Evaluation Report
Shared Signing Science Pictionary Planning Project (SSSPP)
(TERC, July 2010)

The overall objective of this planning project was to examine the potential effectiveness of the Signing Science Pictionary (SSP) in increasing the ability of parents and their deaf and hard of hearing children to engage in informal science learning. To achieve this objective, research and development included four goals.

1) Design several SSP-based activities to help family members engage in informal science learning.
2) Examine the potential effectiveness of the SSP in increasing family member's signed science vocabulary.
3) Find out about the potential effectiveness of the SSP in contributing to children's informal standards-based science content knowledge.
4) Gain insight into what is and is not effective for use in shaping subsequent shared signing science projects.

Project Partners
The project represents an ongoing collaboration between TERC and Vcom3D that began almost a decade ago. Located in Cambridge, MA, TERC is internationally known for the development and implementation of innovative science, mathematics, and technology-based materials for all learners. Located in Orlando, FL, Vcom3D developed and commercialized the interactive 3D SigningAvatar® assistive technology that was used for the project. It offers the deaf and hard of hearing population engaging equal access to information delivered as written and spoken text.

TERC was responsible for the design of the research instruments, development of the SSP-based activities, and coordination and implementation of trips to a zoo, farm, and nature center located in central Massachusetts. TERC was also responsible for the collection, management, and analysis of data and the writing of a final report of findings and recommendations. Vcom3D assisted with instrument development and coordinated and implemented a trip to an aquarium located in Tampa, FL.

The Signing Science Pictionary
The Signing Science Pictionary (SSP) is a SigningAvatar®-enabled dictionary of science terms and definitions for grades K-4. The version of the SSP that was used for the project was a prototype. It included 100 animal terms, which made it ideally suited for use as an assistive tool during visits to each of the four informal settings that were the focus of the project. Families were given access to the Web-based version located at http://signsci.terc.edu so that they could use it to prepare for their visit and in conjunction with follow-up activities afterwards. They also received an iPod-based version for use during their visit. This Mobile Signing Science Pictionary (MSSP) allowed them to look up terms as they observed animals and engaged in activities associated with the exhibits.

Informal Settings Visited – Stone Zoo, Davis' Farmland, EcoTarium, Florida Aquarium

The zoo, farm, and nature center that were the focus of the project were selected for the quality of their offerings and because they are in close proximity to TERC. They were also selected because they provide a range of informal learning opportunities that promised to enable the partners to examine the potential effectiveness of the SSP in improving family-centered informal science-learning experiences. The aquarium was included for these and two additional reasons: 1) Many of the SSP terms relate to animals that live in an aquatic environment. 2) The Co-PI, who was scheduled to assist with data collection lives in the greater Tampa area, is a deaf parent and native ASL signer, and has connections to other deaf parents with deaf children in the area.

- ***Stone Zoo***, Stoneham, MA is located on a 26-acre site and includes a wide variety of animals living in their replicated environments. Highlights include flora and fauna from the Canadian north woods; small birds, mammals, and primates from around the world; animals from the Sierra Madre mountain range and the Himalayan Highlands; and the Stone Zoo Barnyard.

- ***Davis' Farmland***, Sterling, MA is dedicated to preserving our farming heritage. It offers a petting farm and a hands-on children's museum that invites children to engage in activities such as milking goats and cows. It also houses the largest sanctuary for rare and endangered species of livestock in North America.

- ***Ecotarium,*** Worcester, MA is a museum of science and nature. Each year the museum strives to offer thousands of area children unique and exciting avenues for exploring science and nature inside and outside the classroom.

- ***Florida Aquarium***, Tampa, FL is recognized nationally for the quality and variety of its exhibits. It houses more than 20,000 aquatic plants and animals from Florida and around the world.

Participants

The project included 18 families with varying numbers of parent and children participants some of whom visited more than one informal setting. Of these, 10 families returned complete sets of pre-/ and post-visit data. The demographic information for these 10 families and their data are reported in the Results section (page 5).

Research Design

TERC coordinated and conducted the research in Massachusetts. They also coordinated research with the Co-PI from Vcom3D who conducted it in Florida. Major tasks included refinement of the research design, development of the research instruments, family visits to the four sites, collection and analysis of data, and completion of a report of findings.

A pre- /post-visit design that combines quantitative and qualitative methods in which the outcome of interest was measured for participants only was used to identify the potential impact

of the SSP on informal science learning, to ascertain potential vocabulary and content-related gains, and to provide insight into subsequent directions for development. Outcomes related to knowledge of science vocabulary were demonstrated by parents and children's ability to sign groups of standards-based animal terms pre-selected from the SSP. Outcomes related to science content were obtained from analysis of responses to questions related to the activities developed for use with the SSP and from analysis of samples of work produced while doing the activities. Outcomes related to users likes, dislikes, and recommendations were obtained from interviews with family members following visits, a post-use on-line survey, and email exchanges and informal conversations between researchers and family members. Observations of interactions and behaviors during visits provided additional information.

Research studies extended over the course of approximately 6 months from mid-August 2009 through February 2010. They incorporated a seven-step process that was replicated for visits to each of the four sites.

Step 1: Collecting Demographic Information - Parents used a Family Information Form to provide the researchers with logistical and technical information that included items such as the family's availability for the study and each participant's hearing status, native language, and signing ability. The table on page 5 summarizes the demographics of the study population.

Step 2: Establishing Pre-use Signed Science Vocabulary - Parents received a Pre-use Vocabulary Form for themselves and for each of their children. The form listed the names of the animals that TERC researchers had identified from the SSP as those they were most likely to see during their visit. They also received a Picture Page with pictures of the animals. Parents asked each of their children to look at the pictures of the animals and sign their names. They completed the Pre-use Vocabulary Form based on the child's responses. Parents also completed a Pre-use Vocabulary Form for themselves. They mailed the completed forms to TERC for analysis. The tables on pages 6 and 7 summarize this information for parents and children according to the site visited and overall. A sample of a Pre-use Vocabulary form is included in the Appendix.

