.
Lily Pond	A	Turtle; Dragonfly	Search, ASL	Animal Observation. Students saw these animals and looked them up. Discussed the sign.

Swamp	A	Swamp	Search, ASL	Student saw the term on a sign while observing the swamp and looked it up. Discussed observations with teacher.
Trail between swamp and family area	A	Cactus	Search, ASL, Illustration	Observed cacti and then looked up the term. Discussed different “species” of cacti that all look different. Illustration shows tall cactus...the ones being observed were low to the ground and round.
First part path to Lily Pond	B	Mushroom; Mosquito	Alphabet List, ASL	Family observes a mushroom inside of a stump. Child looked up the term. Father looked up mosquito on his own.
Second part path to Lily Pond	B	Acorn; Oak	Alphabet List, ASL, English, Illustration	Child picked up an acorn and was carrying it with her along the trail. Father looked up the term and showed child the signed term and definition. For oak, looking up at a very large oak on the trail, mother points to the sign/label and prompts her child to look it up.
Lily Pond	B	Dragonfly; Lily; Butterfly; Fly; Frog	Alphabet List, ASL, Illustration	Animal and plant observation. Family members looked up terms while observing each plant or animal at the pond.
Trail between Lily Pond and Swamp	B	Moss; Fern; Fungus; Swamp	Alphabet List, ASL, Illustration	Plant Observation. Mother points out “moss” on several rocks and trees in the area. Family sees a fern and mother reads the sign/label and prompts child to look up the "common name" of the plant written below the scientific name. Father observes a mushroom on a bench along the trail. He looks it up and shows child that the term is fingerspelled. Swamp – Looked up after seeing the term on a sign. Parents pointed to the swamp.
Coastal Sand Plain Area	B	Brook; Cactus	Alphabet List, ASL, Illustration	Standing on the bridge overlooking the brook, child looks up the term. Mother points to the cactus and prompts child to look it up.
Trail between Fam Activity Area and Visitors Center	B	Hot; Erosion; Moth; Grasshopper	Alphabet List, ASL, Illustration	Father was starting to feel hot in the sunny area, looked up "hot" on his own. Looking down into the wooded area from up on the top of a hill, the family notices logs in a formation that they think are put there to stop erosion from happening. Father looked up "erosion". Looked up moth and grasshopper after observing them.
Visitors Center	C	Native	Search, ASL	Saw the term on a sign at the entrance to the garden and looked it up.
Trail to Family Activity Center	C	Oak; Bark	Search, ASL, Illustration	Observing a tree with the sign/label "Black Oak". Mother pointed to the bark on the oak tree and said, "what does the bark do?" Child looked up both terms.
Near Family Activity Center	C	Moss; Lichen	Search, ASL, Illustration	Child points to the picture on the scavenger hunt handout and says "I know

				where to find that" and then points to lichen on a tree. Mother asks, "What is it? Why don't you look it up?" After looking up lichen, mother said, "See that green stuff on that tree? It's different." Then prompts child to look up "moss."
Family Activity Center	C	Acorn	Search, ASL, Illustration	Mother said that she saw an acorn and child said that he already looked it up.
Coastal Sand Plain	C	Cactus	Search, ASL, Illustration	Mother pointed to the cacti and said, "Lets look it up?"
Swamp	C	Swamp	Search, ASL, Illustration	Observing the swamp and reading the sign. Family noticed that there was very little water in the swamp area.
End of Trail	C	Mushroom	Search, English	Child stopped and crouched down to touch the mushroom. Mother searched for the term and showed the result to child. He read the English text and remarked that he knew the sign.

*-The language noted was used for terms and definitions.

Table 4c. Perceived Value Added

Botanical Garden		
Group	Parent/Child Teacher/Student	Group Member's Perception
A	Student	Student said that while she knew most of the signs for terms she looked up, she did learn the meaning of several terms and connected them to what she was observing (such as fern and spore).
A	Teacher	I think it helped the students explore on their own.
A	Teacher	Using the glossary made Our visit easier and more fun (1/1), Exhibits more accessible (0/1), Enhanced our visit (1/1), Enabled children's independence (1/1).
A	Students	Using the glossary made Our visit easier and more fun (2/2*), Exhibits more accessible (2/2), Enhanced our visit (2/2), Enabled independence (2/2).
B	Child	I liked that I had all of those words there in the ABC list. For me to see and to do. The signs. It was easy that I could find it (a term) and click on it and see it signed. "It helps us communicate" (pointing to mother and father).
B	Parent	I loved the definitions (in ASL and English). They really helped me. Especially now that our child understands more sign. I'm a good signer but definitely not the strongest when it comes to science and I wouldn't think of those things, so I like how much she can learn with the glossary.
B	Parent	For a parent that is a novice signer, the glossary makes it possible for me to communicate about things that I enjoy, with my child.
B	Parents	It made my daughter more engaged. Typically, when we walk in the woods she doesn't take the time to look around at her surroundings. I want my daughter to learn this stuff but I just don't know how we would do this without the device/glossary.
C	Parent	The information was very thorough and appropriate for my son's age/grade level so he could learn about what he was seeing in the garden.
B and C	Parents	Using the glossary made Our visit easier and more fun (3/3), Exhibits more accessible (3/3), Enhanced our visit (3/3), Enabled children's independence (3/3). Children particularly liked Using the technology (2/2), Independently learning (2/2), Age-appropriate definitions (2/2)

* Only 2 of the 3 students that participated in the visit, completed the Follow-up student survey

Table 4d. Use and Usability

Botanical Garden		
Group	Parent/Child Teacher/Student	Group Member’s Perception of Usability
A	Teacher	Students needed more information to understand fully (beyond just the term and definition).
A	Teachers	Possible to Use with Trial and Error 1/1 Informative 1/1 Most Useful for Deaf/HH Children Definitions in ASL (1/1) Learn signs or see terms signed (1/1), To help understand the instructions or info presented in writing (1/1) Would like to use the Glossary again during a field trip (1/1)
A	Students	Ease of Use Easy to Use (1/2), Possible with Trial and Error (1/2) Informative 1/2 Most Useful for You Terms in ASL (2/2), Terms in English (1/2), Definitions in ASL (2/2) Would like to use the Glossary again during a field trip (2/2)
B	Child	I used the ABC list to find words. Mostly watched signed terms and definitions. Occasionally looked at illustrations.
B	Parent	Alphabetical list - just easy to do...find the letter it starts with and go right to the word. At times I would find the term and then share it with my child.
C	Child	It was better (on the iPad) - it was easy to see the signing. I think it was helpful because it was so big. Mostly watched the signed terms and definitions and sometimes read the English definitions.
C	Parent	My son was mostly looking at the signing, but he read the English text sometimes.
B and C	Parents	Easy to Use 3/3 Informative 3/3 Usefulness of Glossary 2/2 (Useful), Alphabet List 2/2 (Useful), Categories 2/2 (Useful), Search 1/3 (Useful) 2/3 (Never Used), Illustrations 2/2 (Useful) Most Useful for You Terms in ASL (3/3), Definitions in ASL (3/3), Definitions in English (3/3) Most Useful for Deaf/HH Children Terms in ASL (2/2), Definitions in ASL (2/2), Definitions in English (1/2) Reason for Use Learn signs (1/3), See terms signed (1/3) Learn Meaning of Terms (1/3), Learn more about what more about what the family is observing/doing (2/3) Using the Glossary throughout the entire garden would be beneficial (3/3)

