

Field Test Evaluation Report: School Visitors

**The Handheld Signing Math & Science Dictionaries for Deaf and Hard of Hearing
Museum Visitors Research Project**
(NSF, Grant #DRL-1008546)

TERC

by

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PROJECT DESCRIPTION

With this 3-year project, TERC and the Museum of Science (MoS) Boston are studying how family and school visitors integrate iPod Touch versions of the Signing Science Pictionary (SSP), Signing Science Dictionary (SSD), and Signing Math Dictionary (SMD) into their museum experience and the impact of dictionary use. This report focuses on school visitors.

Each dictionary includes more than 700 standards-based science or mathematics terms. The SSP (funded in part by grants from the Shapiro Family Foundation and the U. S. Department of Education, Grant #H327A080040) is intended for children ages 5-8 and grades K-4. The SSD (funded in part by grants from NEC Foundation of America, the National Science Foundation Grant [NSF] #HRD-0533057, and the U.S. Department of Education Grant #H327A060026), and the SMD (funded in part by NSF, #HRD-0833969) are for ages 9-12 and grades 5-8.

The dictionaries follow the concept of *Universal Design for Learning*¹ (UDL) developed by David Rose et al., which means that content is presented in multiple ways in order to allow the learner to select the method of presentation that best matches the ways in which (s)he learns. UDL also means that learners can choose from multiple ways to show what they have learned. Figures 1-3 provide examples of pages from the SSP that incorporate these “universally designed” features.

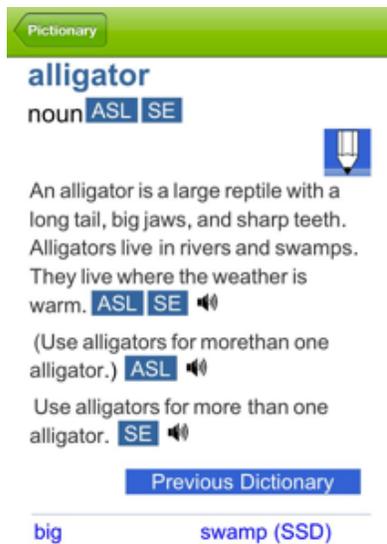


Figure 1. Term Page



Figure 2. Illustration Page



Figure 3. Signing Page

Science in the Park and *Take a Closer Look* were selected as the two exhibits at the outset of the project as the setting for our study. They were selected because: 1) They offer opportunities to accommodate the age-range of participants. 2) Many of the terms used to introduce activities and to help visitors understand their meaning are included in one or more of the dictionaries. 3) They offer opportunities to find out about use of the dictionaries with visitors of varying levels of hearing loss, reading ability, and STEM knowledge. 4) They focus on visual learning, incorporate text that is clear and concise, and include activities of varying difficulty.

¹ Rose, D.H., & Meyer, A. (2002). *Teaching every student in the digital age. Universal design for learning*. Alexandria, VA: Association for Supervision and Curriculum Development.

OBJECTIVES and GOALS

The objectives of the project as they relate to school visitors are twofold: 1) to study how school visitors integrate iPod Touch versions of the Signing Science Pictionary (SSP), Signing Science Dictionary (SSD), and Signing Math Dictionary (SMD) into their museum experience; and 2) to study what kinds of learning are made possible with use of the dictionaries and their impact on the museum experience. The goals of the evaluation as they relate to school visitors are to collect data to answer two primary research questions:

- 1) How do visitors, in grades K-8+ who are deaf or hard of hearing, integrate handheld dictionaries into their museum learning experience during school visits?
- 2) What kinds of learning are made possible with use of the dictionaries and how do they affect the engagement, involvement and interest of visitors, in grades K-8+ who are deaf or hard of hearing, during school visits?

METHODOLOGY

Analysis of our Pilot Test data informed our design of the methodology used for the Field Test². The Field Test used a mixed methods design that integrated quantitative and qualitative methods. The research team collected data from groups of school visitors before they visited the Museum, during their visit to the Museum exhibits, and after their visit. These data included surveys with fixed-response and open response items, observations, and activity sheets. The data sources provided a robust data set to support an analysis that was intended to answer our research questions.

DATA COLLECTION PROTOCOLS

Pre-visit Protocols. Prior to visiting the museum, school group leaders completed a *Site Data Form*. It provided demographic information about each student and about factors such as their hearing level, signing ability, grade level, and academic ability. It also provided a description of the science content students would be studying in class at the time of the visit. The Site Data Form is included in the Appendix.