Step 3: Establishing Effect of the SSP on Children's Pre-visit Content Knowledge — Prior to the visit and before using the SSP, children completed the three parts of Activity 1. For Part I, they described to their parents what they knew about the animals shown on the Picture Page that they would like to learn about during their visit. They also recorded their descriptions (often with the help of their parents) on an activity sheet. For Part II, parents used the movie and activities included with the Web-based SSP to become familiar with its interactive features and practice their use. For Part III, they introduced the SSP to their children. They then used the Web-based SSP together to find out about the animals the children were interested in learning about. They also helped them record what they knew on the activity sheet. The completed activity sheets were mailed to TERC for analysis. Analysis involved assigning the responses for each animal with a point for every correct fact listed about the animal prior to using the SSP. The total number of points was the child's pre-visit score for content knowledge. The child's post-use pre-visit score represented the total number of points assigned for the same animals after using the SSP. The difference between the two scores represented the change in the child's pre-visit

knowledge with use of the SSP. The tables on pages 8 and 9, grouped according to the site children were about to visit, show this change. The examples that follow each table illustrate the kinds of change that occurred. A sample activity sheet for Activity 1 is included in the Appendix.

Step 4: Finding Out About Use of the SSP During a Visit — Upon arrival, families received iPods with the SSP installed and were introduced to its use. They then used the iPod as they explored the exhibits. TERC researchers observed their behaviors and interactions and, at the conclusion of the visit, interviewed parents and children to find out about their experiences. Pictures taken during visits and highlights of their experiences are included in pages 10-11.

It is worth mentioning that Activity 2 (included in the Appendix) was developed to help families use the Pod and to learn more about the animals they were seeing. However, parents told researchers that their children wanted to go directly to the exhibits and were not interested in "wasting time" doing an activity.

Step 5: Finding Out About Children's Post-visit Content Knowledge — Following the visit, children completed Activity 3 at home using the Web-based SSP. For those who visited the zoo, nature center or aquarium, the activity was designed to help them reinforce their understanding of the animals they had observed and to communicate what they knew about two of the concepts and principles that underlie the NSES life science standard for grades K-4 – characteristics of organisms and organisms and their environments. For those children who visited the farm, it was designed to help them also communicate their understanding of the concepts and principles related to characteristics of organisms and life cycles of organisms.

 After children recorded their ideas on the activity sheet (often with the help of parents), the completed activity sheets were mailed to TERC for analysis. Analysis involved grouping the responses for each site visited according to the concept and principle addressed, examining the responses for scientific accuracy and complexity of understanding, and grouping them according to complexity of understanding. The examples on pages 12-15 are indicative of the range of children's responses. Sample activity sheets for Activity 3 (Zoo and Farm) are included in the Appendix.

Step 6: Establishing Post-use Signed Science Vocabulary — Using the same methods described in Step 2, parents and children completed a Post-use Vocabulary Form (that is the same as the Pre-use Vocabulary Form). The tables on pages 15-17 summarize this information for parents and children according to the site visited and overall.

Step 7: Collecting Information About Participants' Experiences and Recommendations — Parents completed a follow-up On-line Survey to provide the researchers with information about their experiences and about their likes, dislikes and recommendations. They also sent unsolicited email testimonials to TERC and responded to specific questions posed by TERC researchers. These comments from users are summarized by category on pages 18-21.

Results

Step 1: Demographics

The study population included 10 families with varying numbers of children some of whom were hearing. In most cases, both the father and mother participated in the project. Although more parents and children visited the sites and some families visited more than one site, not all parents sent their data to TERC. Table 1 provides demographic information for the 10 families that submitted data. In support of TERC's policy for working with human subjects, code names are used to ensure confidentiality. Each code name is comprised of a capital letter to designate the family followed by a number to designate the family member - 1 for fathers, 2 for mothers, and 3+ for children.

Table 1: Demographic Information

Family Member	Code Name	Gender	Age	Hearing Status	Signing Ability
Father	A1			Hearing	Novice
Mother	A2			Hearing	Novice
Child	A3	F	7	Deaf	Advanced
Father	B1			Hearing	Intermediate
Mother	B2			Hearing	Intermediate
Child	B3	M	8	Hearing	Novice
Child	B4	F	9	Deaf	Superior
Father	D1			Hearing	Novice
Mother	D2			Hearing	Novice
Child	D3	M	8	Hearing	No Skills
Child	D4	M	4	Hard of Hearing (HH)	Novice
Mother	E2			Hearing	Novice
Child	E3	F	7	Hard of Hearing (HH)	Intermediate
Child	E4	M	10	Hard of Hearing (HH)	Novice
Child	E5	M	9	Hearing	No Skills
Father	F1			Hearing	Survival
Mother	F2			Hearing	Survival
Child	F3	F	4	Deaf	Advanced
Father	G1			Hearing	No Skills
Mother	G2			Hearing	No Skills
Child	G3	F	10	Hearing	No Skills
Child	G4	F	9	Hearing	No Skills
Child	G5	F	6	Deaf	Novice
Father	H1			Hearing	Novice
Mother	H2			Hearing	Novice
Child	H3	F	6	Deaf	Novice
Mother	I1			Hearing	Intermediate
Child	I2	F	7	Hearing	Novice
Child	I3	F	3	Deaf	Intermediate
Father	J1			Deaf	Superior
Mother	J2			Deaf	Superior
Child	J3	F	3	Deaf	Intermediate
Father	K1			Deaf	Superior
Mother	K2			Deaf	Superior
Child	K3	F	3	Deaf	Intermediate

Step 2: Pre-use Signed Science Vocabulary

The tables below show the percent of terms children and parents who visited each site were able to sign before using the SSP.