Key Findings for Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

Groups used the glossary during their visits to the garden in ways that met their individual needs. Students in the school group used the glossary to look up terms related to plants, animals and insects that they observed as they explored particular areas of the garden

such as the swamp and the pond. Students in the school group and family groups used the ASL to learn signs or see terms signed and sometimes they looked up terms that they saw on signs and information labels. Children in family groups used the glossary to see terms signed, learn more about what they were observing, engage in discussions with their parents and/or learn on their own. Children and parents as well as students and teachers found the glossary useful, fun, and easy to use.

Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

To help us answer this question, as for the zoo, nature center, and aquarium visits, we organized our results around impact categories from the Framework for Evaluating Impacts of Informal Science Education Projects. The Observation Guide, Exit Interview and Post Visit Survey provided data for the results presented in Table 2e.

Table 4e. Learning Outcomes

Botanical Garden			
Impact Category	Group	Parent/Child Teacher/Student	Evidence of Impact
Awareness, Knowledge or Understanding	A	Students	<ul style="list-style-type: none"> • Students could look up single signs and definitions and get information about what they were seeing in ASL. • I learned the meanings of words such as spore, fern, and plant.
		Students	
	B	Parents	<ul style="list-style-type: none"> • It was cool to teach our daughter about how an acorn grows into an oak tree while we were observing both of those things in the garden.
		Child	<ul style="list-style-type: none"> • I learned about the “Lily” and “Butterfly”. I learned that the acorn is a nut and it’s a seed that grows into a tree that is huge! An oak tree.
C	Parent	<ul style="list-style-type: none"> • We used the glossary to learn the difference between moss and lichen and the definitions helped me to explain that to my sons while we were observing each. 	
	Child	<ul style="list-style-type: none"> • I learned the difference between moss and lichen and how they look different and can cover rocks or trees. 	
Engagement	A	Students	<ul style="list-style-type: none"> • It helped/encouraged students to explore on their own.
	B	Parents	<ul style="list-style-type: none"> • It made my daughter more engaged. Typically when we walk in the woods she doesn’t take the time to look around at her surroundings.
	C	Parent	<ul style="list-style-type: none"> • It interested him at first to look up different words. But then he wanted to explore.
Skills	A, B, and C	Students, Parents and Children	<ul style="list-style-type: none"> • Observation of plants, animals and other garden features, prior to and after looking up terms.

			<ul style="list-style-type: none"> • Learning of new information used to further observation and discussion (See Awareness, Knowledge or Understanding).
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Key Findings for Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

Evidence indicates that families and students in the school group liked and welcomed having the glossary available to learn about what they were seeing as they observed plants, animals and other features that were part of the garden. Its use supported children’s independent learning of signs and information about plants and animals that they were learning about as they walked through the garden using the trails. For the school group, it helped students to explore on their own and learn the meanings of terms that they were not familiar with. For the children in the family groups, it helped them to learn the signs for-or learn more about-the plants, insects and animals that they were observing in the garden. It also enabled the families to have discussions about what they were seeing, and/or allowed children to learn independently if they wanted to. Those students who are unable to access information in English were excited to be able to use the glossary and see information delivered in their first language, ASL. This is reflected in children’s comments and in those of their parents and teachers and in observations made during the visit. Families felt that the glossary helped their children become and stay engaged longer in exploring the outdoor setting. Such evidence is also indicative of glossary use leading to engagement, involvement, and interest in the garden and to the application of skills of science process.

Research Question 3: *What terms need to be changed or added to the glossaries?*

Group members were observed looking up the following terms and not finding them: *horticulture, bloom, and pine cone, Rhododendron, cranberry, milkweed Dragonfly, Lily pad, and limestone.*

Review of online garden glossaries and collections of terms from several Botanical Gardens and Universities such as the NY Botanical Garden Online Glossary, Calflora Botanical Names, University of Nebraska and University of Illinois Garden terms, and the Garden Guide Terms for Beginners, resulted in a list of terms to consider adding to a subsequent version of the SBGG. Additionally, staff from The Garden in the Woods in Framingham, MA and The Coastal Maine Botanical Garden in Boothbay, ME reviewed the SBGG terms and categories and the list of terms to consider. They suggested terms to include in the subsequent version. This review resulted in identification of an additional 57 terms that are included in the signing dictionaries. These have been added to the prototype SBGG. It also resulted in a list of additional terms to consider incorporating into a subsequent version. Many of these were for terms likely to be encountered during a visit to a botanical garden while exploring trails and indoor or outdoor exhibits, as well as terms related to programs delivered by garden staff.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

Evidence provided by those who reviewed the terms, as well as information gathered from the exit interviews and post surveys were used to help us answer this question.

Table 4f. Suggested Changes and Dissemination Strategies

Source	Suggestion
Group A	Changes Teacher • It would be nice if a more conceptual idea of each term was presented.
Group C	Parent • I think it would be good to have the picture on the same page as the definition. • The person signing can be too fast especially for kids. So have that slowed down. Dissemination Teacher • Continue to network with the Deaf community and include Deaf in production Coastal Maine Botanical Garden Staff • We are working on our interpretation here at CMBG, to improve the accessibility and universal comprehension for people of all abilities. We look forward to using an ASL interpreter for visual video recordings and it will be great to incorporate the new botanical signs in our efforts. Please consider us in the future for the opportunity to demonstrate the improvements in the ASL world

5: NATURAL HISTORY MUSEUM

Natural History Museum testing was done at the Harvard Museum of Natural History in Cambridge, MA. It included two families and 7 family members as described in Table 5a.

Table 5a. Natural History Museum Visitor Demographics

Group	N	Members	Age/Grade	Gender	Hearing Status	Hearing Loss	Communication Methods	Signing Proficiency
A	3	Mother Child Child	-- 9 5	Female Male Male	Hearing Deaf Hearing	N/A Moderate- Severe N/A	English/ASL English/ASL English/ASL	Advanced Superior Novice
B	4	Mother Father Child 1 Child 2	-- -- 8 5	Female Male Female Male	Deaf Deaf HH* with HA HH with HA	Profound Profound Severe Severe/Pr ofound	English, ASL English, ASL English, ASL English, ASL	Superior Superior Intermediate Intermediate

Upon arrival, after being given the iPods and shown how to use the glossaries, the family groups identified several exhibit areas that they wanted to visit and proceeded to explore each

area. They stopped at exhibits that interested them and used the glossaries to look up terms. Results of this testing are shown in Tables 5b-f.

Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

The Observation Guide provided data for the results presented in Table 5b. The Exit Interview and Post Visit Survey provided data for the results presented in Tables 5c and 5d.

Table 5b. Use and Integration of Terms

Natural History Museum				
Activity	Group	Terms Looked Up	Features Used	Integration
Cenozoic Mammals/Fossils	A	Fossil	ASL*, Illustration	Researcher was demonstrating how to use the glossary and suggested looking up the term.
Vertebrate Paleontology	A	Turtle, Paleontology, Whale	Alphabet List, ASL, English, Illustration	Looked up terms while observing artifacts or models (turtle shell and whale) or when reading text on informational panels (paleontology)
Sea Creatures in Glass	A	Jellyfish	Search, ASL, Illustration	Animal specimen observation. Mother discussed the sign with her son and they compared it to the sign that they knew.
Great Mammal Hall	A	Mammal, Arctic, Human, Goat, Tiger	Alphabet List, ASL, English, Illustration	Looked up terms while observing animal specimens, skeletons or models on display (human, goat, tiger) or when reading text on informational panels (mammal, arctic).
Marine Life	A	Shell	Search, ASL, Illustration	Mother (by herself) looked up the term shell while looking at a display case with several shells/shellfish in it.
Arthropods	B	Fossil, Beetle, Butterfly, Spider, Insect, Arthropod	Search, Alphabet List, ASL, English, Illustration	Both children explored the room individually and looked up terms while observing animal specimens, skeletons or models on display or when reading text on signs or informational panels.
Vertebrate Paleontology	B	vertebrate, dinosaur, predator, fish, reptile, carnivore	Search, Alphabet List, ASL, English, Illustration	Vertebrate-Mother asked (pointing to the word vertebrate on a sign), "Do you know what this means?" Predator - Mother asked daughter to "go and find two words that she doesn't know." This was a term on a sign at an interactive video display. Father and Son were looking at a model of a prehistoric animal that looked like a fish, and child looked up "fish" and "dinosaur." Other terms children looked up as they explored the exhibits.
Great Mammal Hall	B	mammal, monkey	Search, Alphabet List, ASL, English, Illustration	Child pointed to tiger and said, "is this a mammal?" Mother encouraged him to look it up. Both children looked up "monkey" as they viewed the specimen of the monkey.

*-The language noted was used for terms and definitions.

Table 5c. Perceived Value Added

Natural History Museum		
Group	Parent/Child Teacher/Student	Group Member's Perception
A	Child	I liked looking at the signs and I liked how it explained things to me.
A	Parent	I think it is really helpful and it is a great idea. I really love having that ASL piece. I just think it is so great to have the access for people. The definitions were helpful to describe the meaning of terms to my son.
B	Child	It has a lot of vocabulary. I enjoyed this more [visiting the museum] because I had it [the glossary]. You know, sometimes Mom and Dad don't know everything!!
B	Parents	It is great to be able to get information that sometimes is missed because of difficulty hearing. If my kids were on a field trip and an oratory presentation took place, they would be lost. This enables them to take control.
A & B	Parents	Using the glossary made Our visit easier and more fun (3/3), Exhibits more accessible (2/3), Enhanced our visit (2/3), Enabled children's independence (2/3). Children particularly liked Avatar characters (3/3), Independently learning (3/3), Definitions that enhanced learning (3/3)

Table 5d. Use and Usability

Natural History Museum		
Group	Parent/Child Teacher/Student	Group Member's Perception of Usability
A	Child	I looked mostly at the signed terms and definitions. I used the ABC order to find terms. It was a little difficult to use because the iPod is so small.
A	Parent	My son was mostly looking at the signing but he read the English text sometimes. I think having both is really helpful.
B	Child	I (Child 1) used the search feature to type in terms and then read the English definition and watched signing.
B	Child	I (Child 2) used the ABC list to find terms and then mostly watched signed terms and definitions and sometimes read English text.
B	Parent	My kids switched back and forth a lot [between ASL and English]. But a profoundly deaf person may find the visual aspect part very useful. My kids are prone to English so they primarily read the English text, but they viewed the ASL sometimes as well.
A & B	Parents	Easy to Use (2/3) Possible to Use with Trial and Error (1/3) Informative (3/3) Most Useful for Deaf/HH Children Terms in ASL (1/3), Terms in English (1/3), Definitions in ASL (1/3) Reasons for Use Learn signs or see terms signed (1/3), To help understand instructions or information presented in writing (on signs) (1/3) Would like to use the Glossary again (3/3)

Key Findings for Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

Natural History Museum —Groups used the glossary during their visits to the exhibits in ways that met their individual needs. Children in family groups used the glossary to see terms signed, learn signs for terms, and learn more about the animal specimens and artifacts that they were observing. Children and parents found the glossary useful, fun, and easy to use.

Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

To help us answer this question, as for the other venues, we organized our results around impact categories from the Framework for Evaluating Impacts of Informal Science Education Projects. The Observation Guide, Exit Interview and Post Visit Survey provided data for the results presented in Table 5e.

Table 5e. Learning Outcomes

Natural History Museum			
Impact Category	Group	Parent/Child	Evidence of Impact
Awareness, Knowledge or Understanding	A	Child	<ul style="list-style-type: none"> • I learned about what a mammal was and that turtles live in the water.
	A	Parent	<ul style="list-style-type: none"> • We learned about the characteristics of mammals and what paleontology is.
	B	Child	<ul style="list-style-type: none"> • I really liked the description that it had for "beetle." I learned what a predator is.
	B	Child	<ul style="list-style-type: none"> • I learned that a carnivore is an animal that eats other animals.
	B	Parents	<ul style="list-style-type: none"> • We learned how to explain the difference between warm and cold blooded.
Engagement	A	Child	<ul style="list-style-type: none"> • I liked that the Avatar had hearing aides. I liked looking at the signs.
	A	Parent	<ul style="list-style-type: none"> • My child enjoyed typing in the words to see them signed.
	B	Child	<ul style="list-style-type: none"> • I enjoyed this more [visiting the museum] because I had it [the glossary].
	B	Parent	<ul style="list-style-type: none"> • We encouraged the kids use the glossary to explore and learn on their own. I asked my daughter to "go find two words you don't know, look them up and then come back and tell me what they mean."
Skills	A & B	Parents & Children	<ul style="list-style-type: none"> • Observation of animal specimens, models and artifacts prior to and after looking up terms. • Learning of new signs and information used to further observation and discussion (See Awareness, Knowledge or Understanding).

Key Findings for Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

Evidence indicates that families liked and welcomed having the glossary available to learn about what they were seeing as they observed animal specimens, models and artifacts that were part of the exhibits. For the child in the family group, it helped him to learn new signs for terms and learn more about what he was observing. It also enabled the family to have discussions about what they were observing as they explored the exhibits, and supported the parent in helping her child understand unfamiliar vocabulary. This is reflected in the comments made by children and their parents and in observations made during the visit. Such evidence is also indicative of glossary use leading to engagement, involvement, and interest in the exhibits and to the application of skills of science process.