A day or two prior to the visit, the lead researcher from TERC visited the school to introduce students to use of the dictionaries' interactive UDL features and to show them and explain use of the activity sheets that would be distributed to them when they met at the museum. Discussion between the school leader who would accompany students during the visit and the TERC researcher prior to the visit provided insight into the group's needs.

Visit Protocols. The research team affixed Word Lists to some of the activities in each exhibit prior to each visit. We had confirmed during our field test with families (Vesel, Nave, Robillard 2014) that having this information available in this way enabled visitors to immediately identify key terms that were important for doing the activity and for understanding its underlying content.

² Vesel, J., Nave B. & Robillard, T. (2014). *Evaluation report: The Handheld Signing Math & Science Dictionaries for Deaf and Hard of Hearing Museum Visitors Research Project. Field Test Evaluation Report: Family Visitors*. Unpublished report. Posted at http://signsci.test.terc.edu/MoS_SMSD/reports/index.htm

As was the case for family visitors, the Word Lists had the name of the activity at the top followed by: 1) A list of terms that are in at least one of the dictionaries and are related to the activity. 2) A three-letter abbreviation (SSP, SSD, or SMD) to signify the dictionary in which the term could be found. 3) An illustration to help clarify the term's meaning. For *Science in the Park*, Word Lists were placed on the activity panels for *Swing*, *Race*, *Spin*, *Big See Saw*, *Jump*, *Slide and Turn*. For *Take a Closer Look*, Word Lists were placed on the panels for *How Long Is A Minute?*, *Light in the Darkness*, *Vibration Patterns*, *Vibration Sensation*, *Seeing Heat*, *Hot or Cold?*, and *Seeing a Sound Wave*. Figure 4 provides an example of a Word List.

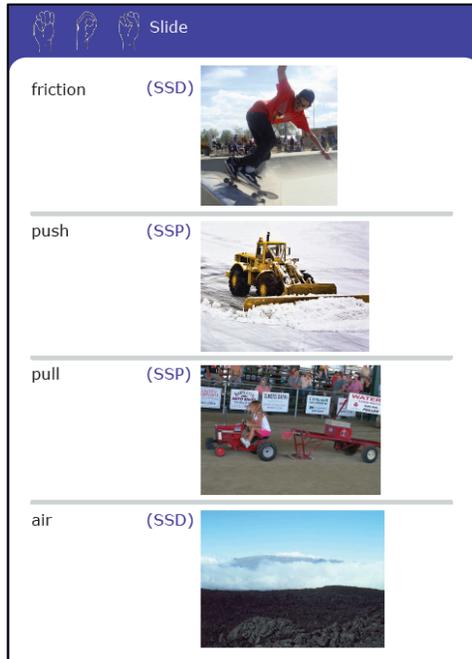


Figure 4. Word List Posted on the Activity Panel for Slide

Prior to the visit, based on information from the Site Data Form and discussion with the leader, the TERC researcher assigned groups to *Science in the Park* or *Take a Closer Look*. On the day of the visit, groups met at the entrance to the exhibit assigned to them. Each group was then divided into subgroups of two or three students, depending on the size of the group. Teachers and other adults who participated in the visit distributed themselves among the subgroups to provide support, as required. Each subgroup was given an iPod with the dictionaries loaded onto it, a clipboard with an activity sheet attached to it, and pencils for writing. The researcher explained that seven of the activities had Word Lists posted on the activity panels. These included important words that they could look up to help them talk about and do the activity. The researcher instructed the students to use the dictionaries to look up words and to use the activity sheets to record their information. The activity sheets asked students to record such things as the words they looked up and what they did or what they learned. One side of the sheet was reserved for recording information about activities with Word Lists. The other side was to be used for activities without Word Lists. An example of the Student Activity Sheet is included in the Appendix.

As we had previously confirmed the value of the Word Lists during our field test with families, it was not necessary to implement the random assignment process that we used with

them to make this determination. Instead, we asked students to do as many activities with Word Lists as they could. We also encouraged them to do the activities without Word Lists that were of interest. Each group’s visit lasted for approximately one hour. During this time, researchers observed the student subgroups, recording their observations on an Observation Log that was identical to the one used for family visitors. A member of the research team also videotaped the visit.