Stone Zoo

Table 2: Children (N=4)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
A3	F	Deaf	Advanced	11	82
B3	M	Hearing	Novice	11	55
B4	F	Deaf	Superior	11	82
D4	M	HH	Novice	11	64

Table 3: Parents (N=6)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
A1	M	Hearing	Novice	11	45
A2	F	Hearing	Novice	11	45
B1	M	Hearing	Intermediate	11	55
B2	F	Hearing	Intermediate	11	82
D1	M	Hearing	Novice	11	64
D2	F	Hearing	Novice	11	64

Davis' Farmland

Table 4: Children (N=4)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
E3	F	HH	Intermediate	15	73
E4	M	HH	Novice	15	0
E5	M	Hearing	No Skills	15	0
F3	F	Deaf	Advanced	15	67

Table 5: Parents (N=3)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
E2	F	Hearing	Novice	15	0
F1	M	Hearing	Survival	15	73
F2	F	Hearing	Survival	15	60

Ecotarium

Table 6: Children (N=3)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
A3	F	Deaf	Advanced	12	100
B3	M	Hearing	Novice	12	58
B4	F	Deaf	Superior	12	100

Table 7: Parents (N=4)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
A1	M	Hearing	Novice	12	33
A2	F	Hearing	Novice	12	58
B1	M	Hearing	Intermediate	12	67
B2	F	Hearing	Intermediate	12	92

Aquarium

Table 8: Children (N=8)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
G3	F	Hearing	No Skills	15	20
G4	F	Hearing	No Skills	15	13
G5	F	Deaf	Novice	15	33
H3	F	Deaf	Novice	15	60
I2	F	Hearing	Novice	15	73
I3	F	Deaf	Intermediate	15	73
J3	F	Deaf	Intermediate	15	60
K3	F	Deaf	Intermediate	15	0

Table 9: Parents (N=9)

Code Name	Gender	Hearing Status	Signing Ability	Number of Terms Pictured	Pre-use % of Terms Able to Sign
G1	M	Hearing	No Skills	15	0
G2	F	Hearing	No Skills	15	20
H1	M	Hearing	Novice	15	47
H2	F	Hearing	Novice	15	80
I1	F	Hearing	Intermediate	15	67
J1	M	Deaf	Superior	15	100
J2	F	Deaf	Superior	15	100
K1	M	Deaf	Superior	15	93
K2	F	Deaf	Superior	15	87

Summary

The table on the next page shows the average percent of terms children and parents were able to sign before using the SSP overall and by hearing status and signing ability. These results show that overall both parents and children were able to sign about half of the terms identified before using the SSP and visiting each site. These data also show that deaf parents and children are able to sign more terms pre-visit, than parents and children who are hearing. With regard to signing ability, the data indicate that the percent of terms that participants are able to sign before their visit increases with increased signing ability.

Table 10: Pre-visit Percent of Terms Able to Sign

Children	Parents
Overall – 53%	Overall – 61%
Deaf – 66%	Deaf – 95%
Hard of Hearing – 46%	Hard of Hearing – N/A
Hearing – 37%	Hearing – 53%
No Signing Skills – 11%	No Signing Skills – 10%
Survival – N/A	Survival – 66.5%
Novice – 49%	Novice – 48%
Intermediate – 52%	Intermediate – 73%
Advanced – 83%	Advanced – N/A
Superior – 91%	Superior – 95%

Step 3: Pre-visit Content Knowledge

The tables below show that the number of facts each child knew about the animals that the child was interested in learning about during a visit increased with use of the SSP prior to the visit. The examples below each table are indicative of the kind of change that occurred.

Stone Zoo

Table 11: Children (N=5)

Code Name	Gender	Hearing Status	Signing Ability	Number of Animals	Pre-use Facts Known	Post-use Facts Known	Increase in Facts Known
A3	F	Deaf	Advanced	5	3	9	+6
B3	M	Hearing	Novice	5	0	7	+7
B4	F	Deaf	Superior	6	0	21	+21
C2	F	Deaf	Superior	7	0	8	+8
C3	M	Deaf	Intermediate	4	0	2	+2

Examples of Pre- Post-use Change
• Pre-use - *Parrots eat seeds*.
• Post-use - *Parrots live in tropical areas where the climate is hot and humid.*

• Pre-use – The child did not know any correct facts about the animals of interest.
• Post-use - *A wolf hunts in groups called packs and a young wolf is called a cub. A deer is a mammal with soft brown fur that lives in forests and fields, has four long legs, and male deer have antlers on their head."*

Davis' Farmland

Table 12: Children (N=8)

Code Name	Gender	Hearing Status	Signing Ability	Number of Animals	Pre-use Facts Known	Post-use Facts Known	Increase in Facts Known
A3	F	Deaf	Advanced	10	5	16	+11
B3	M	Hearing	Novice	5	6	10	+4
B4	F	Deaf	Superior	2	1	7	+6
D3	M	Hearing	No Skills	3	0	6	+6
D4	M	HH	Novice	3	0	14	+14
E3	F	HH	Intermediate	5	3	8	+5
E4	M	HH	Novice	10	4	32	+28
E5	M	Hearing	No Skills	5	5	15	+10

Examples of Pre- Post-use Change
• Pre-use - *A horse is a mammal. A pony lives on a farm.*
• Post –use - *A pony is a small horse.*

• Pre-use – The child did not know any correct facts about the animals of interest.
• Post –use - *A pony is small, hairy, has four legs, eats grass, and is a friendly mammal.*
   A lamb has four legs, eats grass, and we use its hair to make clothes, and we also eat its meat.