Research Question 3: *What terms need to be changed or added to the glossaries?*

Group members were observed looking up the following terms and not finding them: *dodo bird, Africa, clam, Ice Age, hummingbird, barnacle, scorpion, sting, weevil, and shrimp*. Review of maps, exhibit descriptions and other content from several Natural History Museum websites nationwide resulted in a list of terms to consider adding to a subsequent version of the SNHMG. Additionally, staff from the Harvard Museum of Natural History reviewed the SNHMG terms and categories and the list of terms to consider. They suggested terms to include in the subsequent version. This review resulted in identification of an additional 37 terms that are included in the signing dictionaries. These have been added to the prototype SNHMG. It also resulted in a list of additional terms to consider incorporating into a subsequent version. Many of these were for terms for the preserved specimens, models, or artifacts typically on display at a natural history museum, as well as terms related to educational programs delivered by museum.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

Evidence provided by those who reviewed the terms, as well as information gathered from the exit interviews and post surveys were used to help us answer this question.

Table 5f. Suggested Changes and Dissemination Strategies

Source	Suggestion
Group A	<p>Changes</p> <ul style="list-style-type: none"> • I think it would be good to have the sign for the term and the definition separated out. • I think if it [the device] was bigger he would not have got as frustrated. It was hard for him to press the buttons. It would be great if you could put it on the iPad so it would be easier for my child to use. • I think if the signing was a bit slower it would also be clearer. • Maybe add some interesting facts about animals or whatever they are seeing such as "the cheetah is the fastest animal" or "tigers live to be 100 years old" etc. • Move the illustration to fill the blank space below the

Group B	<p>definition so that you can still see the words and see everything in one frame.</p> <p>Changes</p> <ul style="list-style-type: none"> • Add the more specific (scientific) names of animals. <p>Dissemination HMNH Staff The HMNH has an “Accessibility” tab on the HMNH website. This may be a place to add information about a signing dictionary.</p> <p>Group A Create social media accounts such as twitter and Instagram to disseminate – allow for users to tag/share link or draw attention to it with a hashtag.</p>
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6: SCIENCE MUSEUM

Science museum testing was done at the Museum of Science in Boston, MA. It included two families and 9 family members as described in Table 6a.

Table 6a. Science Museum Visitor Demographics

Group	N	Members	Age/Grade	Gender	Hearing Status	Hearing Loss	Communication Methods	Signing Proficiency
A	5	Mother Father Child Child Child	-- -- 7 4 11 mo.	Female Male Male Female Male	Deaf Deaf Deaf Deaf Deaf	Profound Profound Mod-Sev Profound Profound	English/ASL ASL English/ASL English/ASL English/ASL	Superior Superior Superior Superior N/A
B	4	Mother Father Child 1 Child 2	-- -- 7 5	Female Male Male Female	Hearing Hearing Hearing Deaf with CI* and HA	N/A N/A N/A Profound	English, ASL English, ASL English, ASL English, ASL	Survival Survival Advanced Novice

Upon arrival, after being given the iPods and shown how to use the glossaries, the family groups identified several exhibit areas that they wanted to visit and proceeded to explore each area. They stopped at exhibits that interested them and used the glossaries to look up terms. Results of this testing are shown in Tables 6b-f.

Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

The Observation Guide provided data for the results presented in Table 6b. The Exit Interview and Post Visit Survey provided data for the results presented in Tables 6c and 6d.

Table 6b. Use and Integration of Terms

Science Museum				
Activity	Group	Terms Looked Up	Features Used	Integration
Mapping the World Around Us	A	Tornado, Shadow	Search, ASL, English	For both terms mother looked up the term and showed her children the signing. For tornado, the child commented that the sign that he/they use is different than the one being signed by the avatar. For shadow, the mother used the information in the definition to explain, "look it's like a dark area - you can see it under your feet."
Crocs!	A	Model	Search, ASL, English	Children asked (pointing at exhibit case), "Is the croc real?" Mother points to the sign under the croc model that says "model" and shows the word "live" with a line through it. Then she looks up the term. Mother pointed to the sign and explained. Watched signed term and def on her own.
Investigate	A	Screw, Current	Search, ASL, English	Mother interacts with the activity/exhibit, points out the word on information panel/sign and signs it to son and then looks it up. Mother explains the activity to her son using the vocabulary.
Science in the Park	A	Balance	Search, ASL, English	Mother looked up term standing at the activity.
Hall of Human Life	A	Brain, Nerve, DNA, Gene, Allergy	Search, ASL, English	For all terms: Mother looked up terms after seeing the terms on info panels or instructions, or as part of the exhibit content. For "nerve" she commented that the sign was different than what she was used to and could be a regional difference. For several terms she would use information from the definition to discuss exhibits/terms with her children.
Making Models	B	Tornado, Map	Search, ASL	For "tornado" the father looked up the term while viewing a tornado simulation, came back to the family and said, "I just learned the sign for tornado" and then demonstrated the sign to the family. For "map" the father and daughter used the glossary to look up the term while interacting with an activity. The father came back to the family and said, "We just looked up map and it signed map for us and explained what it was which was really cool!"
Math Moves	B	Submarine	Search, ASL	Mother looked up the term, watched the signed term and then confirmed that this was the sign that they use for the term.
Science in the Park	B	Balance	Search, ASL	Mother watched the signed term and then got her daughters attention and signed "balance" to her.

Table 6c. Perceived Value Added

Science Museum		
Group	Parent/Child Teacher/Student	Group Member's Perception
A	Children	We liked being able to type in the word we didn't know and look it up. We also liked that it had signing and English, as well as pictures sometimes.
A	Parent	It was nice to be able to look up terms and find out what they meant so we could find a way to explain to our Deaf kids what they meant. Learning more about terms such as "gravity" and "magnet" and trying to explain it to the kids was great.
B	Children	They liked having access to ASL and explanations for things that I [parent] cannot fully explain in my limited ASL.
B	Parent	I looked up terms to expand my vocabulary to sign to my daughter. The definitions were helpful to fully explain things in ASL.
A & B	Parents	Using the glossary made Our visit easier (2/4) and more fun (4/4), Exhibits more accessible (4/4), Enhanced our visit (4/4), Enabled children's independence (2/4). Children particularly liked Avatar characters (0/4), Independently learning (2/4), Definitions that enhanced learning (4/4), Illustrations (4/4)