Post-visit Protocols. We did not conduct exit interviews with the school groups as the size of the groups and students’ high activity level precluded obtaining information that was accurate and detailed enough to be useful. Instead, we reconvened the group at the original meeting place and gave the teacher an envelope containing a *Follow-Up Survey for Teachers* and a *Follow-Up Survey for Students*. They completed these surveys when they were back in school. Teachers returned the set of surveys to TERC via U.S. mail within one week of the visit. The Follow-Up Survey for Teachers and Follow-Up Survey for Students are included in the Appendix.

VISITOR DEMOGRAPHICS

Thirteen school groups participated in the Field Test. As shown in Table 1, this included 88 students ranging from Kindergarten through 11th grade. As shown in Tables 2-4, students had varying reading levels, signing skills, and degree of hearing loss. As shown in Tables 5 and 6, there was also considerable variation in the communication methods used in the schools and in the science content being studied in the classroom at the time of the visit.

Table 1. Grade Level (N=88)

Grade level	K	1	2	3	4	5	6	7	8	9	10	11
# of students	4	14	12	3	7	10	27	2	2	6	0	1

The most common grade level was grade 6. Slightly more than half of the students are in grade 5 and up.

Table 2. Reading Skill Level

Reading skill level	Below grade level	At grade level	Above grade level
# of students	69	17	2

Over three quarters of the students are reading below grade level, a statistic that is common for students who are deaf or hard of hearing.³

Table 3. Signing Skill Level

Signing skills	None	Novice	Survival	Intermediate	Advanced	Superior
# of students	0	3	23	29	26	7

Nearly three quarters of the students have signing skills that are intermediate or better.

³ Mitchell, R. E., & Karchmer, M. A. (2011). *Demographic and achievement characteristics of deaf and hard of hearing students*. In M. Marschark & P. E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education* (vol. 1, 2nd ed.) (pp. 18-31). New York: Oxford University Press.

Table 4. Degree of Hearing Loss

Degree of hearing loss	Mild	Moderate	Moderate-Severe	Severe	Profound
# of students	1	9	24	7	47

Table 5. Communication Methods Used At School*

Communication Method	Spoken English	American Sign Language (ASL)	Signing Exact English	Finger-spelling	Simultaneous Communication	Manually Coded English System (MCE)**	Cued Speech
# of students	34	76	4	0	15	1	1

* Students often use more than one method of communication.

** MCE includes word-for-word translations of English, represented in the dictionaries as Signed English (SE).

Table 6. Science Studied at the Time of the Visit

	Life Science*	Physical Science**	Earth and Space Science***	Not provided
# of schools	7	5	4	3

* Includes: human body; the five senses; living things; life cycles; classification; evolution

** Includes: matter; forces; simple machines; electricity and magnetism

***Includes: weather; volcanoes; solar system; space

RESULTS

Research Question 1—*How do visitors, in grades K-8+ who are deaf or hard of hearing, integrate handheld dictionaries into their museum learning experience during school visits?*

To help us answer this research question, we organized our results around the five sub-questions listed below. Results that emerged from analysis of the data for each of the sub-questions are included in the pages that follow. Results for sub-questions 1-3 are provided in Tables 7-13. Results for sub-question 4 are provided in narrative form. These results are then summarized as key findings for our first research question.

- 1) What do school groups do during their visit?
- 2) Why do student visitors use the dictionaries to look up science and math terms?
- 3) Which dictionary features do student visitors use to acquire information?
- 4) What are students and teachers' perspectives and opinions about using the dictionaries during their visit?

Sub-question 1: *What do school groups do during their visit?* —Observation data provided the evidence for these results. Additionally, students generated their own set of data about the words

they looked up on their Student Activity Sheets. These student-generated data confirm the TERC researcher’s observations.

Table 7. What Do School Groups Do at *Science in the Park* Activities *With Word Lists*?

Activity	# of Groups	Read Instructions	Read Labels	Used Word List	Terms Looked Up	Used the ASL Sign	Engaged in Discussion
Big See Saw	5	1/5, 20%	1/5, 20%	4/5, 80%	balance (2)*, lever (2), fulcrum (2), weight (2), distance, heavy, light	3/5, 60%	5/5, 100%
Jump	1	1/1, 100%	0	1/1, 100%	jump, gravity,	0	1/1, 100%
Race	5	3/5, 60%	3/5, 60%	4/5, 80%	race*, acceleration, fast (2), slow, kinetic energy, potential energy	1/5, 20%	4/5, 80%
Slide	1	0	0	1/1, 100%	friction	0	1/1, 100%
Spin	3	0	0	3/3, 100%	inertia, spin (2)	1/3, 33%	1/3, 33%
Swing	9	3/9, 33%	3/9, 33%	9/9, 100%	swing*, pendulum (7), angle (2), gravity (4), long (3), short (3), fast	3/9, 33%	8/9, 89%
Turn	2	2/2, 100%	1/2, 50%	1/3, 33%	Rotate, inertia, momentum, turn	1/2, 50%	1/2, 50%
TOTAL	26	10/26, 38%	8/26, 31%	23/26, 88%		9/26, 35%	21/26, 81%

**Term not listed on the Word List*

Table 8. What Do School Groups Do at *Science in the Park* Activities *Without Word Lists*?