Ecotarium

Table 13: Children (N=3)

Code Name	Gender	Hearing Status	Signing Ability	Number of Animals	Pre-use Facts Known	Post-use Facts Known	Increase in Facts Known
A3	F	Deaf	Advanced	12	8	20	+12
B3	M	Hearing	Novice	10	10	22	+12
B4	F	Deaf	Superior	5	3	9	+6

Examples of Pre- Post-use Change
• Pre-use – *A polar bear lives in the Arctic.*
• Post –use - *Polar bears have long white feet that are good for swimming. They eat seals, young walruses, and fish.*

• Pre-use – *Fish like to eat bread.*
• Post –use - *Fish live in fresh or salt water.*

Aquarium

Table 14: Children (N=4)

Code Name	Gender	Hearing Status	Signing Ability	Number of Animals	Pre-use Facts Known	Post-use Facts Known	Increase in Facts Known
G3	F	Hearing	No Skills	6	18	34	+16
G4	F	Hearing	No Skills	8	19	43	+24
G5	F	Deaf	Novice	5	7	18	+11
H3	F	Deaf	Novice	5	6	13	+7

Examples of Pre- Post-use Change
• Pre-use – *Snails leave a trail of slime wherever they go. They have a spiky tongue.*
• Post –use – *A snail is a mollusk. Snails have a shell for protection and they move very slowly.*

• Pre-use – *A crocodile has rough skin and a long tail.*
• Post –use – *Crocodiles are large reptiles that live where the weather is warm.*

Step 4: The Visit

Observation of behaviors and interactions of children and parents using the SSP during visits indicate that it helps them learn individually and as a family. For example, as one family was viewing a llama exhibit and reading about its habitat and sources of food, they came across the term *lichen*. The deaf child became frustrated because she did not recognize this word. Her parents were even more frustrated because they did not know how to sign the term and could not explain what it meant. To remedy the situation, they turned to the iPod. The whole family was

able to look up the term together, learn its sign, and find out about the animal right there with the llama in full view.

During the aquarium visit, as one family was viewing the *Ocean Commotion Exhibit* and reading about its habitat and different types of animals, the daughter came across the term *jellyfish*. The deaf child was curious about how the animal functioned since she asked her parents how do they eat, sleep and move. Her parents were not sure how to explain its functionalities to their daughter. They used the iPod as a resource and were able to look up the term together, learn its meaning and the daughter was able to explain *jellyfish* to her family at the end.

An unexpected outcome was that the SSP not only increased interaction between deaf and hard of hearing children and their families but with other hearing children. For example, several deaf children went to the zoo's playground area and were using the mobile SSP to find out about animals they had seen. Their use of the iPod caught the interest of some of the hearing children playing in the playground. They came over to see what the deaf children were doing. They subsequently spent considerable time together viewing a demonstration of the avatar and reading about the animals. A mother of one of the children subsequently said that her child often struggles with any kind of social interaction with hearing children. This experience was evidence to her of the potential of devices like the SSP being vehicles that could help deaf children interact with other hearing children.

The pictures below show parents and children using the mobile SSP during their visits. The comments from parents and testimonials on pages 18-21 provide additional information about their experiences.

Figure 1. At the Stone Zoo

Figure 2. At the Stone Zoo

Figure 3. At Davis' Farmland

Figure 4. At Davis' Farmland

Figure 5. At the Ecotarium

Figure 6. At the Ecotarium

Figure 7. At the Florida Aquarium

Figure 8. At the Florida Aquarium

Step 5: Post-visit Content Knowledge

Children completed Activity 3 at home after a visit using the Web-based SSP. For those who visited the zoo, nature center, or aquarium, the activity was designed to help them reinforce their understanding of the animals they had observed and to communicate what they knew about two of the concepts and principles that underlie the NSES life science standard for grades K-4 – characteristics of organisms and organisms and their environments. For those children who visited the farm, it was designed to help them also communicate their understanding of the concepts and principles related to characteristics of organisms and life cycles of organisms. Analysis involved grouping the responses for each site visited according to the concept and principle addressed, examining the responses for scientific accuracy and complexity of understanding, and grouping them according to complexity of understanding.

The concepts and principles that are the focus of Activity 3 are listed below. These are followed by examples that are indicative of the range of children's post-visit understanding of each concept and principle. A1 designates a response that shows a less complex understanding. A2 designates a response that shows a more complex understanding.

Concept 1. The Characteristics of Organisms - NSES, Life Science, Content Standard C for Grades K-4, page 129
- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in environments in which their needs can be met. The world has many different environments, and distinct environments support the life of different types of organisms.
- Each plant or animal has different structures that serve different functions in growth, survival, and reproduction. For example, humans have distinct body structures for walking, holding, seeing, and talking.
- The behavior of individual organisms is influenced by internal cues (such as hunger) and by external cues (such as a change in the environment). Humans and other organisms have senses that help them detect internal and external cues.

Concept 1. The Characteristics of Organisms

Q: Which animals did you see at the [name of visit location]?

(Zoo) A1: bear, deer, flamingo
(Zoo) A2: bear, deer, goat, eagle, monkey, snake, leopard, cow, coyote, and flamingo

(Ecotarium) A1: snail, hawk, parrot, polar bear, owl, turtle, insect
(Ecotarium) A2: polar bear, a lot of birds, snake, frog, hawk, owl, turtle, fish, insect, parrot

(Aquarium) A1: penguins, sharks, ducks, fish, jellyfish, frogs
(Aquarium) A2: penguin, fish, jellyfish, lobster, shark, turtle, whale, stingray

(Farm) A1: cow, sheep, goat, pig
(Farm) A2: A baby chick, a big pink pig, goats, sheep, and a peacock

Q: What do you remember about what they looked like and what they were doing?

(Zoo) A1: The bears were fighting, the deer was sleeping, and the flamingo's were standing.
(Zoo) A2: The bear was hairy and mean looking. The flamingo had pink feathers. The eagle had a long beak.

(Ecotarium) A1: The parrot was talking. The polar bear was sleeping. Most of the birds were sleeping. The eagles were eating mice.
(Ecotarium) A2: There was a turtle with a long nose. It was swimming pressed up against the glass, it's nose looked like a pig.