Table 6d. Use and Usability

Science Museum		
Group	Parent/Child Teacher/Student	Group Member's Perception of Usability
A	Child	If you don't understand you can watch it [signed term and/or def] again and that would help.
A	Parent	The glossary itself was easy to navigate, but it was hard to understand the ASL version. Apart from a few terms that should be added, the glossary was comprehensive and had good information/examples for each word. Reading the English first helped me understand the signer better, then I could resign it.
B	Children	My [hearing] son looked up signs to sign to his sister to discuss things they were seeing and doing together. My daughter watched the explanations and used it to learn more at times.
B	Parents	Although we looked up signs to learn the terms, I would actually never use this app for this purpose. The computer generated signs lack the necessary facial expressions or explanation about how you would adjust the sign for context.
A & B	Parents	Difficult (2/4) Easy (2/4) Informative (4/4) Most Useful for Deaf/HH Children Terms in ASL (2/4), Definitions in ASL (2/4), Terms in English (2/4), Definitions in English (2/4) Reasons for Use Learn signs or see terms signed (2/4), To help children learn something new, extend their learning, or answer their questions (4/4). Would like to use the Glossary again (2/4)

Key Findings for Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

Groups used the glossary during their visits to the exhibits in ways that met their individual needs. Children in family groups used the glossary to see terms signed, learn signs for

terms, and learn more about the activities they were engaged in or the phenomena that they were observing. In one family, a hearing child looked up terms to sign to his deaf sister and discuss things they were seeing and doing together. Parents used the glossary to expand their vocabulary to sign to their child. Children and parents found the glossary useful, fun, and easy to use.

Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

To help us answer this question, as for the other venues, we organized our results around impact categories from the Framework for Evaluating Impacts of Informal Science Education Projects. The Observation Guide, Exit Interview and Post Visit Survey provided data for the results presented in Table 6e.

Table 6e. Learning Outcomes

Science Museum			
Impact Category	Group	Parent/Child	Evidence of Impact
Awareness, Knowledge or Understanding	A	Parent	<ul style="list-style-type: none"> • On several occasions I looked up a term and used what I learned from the definition to help the children understand/to explain it to them. For example "shadow" - the definition said it was a "dark area" and I was able to point that out and explain it that way.
	B	Parents	<ul style="list-style-type: none"> • I looked up "Tornado" and "Map" and it helped me to learn the sign for tornado. The signed information helped my daughter learn what a map is. • The definitions were helpful to fully explain things in ASL.
Engagement	A	Parent	<ul style="list-style-type: none"> • My children liked being able to type in words they didn't know and see them in both ASL and English.
	B	Parents	<ul style="list-style-type: none"> • Our daughter used it to learn more at times. She was more focused on engaging with the exhibits, but used the app as well.
Skills	A & B	Parents & Children	<ul style="list-style-type: none"> • Observation and interaction with exhibits prior to and after looking up terms. • Learning of new signs and information used to further observation and discussion (See Awareness, Knowledge or Understanding).

Key Findings for Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

Evidence indicates that families liked and welcomed having the glossary available to learn about what they were seeing as they observed and interacted with exhibits. For example, the children looked up words they didn't know to see them both in ASL and in English. It supported the parents in helping their children understand unfamiliar vocabulary. The mother in family A used the definitions of the terms to help the children understand the meaning of the term, for example pointing out a shadow so the children could see an actual shadow, and

understand what the sign is referring to. In family B, the father used the glossary to learn the sign for “tornado” and explain the meaning of several terms that they encountered while interacting with exhibit activities. This is reflected in the comments made by children and their parents and in observations made during the visit. Such evidence is also indicative of glossary use leading to engagement, involvement, and interest in the exhibits and to the application of skills of science process.

Research Question 3: *What terms need to be changed or added to the glossaries?*

Group members were observed looking up the following terms and not finding them: *crocodile, Watt, Sulfur, mutation, microbe, allergen, melanin, and ion, shell, grasshopper, glacier, hover, perspective, and illusion.* Review of maps, exhibit descriptions and other content from several Science Museum websites nationwide resulted in a list of terms to consider adding to a subsequent version of the SSMG. Additionally, staff from the SEE Science Center in Manchester, NH reviewed the SSMG terms and categories and the list of terms to consider. They suggested terms to include in the subsequent version. This review resulted in identification of an additional 39 terms that are included in the signing dictionaries. These have been added to the prototype SSMG. It also resulted in a list of additional terms to consider incorporating into a subsequent version. Many of these were for terms for the phenomena and science concepts on display at a science museum, as well as terms related to educational programs delivered by museum.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

Evidence provided by those who reviewed the terms, as well as information gathered from the exit interviews and post surveys were used to help us answer this question.

Table 6f. Suggested Changes and Dissemination Strategies

Source	Suggestion
Family A	<p>Changes</p> <ul style="list-style-type: none"> • I honestly believe it will have a more positive impact if the terms were signed by a live person, since both parents and kids will be able to understand it better and be more engaged. • I would like to be able to start the signing myself once the Avatar window opened up after clicking on ASL. The signing seemed to start very quickly. I just think it would be better if I could start it when I was ready. • Add more terms. It would be good if all of the words that I looked up were there.
Family B	<ul style="list-style-type: none"> • The biggest issues with the app are the interface, lack of words and especially concepts, and the app having computer generated signs. Improving the interface and expanding the words and concepts would make it more helpful. The lack of realistic signs would give me the greatest reluctance in utilizing the app.

	<p>Dissemination SEE Science Center Staff</p> <ul style="list-style-type: none"> • If you have a recognizable logo, please share it. We would be happy to put a logo and link on website, and posters at the entrance of our science center and share common social media posts. • I would suggest to try to reach potential visitors/users through disseminating your logo, social and web links to organizations that service the deaf community, library, and museum associations, the NEA and IMLS.
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Key Findings

Thirteen visitor groups, consisting of eleven family groups and two school groups, participated in the study in six informal STEM learning environments (Stone Zoo, Stoneham, MA; Mass Audubon’s Joppa Flats Education Center, Newburyport, MA; the Ecotarium in Worchester, MA; New England Aquarium Boston, MA; the Garden in the Woods in Framingham, MA; the Harvard Museum of Natural History in Cambridge, MA; and the Museum of Science in Boston, MA). Of the family groups, nine of the groups included both mother and father, and the other two included the mother and two sons. Among all eleven family groups, there were ten sons ranging in age from eleven months to nine years old, and there were ten daughters ranging in age from four to twelve years old. The ten sons included four who were deaf, two who were hard of hearing with hearing aids, and four were hearing. The ten daughters included one who was hearing, eight who were deaf, two of whom had cochlear implants with hearing aids, and two who were hard of hearing with hearing aids.

The school groups each consisted of eight students, two boys and six girls, and one group ranged in age from 17-22, and the other group’s students were 13 and 14. All the students were deaf and communicated using ASL, and in addition some of the students in the older group used assistive devices and other technology to communicate.