Activity	# of Groups	Read Instructions	Read Labels	Used Word List	Terms Looked Up	Used the ASL Sign	Engaged in Discussion
Small Balances	2	1/2, 50%	2/2, 100%	N/A	lever, fulcrum, weight	1/2, 50%	1/2, 50%
Lift	1	1/1, 100%	1/1, 100%	N/A	lever, fulcrum	0	1/1, 100%
Run	1	0	0	N/A	run	0	0
Speed Up	1	1/1, 100%	1/1, 100%	N/A	forward	0	1/1, 100%
TOTAL	5	3/5, 60%	4/5, 80%		N/A	1/5, 20%	3/5, 60%

Table 9. What Do School Groups Do at *Take a Closer Look* Activities *With Word Lists*?**

Activity	# of Groups	Read Instructions	Read Labels	Used Word List	Terms Looked Up	Used the ASL Sign	Engaged in Discussion
Hot or Cold	7	6/7, 86%	5/7, 71%	7/7, 100%	hot (3), cold (4), nerve (4), metal, temperature (2), warm	5/7, 71%	7/7, 100%
How Long is a Minute?	3	3/3, 100%	0	3/3, 100%	sixty, second, minute (2), hour	0	1/3, 33%
Seeing Heat	4	1/4, 25%	2/4, 50%	4/4, 100%	measure*, temperature (2), visible light (4), infrared light (4), warm (2), cool (2)	2/4, 50%	4/4, 100%
Vibration Patterns	2	2/2, 100%	2/2, 100%	2/2, 100%	vibrate (2), pattern, frequency	2/2, 100%	2/2, 100%
Vibration Sensation	5	4/5, 80%	4/5, 80%	5/5, 100%	hertz (3), frequency (3)	5/5, 100%	5/5, 100%
TOTAL	21	16/21, 76%	13/21, 62%	21/21, 100%	NA	14/21, 67%	19/21, 90%

*Term not listed on the Word List

** None of the school groups visited any of the *Take a Closer Look* activities *without* Word Lists.

Sub-question 2: *Why do student visitors use the dictionaries to look up science and math terms*—Student and teacher follow-up survey data provided the evidence for the results.

From here on, tables display the data disaggregated by the grade level bands K-3, 4-6, and 7-11 (as the sample did not include a 12th grader) and in total. This disaggregation reflects differences across these grade bands that are not reflected in the aggregated dataset.

Table 10. Why do student visitors use the dictionaries to look up terms?*

Reasons for Using the Dictionary	# of K-3 Students (N=21)	# of 4-6 Students (N=34)	# of 7-11 Students (N=7)	Totals (N=62)
To learn new signs or see terms signed	19/21, 90%	16/34, 47%	5/7, 71%	40/62, 65%
To learn more about science and math	9/21, 43%	11/34, 32%	5/7, 71%	25/62, 40%
To help me understand written information	5/21, 24%	11/34, 32%	4/7, 57%	20/62, 32%
To be able to discuss and explain what was happening	6/21, 29%	10/34, 29%	3/7, 43%	19/62, 31%
To learn more about what was happening	7/21, 33%	5/34, 15%	3/7, 43%	15/62, 24%
To hear definitions and learn what terms mean	3/21, 14%	5/34, 15%	2/7, 29%	10/62, 16%
To understand the instructions	6/21, 29%	3/34, 9%	1/7, 14%	10/62, 16%
To communicate in English	2/21, 10%	5/34, 15%	1/7, 14%	8/62, 13%

*-Students could check more than one response.

Students' most frequent reason for using the dictionaries was to learn the signs for the terms that they did not know. Their second most frequent reason was to learn about the science that was the focus of the activity they were visiting.