(Aquarium) A1: The penguins were black and white and they kept trying to hide under a glass tank.
(Aquarium) A2: The penguins were small, black and white and walking around. There were so many jellyfish floating around, they looked bright in color. The shark looked mean with its sharp teeth, swimming around.

(Farm) A1: The cow was black and white. The sheep and goat were white. The pig was pink.
(Farm) A2: They were eating food from the purple cup. The peacock had blue and green feathers.

Use the SSP to find out about animal groups. Then try to answer these questions:
Note: Examples of responses from each animal category are included below. Activity 3 only included questions about the animal groups that were applicable to the animals seen at each particular location. For example, the zoo animals that were observed, and shown in the SSP could only be characterized as either birds, mammals, or reptiles.

Q: What did you learn about birds?
(Farm) A1: Birds can fly.
(Zoo) A2: They live in large groups, are different sizes, and have beaks and colorful feathers.

Q: What did you learn about mammals?
(Farm) A1: Mammals have fur.
(Zoo) A2: All mammals drink milk when they are born, some mammals eat grass, some are meat eaters, and some eat vegetables.

Q: What did you learn about reptiles?
(Aquarium) A1: They have scales and lay eggs.
(Zoo) A2: Most reptiles crawl and they are cold blooded. Reptiles lay eggs and have scales, and no fur.
Q: What did you learn about amphibians?
(Aquarium) A1: A frog is an amphibian.
(Aquarium) A2: They don't need to live in water.

Q. What did you learn about crustaceans?
(Aquarium) A1: Some live in the ocean.
(Aquarium) A2: They have big claws (lobsters and crabs).

Q. What did you learn about fish?
(Aquarium) A1: They swim in the water.
(Aquarium) A2: They live in water. That they have fins and a tail.

Q. What did you learn about mollusks?
(Aquarium) A1: Their bodies are soft like clams.
(Ecotarium) A2: Mollusks have a soft body. Clams are mollusks.

Q. Is your favorite animal a bird, mammal, reptile, amphibian, crustacean, fish, or mollusk? How do you know?
(Zoo) A1: My favorite animal is a mammal. It has fur (Animal = Leopard).
(Aquarium) A2: My favorite animal is a bird. It has a beak, wings, and feathers (Animal = Penguin)

**Concept 2. Organisms and their Environment** - NSES, Life Science Content Standard for
Grades K-4, page 129
- All animals depend on plants. Some animals eat plants for food. Other animals eat
  animals that eat the plants.
- An organism's patterns of behavior are related to the nature of that organism's
  environment, including the kinds and numbers of other organisms present, the availability
  of food and resources, and the physical characteristics of the environment. When the
  environment changes, some plants and animals survive and reproduce, and others die or
  move to new locations.
- All organisms cause changes in the environment where they live. Some of these changes
  are detrimental to the organism or other organisms, whereas others are beneficial.
- Humans depend on their natural and constructed environments. Humans change
  environments in ways that can be either beneficial or detrimental for themselves and
  other organisms.

**Concept 2. Organisms and their Environment**

Q. Think about your favorite animal. What did the animal's exhibit look like?

(Zoo) A1: (Animal = Bear) Looked like a field
(Zoo) A2: (Animal = Monkey) Trees and rope

(Ecotarium) A1: (Animal = Polar Bear) A window in front of the water and a small cave.
(Ecotarium) A2: (Animal = Eagle) A cage with a shelter, branches for them to walk and perch on, and tree stumps.

(Aquarium) A1: (Animal = Penguin) A room with a red carpet.
(Aquarium) A2: (Animal = Jellyfish) A big tank. Lots of water and fish.

Q: Do you think this is what its habitat looks like in the wild? What would be the same? What would be different?

(Zoo) A1: Yes, the long grass would be the same. There wouldn't be a fence.
(Zoo) A2: No, the zoo had a fence around and above. The trees would be the same. The jungle would have more vines.

(Ecotarium) A1: No, polar bears live in a cave in the snow. In the wild they have more room.
(Ecotarium) A2: No, there wouldn't be a metal cage, and the trees wouldn't be cut down. There are trees in the wild.

(Aquarium) A1: No. The water would be the same. There would be people, snow, and ice.
(Aquarium) A2: No. It would live where there is lots of water.

Q: Where does this animal live? Why do you think it lives there?

(Zoo) A1: In forests and fields. Because it is wild and cannot be a pet.
(Zoo) A2: Where there are trees and it is hot. To swing, climb and eat bananas.

(Ecotarium) A1: The north pole. There are polar bear caves there.
(Ecotarium) A2: It lives in the forest. So it can soar above the trees.

(Aquarium) A1: The ocean. So it can dive and eat fish.
(Aquarium) A2: No answer.

**Concept 3. Life Cycles of Organisms** - NSES, Life Science Content Standard for Grades K-4, page 129
- Plants and animals have life cycles that include being born, developing into adults, reproducing, and eventually dying. The details of this life cycle are different for different organisms.
- Plants and animals closely resemble their parents.
- Many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment. Inherited characteristics include the color of flowers and the number of limbs of an animal. Other features, such as the ability to ride a bicycle, are learned through interactions with the environment and cannot be passed on to the next generation.

**Concept 3. Life Cycles of Organisms**

Q: Did you see any baby or young animals at the farm? List the name of any animal babies that you saw.
A1: kitten
A2: kid
A3: chick
A4: baby cow

Q: Did they look the same or different than their parents? How are they the same? How are they different?
A1: They look the same but the adults are bigger.
A2: They are smaller
A3: smaller
A4: The baby cow was small but they both eat grass (adults and young).

Q: What is your favorite animal's baby called?
A1: The baby is called a kid. (Animal = goat)
[Note: only two children provided answers. Both had chosen "goat" as their favorite animal and indicated that it's baby is called a "kid."]

Step 6: Post-use Signed Science Vocabulary
      The tables below show the percent of terms children and parents who visited each site were able to sign after using the SSP prior to, during, and after a visit. It also shows the percent of terms they were able to sign before using the SSP and the change in pre- to post-use percent of terms children and parents were able to sign.