Key Findings for Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

The family and school groups visited six informal STEM learning environments. How did their experiences in using the handheld signing glossaries compare across these four venues? First, members of all thirteen groups used the glossary in ways that met their individual needs. For example, the students in the school group who were able to use the glossary looked up terms during the presentations at the Audubon Joppa Flats Learning Center, and the school group that visited the Garden in the Woods looked up flora and fauna they saw along the trail, and in addition looked up terms that were on the various trail signs. Parents and children used the glossary to look up terms related to the exhibits they were observing at the Stone Zoo,

Ecotarium, Aquarium, Garden in the Woods, Harvard Museum of Natural History, and the Boston Museum of Science. Observations across all eleven family groups revealed that each of the ways the glossaries provide to look up terms were used – the magnifying glass, the category lists, and the alphabet list.

The children in the family groups at each of the venues used the glossaries both to look up signs for what they were observing and to learn more the animal they had looked up. The students in the school groups used the glossary to learn signs or to see a term signed. Visitors in all thirteen groups, students, children, and parents, all agreed that the glossaries were easy to use and that they were fun and useful.

Use of the glossary for the family groups who visited the zoo and the aquarium led to discussions among the family members about animal structures and behaviors. Parents in these groups appreciated that the glossary supported their children engaging in the exhibits more independently, and that the children spent more time at each exhibit.

Key Findings for Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

To help us answer this question, we organized our results around impact categories from the Framework for Evaluating Impacts of Informal Science Education Projects, as noted in earlier and as seen in Tables 1e, 2e, 3e, 4e, 5e, and 6e in the body of the report.

With regard to the first category of the Framework, Awareness, Knowledge, or Understanding, children at the Stone Zoo used the glossary to observe the animals, looking up the animals' names, structures. The girl who visited the Ecotarium with her parents told the researcher that she learned from the glossary what bears eat. One child at the aquarium told the researcher that she learned from the glossary that penguins live where it's cold and that they swim.

With regard to the second Framework category, Engagement, all the parents told the researchers that their children were more engaged in looking at the exhibits than had been the case during other visits to similar venues. The parents attributed this to their children using the glossary to look up information about what they were seeing.

With regard to the third Framework category, skills, both the children and the parents told the research that they (both the parents and the children) had learned new signs by using the glossary.

Key Findings for Research Question 3: *What terms need to be changed or added to the glossaries?*

The researcher recorded a number of terms that the visitors tried to look up and did not find in the glossary during their visit. In addition, the staff at each of the venues suggested additional terms to add to the glossary, as did staff at a number of informal science venues across the country. The researcher also examined the websites of similar institutions to identify other terms that should be added to the glossaries. Of the terms identified by the visitors, institution staff, and the researcher's examination of websites, 37 terms to add to the zoo glossary were in the collection of signing dictionaries, and they have been added to the glossary. Similarly, 49 terms from the signing dictionaries have been added to the nature center glossary, 41 terms to the aquarium glossary, 57 terms to the botanical garden glossary, 37 terms to the natural history

glossary, and 39 terms to the science museum glossary. The development team is in the process of preparing the other terms identified, but not in any of the dictionaries, for inclusion in the glossaries.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

Visitors, parents and children both, venue staff, and staff from institutions across the country made a number of suggestions for enhancing the glossaries. Some of the suggestions applied to the glossaries themselves, for example, some wished that the signing speed could be slowed down. Other suggestions applied to the venues themselves, for example, one venue suggested that a link to the glossary download could be placed on their own website, and in addition, their newsletter could include a note about the availability of the glossary with a link embedded in the note.

This kind of dissemination has begun. The CAISE website includes links to the glossaries. Apps are available free from iTunes that can be used with iPhones, iPads, and iPods. Apps that can be used with Android devices, including phones, tablets, and other devices running Android OS 4.1 or later are available free from the Google Play Store.

Conclusion

The *Signing Glossaries for Science Exhibits* project has completed a busy and successful year with the pilot work with family and school visitors at six informal science venues. The data collected has provided answers to the four research questions.

Research Question 1: *How do visitor groups that include members who are deaf or hard of hearing integrate and use handheld signing glossaries during visits to informal STEM learning environments?*

All the visiting family groups seamlessly integrated the handheld glossaries into their visits to the several venues. The school group students used the glossary to help them understand the presentation from the nature center venue they were visiting, and the students in the school group that visited The Garden in the Woods used the glossary to learn about what they saw along the trail.

Research Question 2: *What kinds of learning outcomes are made possible with use of the glossaries?*

The data show that visitors learned new signs for animals and other artifacts in the exhibits, and that they learned basic facts about the animals in the exhibits. Parents report that their children were more engaged with the exhibits than had been the case during visits without the glossary.

Research Question 3: *What terms need to be changed or added to the glossaries?*

The development team has added 260 terms to the glossaries that were already in the signing dictionaries, and the team intends to develop the additional suggested terms to add to the glossaries.

Research Question 4: *What changes and dissemination strategies would help visitor groups that include members of our audience use the glossaries during a visit?*

The development team is modifying the glossaries to address some of the visitor concerns. The team has created a press release and is working with the TERC marketing team to use it to disseminate the glossaries. The team will also work directly with interested informal science venues across the country to offer the glossaries to visitors. As noted, the CAISE website will have links to the dictionaries. Proposals have been submitted to present the glossaries at the 2019 ASTC annual meeting and at the 2019 STEM for All video showcase. Other avenues of dissemination that emerge will be pursued

Appendix A
RESEARCH INSTRUMENTS

Observation Guide *

Behaviors & Interactions	Research Question Alignment								
<p>1. Glossary Term Use</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">Exhibit/Activity</th> <th style="width: 25%;">Looked Up</th> <th style="width: 25%;">Reason</th> <th style="width: 25%;">Used**</th> </tr> </thead> <tbody> <tr> <td style="height: 20px;"> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table> <p>**Alphabetical Look Up, Search, Category Look Up, ASL Version; English Version; ASL Definition; English Definition, Illustration, Audio</p> <p>2. Actions and/or Discussions Undertaken</p> <p>a) Read the instruction labels and decided what to do. Yes ___ No ___</p> <p>b) Read the content labels to understand the concept. Yes ___ No ___</p> <p>c) Practiced the sign. Yes ___ No ___</p> <p>d) Spoke with others in the group. Yes ___ No ___</p> <p>3. Other actions and discussions undertaken.</p> <p>*- A different sheet was used for each exhibit area visited.</p>	Exhibit/Activity	Looked Up	Reason	Used**					<p>1. Question 1 and/or 2</p> <p>2. Question 1 and/or 2</p> <p>3. Question 1 and/or 2</p>
Exhibit/Activity	Looked Up	Reason	Used**						

Exit Interview

Questions for Visitors Ages 5-12+ Who Are Deaf or Hard of Hearing	Research Question Alignment
<p>1. What do you think about using the glossary during the visit?</p> <p>2. Did you use the glossary to look up any words?</p> <ul style="list-style-type: none"> • Yes • No <p>3. Which words did you look up? Give some examples.</p> <p>4. Choose a word that you looked up and tell me why you looked it up.</p> <ul style="list-style-type: none"> • It was one of the key terms listed. • It was a word displayed on an activity panel. • It was a word I did not know. • It was a word I was asked to look up or that I helped look up. <p>4a. How did you use the glossary after you looked up this word?</p> <ul style="list-style-type: none"> • Read the English term. • Read the English definition. • Watched the term signed in ASL. • Watched the definition signed in ASL. • Looked at the illustration. • Listened to the audio. <p>4b. What did you learn from looking up that word?</p> <ul style="list-style-type: none"> • Did you learn how to sign it? • Did you learn more about its meaning? <p>5. Name any words you could not find in the glossary.</p> <p>6. Was the glossary easy to use to find what you were looking for?</p> <ul style="list-style-type: none"> • Yes • No <p>7. Did using the glossary help you?</p> <ul style="list-style-type: none"> • Yes • No <p>7a. If the glossary helped you, how did it help you? Give an example.</p> <p>8. Did you like using the glossary during the visit?</p> <ul style="list-style-type: none"> • Yes 	<p>1. Question 1</p> <p>2. Question 1</p> <p>3. Question 1</p> <p>4. Question 1 and/or 2</p> <p>4a. Question 1</p> <p>4b. Question 1 and/or 2</p> <p>5. Question 3</p> <p>6. Question 1</p> <p>7. Question 1</p> <p>7a. Question 1 and/or 2</p> <p>8. Question 1</p>

<ul style="list-style-type: none"> • No <p>9. Do you think having a glossary made the visit easier for you than if you did not have it?</p> <ul style="list-style-type: none"> • Yes • No <p>9a. If you think the glossary made your visit easier, give an example of how.</p>	<p>9. Question 1</p> <p>9a. Question 1 and/or 2</p>
Questions for Parents or Those Assuming that Role	Research Question Alignment
<p>1. What do you think about using the glossary during your visit?</p> <p>2. Tell me how you used the glossary in the exhibit areas you visited.</p> <p>3. Why did you look up terms?</p> <ul style="list-style-type: none"> • To understand written information. • To see the term signed. • To see the definition signed. • To better communicate with a child or another visitor. • To ask or answer questions. <p>4. Which features did you most frequently use?</p> <ul style="list-style-type: none"> • Read the English term. • Read the English definition. • Watched the term signed in ASL. • Watched the definition signed in ASL. • Looked at the illustration. • Listened to the audio. <p>5. How did you decide which words to look up?</p> <p>6. Give an example of an activity for which you looked up a term.</p> <p>6a. What term did you look up? [Provides data for RQ 2]</p> <p>6b. Why did you look it up?</p> <p>6c. What did you learn?</p> <p>6d. What did you do with what you learned?</p> <p>7. Were there any terms you could not find in the glossary?</p> <ul style="list-style-type: none"> • Yes • No <p>7a. Name any terms you could not find.</p> <p>8. Do you think having a glossary made the visit easier for you than if you did not have it?</p> <ul style="list-style-type: none"> • Yes • No <p>8a. If you think the glossary made your visit easier, give an example of how.</p> <p>9. What did you think about the user interface? Were you able to easily find what you were looking?</p> <p>9a. If you had difficulty using the interface, how might it be improved?</p> <p>10. Do you think it would be helpful to have the glossary during your next visit?</p> <ul style="list-style-type: none"> • Yes • No <p>10a. If so, how would you like to have the glossary made available?</p> <p>10 b. Do you think it would be helpful to have a glossary during visits to other informal STEM venues?</p> <p>11. Do you have anything further to add about use of the glossary during your visit?</p>	<p>1. Question 1 and/or 2</p> <p>2. Question 1</p> <p>3. Question 1 and/or 2</p> <p>4. Question 1</p> <p>5. Question 1</p> <p>6. Question 1</p> <p>6a. Question 1</p> <p>6b. Question 1</p> <p>6c. Question 2</p> <p>6d. Question 2</p> <p>7. Question 3</p> <p>7a. Question 3</p> <p>8. Question 1</p> <p>8a. Question 1 and/or 2</p> <p>9. Question 3</p> <p>9a. Question 3</p> <p>10. Question 4</p> <p>10a. Question 4.</p> <p>10b. Question 4</p> <p>11. Question 1, 2, 3 and/or 3.</p>

Post-Visit Survey

Questions for Parents or Those Assuming that Role	Research Question Alignment
1. How easy was it for you to use the glossary?	1. Question 1

<ul style="list-style-type: none"> • Easy • Difficult • Comments: 	
<p>2. How informative was the information in the glossary?</p> <ul style="list-style-type: none"> • Informative • Not Informative • Comments: 	2. Question 2
<p>3. How useful was the glossary during your visit?</p> <ul style="list-style-type: none"> • Useful • Not Useful • Comments: 	3. Question 1
<p>4. Rate how useful each of the following glossary features was for you as Useful. Not Useful. Not Sure. Never Used.</p> <ul style="list-style-type: none"> • Alphabet List • Key Terms • Categories • Search • ASL • English • Audio • Definitions • Illustrations 	4. Question 1
<p>5. Which of the following best describes the way your family experienced the exhibits?</p> <ol style="list-style-type: none"> a. We stayed together and explored the exhibit(s). b) We split up and explored the exhibits individually, checking in at times. c) Both a and b. d. Other (Please describe.) 	5. Question 1
<p>6. Which of the following best describes the way your family used the glossary?</p> <ol style="list-style-type: none"> a. We looked up words to learn new signs or see terms signed. b. We looked up words to learn more about science concepts. c. We/I looked up words to help others learn something new, extend their learning, or answer their questions. d. We/I looked up words to be able to ask others in our group questions about what they were observing/doing. e. Each of us used the glossary individually to look up terms. f. We/I looked up terms to learn more about or be able to talk about and explain what was happening. g. We/I looked up terms to help us/me understand instructions or written information. 	6. Question 1
<p>7. Which of the following did you find useful? (Check all that apply.)</p> <ol style="list-style-type: none"> a. Terms in ASL b. Terms in English c. Definitions in ASL d. Definitions in English e. Audio <p>Please explain your selections.</p>	7. Question 1
	8. Question 1