**Stone Zoo**

Table 15: Children (N=4)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
A3	F	Deaf	Advanced	82	91	+9
B3	M	Hearing	Novice	55	82	+27
B4	F	Deaf	Superior	82	100	+18
D4	M	HH	Novice	64	100	+36

Table 16: Parents (N=6)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
A1	M	Hearing	Novice	45	55	+10
A2	F	Hearing	Novice	45	73	+28
B1	M	Hearing	Intermediate	55	100	+45
B2	F	Hearing	Intermediate	82	100	+18
D1	M	Hearing	Novice	64	100	+36
D2	F	Hearing	Novice	64	100	+36

Davis' Farmland

Table 17: Children (N=4)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
E3	F	HH	Intermediate	73	100	+27
E4	M	HH	Novice	0	100	+100
E5	M	Hearing	No Skills	0	100	+100
F3	F	Deaf	Advanced	67	100	+33

Table 18: Parents (N=3)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
E2	F	Hearing	Novice	0	100	+100
F1	M	Hearing	Survival	73	100	+27
F2	F	Hearing	Survival	60	100	+40

Ecotarium

Table 19: Children (N=3)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
A3	F	Deaf	Advanced	100	100	+0
B3	M	Hearing	Novice	58	100	+42
B4	F	Deaf	Superior	100	100	+0

Table 20: Parents (N=4)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
A1	M	Hearing	Novice	33	58	+25
A2	F	Hearing	Novice	58	67	+9
B1	M	Hearing	Intermediate	67	92	+25
B2	F	Hearing	Intermediate	92	100	+8

Aquarium

Table 21: Children (N=8)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
G3	F	Hearing	No Skills	20	40	+20
G4	F	Hearing	No Skills	13	67	+54
G5	F	Deaf	Novice	33	73	+40
H3	F	Deaf	Novice	60	80	+20
I2	F	Hearing	Novice	73	86	+13
I3	F	Deaf	Intermediate	73	86	+13
J3	F	Deaf	Intermediate	60	80	+20
K3	F	Deaf	Intermediate	0	80	+80

Table 22: Parents (N=9)

Code Name	Gender	Hearing Status	Signing Ability	Pre-use % of Terms Able to Sign	Post-use % of Terms Able to Sign	Change in %
G1	M	Hearing	No Skills	0	33	+33
G2	F	Hearing	No Skills	20	73	+53
H1	M	Hearing	Novice	47	73	+26
H2	F	Hearing	Novice	80	87	+7
I1	F	Hearing	Intermediate	67	80	+13
J1	M	Deaf	Superior	100	100	+0
J2	F	Deaf	Superior	100	100	+0
K1	M	Deaf	Superior	93	93	+0
K2	F	Deaf	Superior	87	93	+6

Summary

The table below shows the average change in percent of terms children and parents were able to sign after their visit. Results show that overall the percent of terms children and parents were able to sign increased by 34% and 25%, respectively. They also show that hearing parents and children learned to sign more terms than deaf parents and children. With regard to signing ability, they indicate that the change percent of terms participants are able to sign following their visit and use of the SSP decreases with increased signing ability. Therefore, those children and parents that have little or no signing skill showed the largest gain in ability to sign the terms.

Table 23: Post-visit Change in % Percent of Terms Able to Sign

Children	Parents
Overall – +34%	Overall – +25%
Deaf – +23%	Deaf – +2%
Hard of Hearing – +54%	Hard of Hearing – N/A
Hearing – +43%	Hearing – +30%
No Signing Skills – +58%	No Signing Skills – +43%
Survival – N/A	Survival – +34%
Novice – +40%	Novice – +31%
Intermediate – +35%	Intermediate – +22%
Advanced – +14%	Advanced – N/A
Superior – +9%	Superior – +2%

Step 7: Experiences and Recommendations

The iPod Version

We really liked having the information conveniently available.

It was great to look up terms and explanations during a visit.

My son was able to it to identify animals and their names.

We were able to view the character using the signs and could go back again to see it if we needed to which was very handy for us.

Children loved using the iPods and being able to look up all of the animals and learn their signs.

Our family does not use sign language to communicate so we only used it [at the aquarium] when we wanted to learn a new sign.

The iPod was really helpful too because it showed the picture with the word. Also, the sign language helped us to understand the definition with the picture.

It was "cool" and easy to use. They [kids] liked that they could match the pictures to learn new signs.

I noticed that my daughter really liked the character in the SSP. She enjoyed positioning, cropping, and pacing the character.

The Web-based Version

Children really enjoyed looking at the Web site and taking turns learning about different animals.

Because my daughter knew how to sign most of the animals, we really benefited from having the definitions done in sign, too. It really helped us be able to explain things to her in a way we never could have without it. We loved it !!!

It was nice to be able to see the demonstration as many times as necessary.

We used it to learn the signs for the (aquarium) animals that our family didn't know.

It's very user friendly! I think it needs to expand its vocabulary and maybe use a real person with actual facial expressions as one of the options.

Learning Strategies

We learned the most by stopping at the animals and leaning the signs and then all of us going through the signs with each other. That was the most beneficial for all of us.

In terms of learning more signs, the individual animal sign sticks more when I am "in the moment" of looking at an animal or exhibit. I want to be able to sign it to or with my daughter. When I didn't know a sign but wanted to learn one, it was very motivating. My husband also benefited more from doing it that way. Honestly he rarely went on the Web site, because he is paranoid about using the computer. He hates the computer. So the iPod was the way to go for him because he was less intimidated.

Doing the activities was helpful. When we were home and trying to do the sheets, our daughter would look up an animal word. While we were on that word, I would keep hitting and re-hitting the main word and the different

individual words that I did not know (even just everyday words, such as *use* and *protect*).