<p>8. Which of the following were most useful for members of your group who were deaf or hard or hearing?</p> <ul style="list-style-type: none"> a. Terms in ASL b. Terms in English c. Definitions in ASL d. Definitions in English e. Audio <p>Please explain your selections.</p>	
<p>9. Which of the following were most useful for members of your group who were hearing?</p> <ul style="list-style-type: none"> a. Terms in ASL b. Terms in English c. Definitions in ASL d. Definitions in English e. Audio f. N/A <p>Please explain your selections.</p>	9. Question 1
<p>10. Did you or members of your group use the glossary to learn new signs? If so, please list the terms that you learned to signs.</p>	10. Question 2
<p>11. Did you or members of your group use the glossary to learn the meaning of a term that you did not know or were not sure about? If so, please give example.</p>	11. Question 2
<p>12. Did you or members of your groups use the glossary to learn something about the exhibit science content that you did not know before or were not sure about? If so, please give an example.</p>	12. Question 2
<p>13. Rate how much you agree/disagree with the following as Strongly Agree. Agree. Disagree.</p> <ul style="list-style-type: none"> a. Using the glossary during the visit made it fun. b. Using the glossary during the visit made it easy to explore the exhibits. c. Using the glossary during the visit gave all of us access to exhibit content. d. Using the glossary during the visit helped all of us learn science. e. Using the glossary during the visit helped group members explore and learn on their own without instruction from an adult. 	13a-b. Question 1 13 c-e. Question 2
<p>14. Would you like to use the glossary while visiting other exhibits at this venue?</p> <ul style="list-style-type: none"> Yes No <p>If so, please give an example.</p>	14. Question 1
<p>15. Describe any difficulties you or group members had using the glossary.</p>	15. Question 1
<p>16. Give one example of how use of the glossary was valuable to you and/or members of your group during your visit.</p>	16. Question 2
<p>17. How might the glossary be improved?</p>	17. Question 3 and/or 4
<p>18. Were there terms that you wanted to look up or see signed, but did not find in the glossary?</p> <ul style="list-style-type: none"> Yes 	18. Question 3

<p>No If so, please list these terms.</p> <p>19. What did others in your group like about using the glossary?</p> <p>20. Please provide any additional comments about the value the glossaries added to your visit experience.</p>	<p>19. Question 1</p> <p>20. Question 1 and/or 2</p>
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Questions for Teachers	Research Question Alignment
<p>1. How would you rate students' ability to find info in the glossary?</p> <ul style="list-style-type: none"> • Easy • Possible with Trial and Error • Difficult <p>2. How would you rate the glossary as a resource that complements and enriches the visit?</p> <ul style="list-style-type: none"> • Valuable • Neutral • Not Valuable <p>3. How did your students use the glossary?</p> <ol style="list-style-type: none"> a. Looked up words to learn new signs or see terms signed. b. Looked up words to learn more about science and math. c. Looked up words to learn more about what was happening. d. Looked up words to be able to discuss and explain what was happening e. Looked up words to help me understand written information. f. Looked up words to hear their definition and learn what they mean, understand instructions, and/or communicate in English. <p>4. What features were most useful for students? (Check all that apply.)</p> <ol style="list-style-type: none"> a. Terms in ASL b. Terms in English c. Definitions in ASL d. Definitions in English e. Audio <p>5. Rate how much you agree/disagree with the following as Strongly Agree. Agree. Disagree.</p> <ol style="list-style-type: none"> a. Using the glossary during the visit made it fun. b. Using the glossary during the visit made it easy to explore the exhibits. c. Using the glossary during the visit helped students learn. d. Using the glossary during the visit helped students and learn on my own without instruction from an adult. <p>6. Did using the glossary accommodate students' different needs and learning styles? __Yes __No If yes, give an example.</p> <p>7. Describe the value the glossary added to a field trip visit experience in the areas of comprehending the content, communicating about a topic, and working independently.</p> <p>8. Would you like to use the glossary again if you came back to this place? Yes</p>	<p>1. Question 1</p> <p>2. Question 2</p> <p>3. Question 1</p> <p>4. Question 1</p> <p>5a-b. Question 1</p> <p>5c-d. Question 2</p> <p>6. Question 2</p> <p>7. Question 2</p> <p>8. Question 1</p>

<p>No</p> <p>If so, were there any specific areas or activities where you thought that having access to the glossary would have been particularly helpful for your students? Are there other field trip or outing locations where you think a signing glossary would be helpful?</p> <p>9. How might the glossary be improved?</p> <p>10. What suggestions do you have for helping potential users find out about the glossary?</p>	<p>9. Question 3 and/or 4</p> <p>10. Question 4</p>
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Questions for Students	Research Question Alignment
<p>1. How easy was it for you to use the glossary?</p> <ul style="list-style-type: none"> • Easy • Possible with Trial and Error • Difficult <p>2. How helpful/useful was the glossary?</p> <ul style="list-style-type: none"> • helped me a lot • helped me a little bit • didn't help me at all <p>3. How did you use the glossary?</p> <ol style="list-style-type: none"> a. I looked up words to learn new signs or see terms signed. b. I looked up words to learn more about science and math. c. I looked up words to learn more about what was happening. d. I looked up words to be able to discuss and explain what was happening e. I looked up words to help me understand written information. f. I looked up words to hear their definition and learn what they mean, understand instructions, and/or communicate in English. <p>4. What features did you use/look at? (Check all that apply.)</p> <ol style="list-style-type: none"> a. Terms in ASL b. Terms in English c. Definitions in ASL d. Definitions in English e. Audio <p>5. Rate how useful each of the following glossary features was for you as Useful. Not Useful. Not Sure. Never Used.</p> <ul style="list-style-type: none"> • Alphabet List • Categories • Illustrations <p>6. Would you like to use the glossary again if you came back to this place?</p> <p>Yes</p> <p>No</p> <p>7. Rate how much you agree/disagree with the following as Strongly Agree. Agree. Disagree.</p> <ol style="list-style-type: none"> a. Using the glossary during the visit made it fun. b. Using the glossary during the visit made it easy to explore the exhibits. c. Using the glossary during the visit helped me learn. 	<p>1. Question 1</p> <p>2. Question 2</p> <p>3. Question 1</p> <p>4. Question 1</p> <p>5. Question 1</p> <p>6. Question 1</p> <p>7a-b. Question 1</p> <p>7c-d. Question 2</p>

d. Using the glossary during the visit helped me explore and learn on my own without instruction from an adult.	
8. Did you use the glossary to learn new signs? If so, please list the terms that you learned the signs for.	8. Question 2
9. Did you learn the meaning of a term that you did not know or were not sure about? If so, please give example.	9. Question 2
10. How might the glossary be improved?	10. Question 3 and/or 4

Online Feedback Form

Questions for Venue Staff Members	Research Question Alignment
1. List any terms that do not appear on either list and that you think should be included in the glossary.	1. Question 3
2. List any terms that appear on either list and that you think should not be included in the glossary.	2. Question 3
3. What suggestions do you have for improving the glossary interface? In particular, please consider how the terms are organized, the set of categories, search options, tutorials that might be added. ease of use, other items to consider.	3. Question 4
4. The prototype and subsequent versions of the glossary will be available as an app that users can download from iTunes, from signsoci.terc.edu, and from other locations for free. How might you offer the app from your site? How might visitors be made aware of and/or download the app prior to visiting your site and/or upon arrival at your site?	4. Question 4

Appendix B
VISITORS USING THE GLOSSARIES



Stone Zoo, Stoneham, MA



Joppa Flats Education Center, Newburyport, MA



Ecotarium, Worcester, MA



New England Aquarium, Boston, MA



Garden in the Woods, Framingham, MA



Museum of Science, Boston, MA



Harvard Museum of Natural History, Cambridge, MA