I liked to see the definition signed. Our daughter who is learning to read just wanted to read it. However knowing her comprehension issues around reading, I liked having her watch the definition with me to really reinforce its meaning and to help with her comprehension. It was helpful for me, too, to learn more about the grammatical structure of ASL signing while watching the avatar.

I used the Web site to learn a lot more than just how to sign science terms and animal names. This is a huge plus for me, as a hearing parent. While it is great and important to learn to sign science terms, when helping our daughter with homework or conversing with her, it is equally important to learn everything I can about ASL, including the grammatical structure of the language and how to sign everyday words as well as new science words.

We mostly learned signs we didn't know from our daughter who is our resident expert. Our hearing son learned any signs he didn't know from the SSP.

The SSP was helpful in its description of the animals and their specific groups. The kids would often linked off to the sites provided to gather additional information.

I learned the signs by working with my daughter with the activities before and after the visit to the aquarium.

I learned by helping my children complete the activities and trying to figure the program out before doing the activities.

Recommendations and Suggestions for Improvement

One challenge was trying to sign while holding the Ipod. We often had to pass it off to another family member, in order to sign. We need a strap or carrying case for the iPod to make signing easier while using the device.

The SSP needs more pictures for those that don't have them. Also, it does not have some of the words from the aquarium, but it has different animals [not seen at the aquarium].

A suggestion is to incorporate voice. For example, if you hit a button, next to ASL/ESL marked English, Spanish, you could hear the name or description spoken. Improving our signing skills is a top priority and most deaf people don't need the voice. Although a typical hearing four year old (sibling of a deaf child) will be excited to learn the sign names for animals, the description in sign may be too much initially for a child that cannot yet read. They could listen to the description, if an adult is not available to read it to them. Also for some deaf children with cochlear implants, like my daughter, we are working on both sign and spoken English. She could practice her listening skills, while having the signed language support even if she switches over to exact signed language. Many deaf babies/toddlers start off with sign language before their implant surgery and many continue to use it as they are developing their spoken English with sign language being a sort of a bridge to spoken language. So, it is worth at least, considering the possibility of adding a voice over to it.

I would like to see an option for voice to be added to program. Our child has a cochlear implant and is just learning to listen with it. While she might still prefer the signing, it may also be motivating for her to practice listening skills while having sign support. Also for hearing young children, who cannot read yet, it would be nice to have a verbal explanation to go along with the signs.

Perhaps adding a writing notepad so hearing parents can write quick explanation notes to their deaf children without disturbing the presentations.

Make the iPod bigger and expand the options to learn about the animals that they want to know more about. (What they eat, their habitat, etc.) My kids would like to have seen texting available between all the devices being used so they could communicate with each other through it.

Find a way to extend battery life. The iPod keeps turning off when you don't use it for a while. Battery life was not enough for the entire visit.

I cannot remember if it also has an option for text to be written in Spanish. Having a voice over in Spanish would help out with that. It would be ideal to have a written Spanish text option.

The paperwork was challenging for my children because they felt it was like homework and I believe it took some of the "fun" out of it for them. They really enjoyed looking at the Web site and taking turns learning about different animals. They loved using the iPods and being able to look up all the animals as well as others and learning their signs.

Terms to Add

Zoo: cougar, coyote, crane, falcon, gila monster, hornbill, jaguar, llama, lynx, meerkat, porcupine, sloth, roadrunner, tern, yak

Farm: ferret, alpaca, emu

Ecotarium: chinchilla, cockroach, pheasant, millipede, bearded dragon, oppossum

Aquarium: starfish, stingray, horse-shoe crab

Testimonials

I think this whole system is fantastic for kids that are deaf and hard of hearing.

TERC may be looking to improve the science and math vocabulary of hearing parents and deaf children; however this tool is doing a whole lot more, in my opinion. When you use a term, such as weather, you need to learn where to place it in a sentence. ASL structure is unlike English – I've heard it is more like Spanish or French in terms of word placement. When a deaf child's primary language is ASL, the child needs lots of exposure to correct usage of the language. She does not get that from me, because I am not fluent. Luckily she attends a school that uses ASL. But as her mom, I want to learn to be fluent so I am helping her and communicating well.

We all really enjoyed our visit to the zoo – our daughter especially. My husband goes to zoos often and I must admit, I've been opting out the last couple times. However, I truly enjoyed Saturday. For me, it was a special gift to have the handheld pictionary and be able to instantly look up animals and other information. It was a gift to be able to learn new signs and communicate more freely with our daughter. When you are a hearing parent to a deaf child and ASL is not your first language, it takes tons of energy, time and research and education to learn sign language and to be able to communicate naturally the way most parents do with their hearing children (or deaf parents with deaf children).   My heart has broken more than once over the last years when I could not instantly come up with the signs to explain something or talk about something we have seen. Being a child, our daughter does not always want to wait until we get home and I can look it up on the computer or in a signing book. That is why, whenever these pictionaries come out in Ipod (or whatever those handheld computers are called), I would love to be notified so that we can be the first in line to buy one - or two   Many thanks to you and your organization for considering the needs of families like ours and creating these programs.

We were very excited for this opportunity and hope to see more versions of this type of program. Having such programs for math or social studies would be great and so helpful. I think it would be a great tool to use while helping our daughter with her homework, too... if it was in different curriculum areas. We appreciate being given this opportunity! Thank you!"

The SSP has been valuable to my family and I because it brought us together to learn something that is important to

everyone in my family.

I think that the event [aquarium visit] was very important and informative not only for my children but other hearing kids! I did notice that there were families asking what tool I was using to educate my kids. Yes, it is very important that deaf families have tools to educate their kids. It is more important to find out about the animal/fish then knowing its pretty! I found the experience to be amazing – for my deaf daughter as well as the rest of my hearing family! Thank you for the time and the event.

Summary of Findings

Results of the Shared Signing Science Pictionary Planning Project show that the SSP is indeed effective in increasing the ability of parents and their deaf, hard of hearing, and hearing children to engage in informal science learning. As a result of their participation, parents and children increased their signing vocabulary; children demonstrated increased science content knowledge. Both parents and children thought that using the SSP enhanced their learning and overall visit experience. They described use of the SSP before, during, and after a visit as beneficial, educational, and fun.

Increased Signing Vocabulary
Results from analysis of pre-post vocabulary data indicate that using the SSP and related activities before, during, and after a visit contributes to hearing and deaf and hard of hearing children and their deaf and hearing parents learning how to sign the names of animals that they saw during a visit. All participants (parents and children) demonstrated increases in their signed science vocabulary with respect to animals identified as "likely to be seen" during a visit. The results for subgroups of participants show that deaf children increased their signing vocabulary by 23%, hearing children increased by 43%, and hard of hearing children by 54%. Deaf parents increased their signing vocabulary by 2%, while the mean increase for hearing parents was 30%.

Science Content Knowledge Gains
One of the goals of the project was to develop activities to guide children's learning of standards-based, age-appropriate science content, related to the animals that they were likely to see during their visit. Analysis of student work generated by participating children for each activity was conducted. Results show that all participating children (deaf, hard of hearing, and hearing siblings) were able to use the SSP to learn facts about the animals that they were likely to see. These facts included information about an animals characteristics (bright colored feathers, brown fur, curved beak, etc.), it's behavior (frogs eat insects, a snake moves by sliding along the ground), and/or its habitat (lives in the ocean, lives in a warm and dry climate, etc.).

Analysis of participants answers to the post-use activities show that they were able to use the Web-based SSP to review what they learned during their visit. They also show that they were able to learn more about the animals seen at each location with respect to one or more applicable standards-based science concepts, including the characteristics of animals, life cycles of organisms, and organisms and their environment.

Lessons Learned from Qualitative Data

In addition to the quantitative results described above, the project also collected qualitative data via interviews, an online feedback survey, and numerous informal email and personal conversations. Participating families provided feedback, suggestions, and anecdotes about their experiences that provided researchers and developers with valuable information about usability, and effectiveness.

Parents reported that using the SSP and related activities did indeed help them and their deaf and hard of hearing children develop visually-based ways to communicate about science and increased their access to informal science learning. It use also empowered them to engage in their children's learning, enabled them to answer their children's questions, and ultimately maximize learning opportunities during their visit(s). Specifically, these comments revealed:

- insights into how parents and children use the Web and mobile versions of the SSP.
- how parents (and hearing siblings) best "learned" signs and science content.
- which terms needed to be added to the SSP for each location
- how to improve the user SSP interface of the SSP interface to maximize learning and ease of use.

Appendix

Sample of a Pre-use Vocabulary Form

	Able to Sign
1) Cow	___ Yes ____ No
2) Calf	___ Yes ____ No
3) Bull	___ Yes ____ No
4) Hen	___ Yes ____ No
5) Rooster	___ Yes ____ No
6) Goose	___ Yes ____ No
7) Horse	___ Yes ____ No
8) Pony	___ Yes ____ No
9) Sheep	___ Yes ____ No
10) Lamb	___ Yes ____ No
11) Duck	___ Yes ____ No
12) Chicken	___ Yes ____ No
13) Turkey	___ Yes ____ No
14) Pig	___ Yes ____ No
15) Goat	___ Yes ____ No

Sample of an Activity Sheet for Activity 1: Using the SSP Before A Visit

What I Already Know	What I Know After Using the SSP
Animal 1: _____	
Animal 2: _____	
Animal 3:_____	
Animal 4:_____	

Sample of an Activity Sheet for Activity 2 – Using the SSP During a Visit

1. Find an animal you learned about before your visit.

   • Stop and watch the animal. Practice the sign for its name.

   > What does the animal look like?
   > Does it look like its picture?

   • Think about what you know about the animal.

   > What does it eat?
   > How does it move?

   • Find the name of the animal in the SSP.

   > What else did you learn about the animal?
   > What do you still wonder about?

2. Try the things you just did for another animal.

3. Use the SSP to check your signs and find out more about the animals that you see during your visit.

Sample of an Activity Sheet for Activity 3 – (Zoo) After Your Visit

Welcome back! Hope your visit to the zoo was fun! Let's find out what you learned about zoo animals. Take another look at the Zoo Animals Picture Page. Then, try to answer these questions:

> • Which animals did you see at the zoo?
> • What do you remember about what they looked like and what they were doing?
> • What was your favorite animal?

1. Find out about Animal Groups

> • What did you learn about birds?
> • What did you learn about mammals?
> • What did you learn about reptiles?
> • Is the favorite animal you picked a bird, mammal, or reptile?
> • How do you know?

2. Find out about Animal Habitats

When you visited the zoo you saw animals living in areas that are made to look like their natural habitat or home. Think about your favorite animal. Then, try to answer these questions:

> • What did the animals exhibit area look like?
> • Do you think this is what its habitat looks like in the wild?
> • What do you think might be the same?
> • What do you think might be different?

• Go to the Signing Science Pictionary (SSP) to learn more about animal habitats. Type the name of your favorite animal, or the animal that you want to learn more about in the Search box and select the magnifying glass (add picture of icon). Use the SSP like you did at the zoo to see the Avatar character sign the word and the definition. Then, try to answer these questions:

> • Where does this animal live?
> • Why do you think it lives there?

Sample of an Activity Sheet for Activity 3 (Farm)– Using the SSP After a Visit

1. Look at the Picture Page.

> Which animals did you see?
> How did they look? What were they were doing?
> What animal was your favorite?

1. Find out about Animal Groups.

> What did you learn about birds?
> What did you learn about mammals?
> Pick an animal that is a bird? How do you know?
> Pick an animal that is a mammal? How do you know?

2. Find out about Animal Babies

> Did you see a baby animal?
> What is the name of the baby animal?
> Did it look the same as its parents? Did it look different?