Table 11. Why do teachers perceive student visitors use the dictionaries to look up terms?*

Reason for Using the Dictionary	# of K-3 Teachers (N=9)	# of 4-6 Teachers (N=8)	# of 7-12 Teachers (N=3)	Totals (N=20)
To learn new signs or see terms signed	6/9, 67%	4/8, 50%	2/3, 67%	12/20, 60%
To learn more about science and math concepts	2/9, 22%	2/8, 25%	1/3, 33%	5/20, 25%
To be able to discuss and explain what was happening	3/9, 33%	1/8, 13%	1/3, 33%	5/20, 25%
To help understand the instructions or information presented in writing	1/9, 11%	0	1/3, 33%	2/20, 10%
To hear terms and definitions and learn what they mean, understand instructions, and /or communicate in English	0	1/8, 13%	1/3, 33%	2/20, 10%
Combination of the above or other	0	3/8, 38%	1/3, 33%	4/20, 20%

*-Students could check more than one response.

Teachers' most frequent perception was that their students used the dictionaries to learn the signs for new terms. Their second most frequent perception was twofold: 1) Students used the dictionaries to learn more about science concepts. 2) Students used the dictionaries to be able to discuss and explain what was happening.

Teachers of older students (grades 7-12) provided additional clarification about why their students used the dictionaries. They wrote: The reading levels of the students varied a great deal. Some students used the handhelds to help read directions. Others used them for specific vocabulary.

Sub-question 3: *Which dictionary features do student visitors use to acquire information* — Student and teacher follow-up survey data provided the evidence for these results.

Table 12. Which dictionary features do students use?*

Dictionary Features Used	# of K-3 Students (N=21)	# of 4-6 Students (N=34)	# of 7-12 Students (N=7)	Total (N=62)
Terms in ASL	7/21, 33%	27/34, 79%	6/7, 86%	40/62, 65%
Terms in English	7/21, 33%	14/34, 41%	3/7, 43%	24/62, 39%
Definitions in ASL	7/21, 33%	11/34, 32%	5/7, 71%	23/62, 37%
Terms in Signed English (SE)	15/21, 71%	5/34, 15%	1/7, 14%	21/62, 34%
Definitions in English	1/21, 5%	5/34, 15%	4/7, 57%	10/62, 16%
Definitions in Signed English (SE)	2/21, 10%	2/34, 6%	1/7, 14%	5/62, 8%
Voiced Definitions	1/21, 5%	2/34, 6%	1/7, 14%	4/62, 7%

*-Students could check more than one response.

The majority of students used the feature that demonstrated the ASL sign for the term they were looking up. This supports students saying that the main reason they used the

dictionaries was to learn the signs for the new terms. More than a third also used the ASL definitions feature.

Table 13: What dictionary features do teachers perceive students use?*

Dictionary Features Used	# of K-3 Teachers (N=9)	# of 4-6 Teachers (N=8)	# of 7-12 Teachers (N=3)	Total (N=20)
Terms in ASL	6/9, 67%	7/8, 88%	3/3, 100%	16/20, 80%
Definitions in ASL	7/9, 78%	6/8, 75%	3/3, 100%	16/20, 80%
Definitions in English	1/9, 11%	4/8, 50%	0	5/20, 25%
Terms in Signed English	2/9, 22%	2/8, 25%	0	4/20, 20%
Definitions in Signed English	2/9, 22%	1/8, 13%	0	3/20, 15%
Terms in English	1/9, 11%	2/8, 25%	0	3/20, 15%
Voiced Definitions	0	2/8, 25%	0	2/20, 10%

*-Students could check more than one response.

All but four of the teachers indicated their students used the ASL term and definition features. Teachers of the K-3 group provided additional detail: My students are bilingual and being exposed to both ASL and English is beneficial. [I] used definitions in ASL for deaf students and voiced definitions for the hard of hearing students. Some students only looked at signs for terms and pictures, while others watched definitions. We were able to match the students' levels with which words they selected to look up and with what they viewed (signed term, picture, signed definition) once they found the word.

Teachers of the grade 4-6 group commented on how their versatility made the dictionaries valuable: Depending on students' level of reading they used the dictionaries differently. A student with 3rd grade reading skills used the written definitions for understanding information. On grade level readers could read the text; lower [level] readers depended on the signing/pictures. Students with strong academic skills could use the written information.

One of the teachers of the grade 7-12 group commented on the importance of presenting terms in ASL: ASL is their native/first language. This visual language is the most clear for them to understand information.

Sub-question 4: *What are students' and teachers' perspectives and opinions about using the dictionaries during their visit?* —Student and teacher follow-up survey data provided the evidence for these results.

Regarding ease of use, 39% of the students found the dictionaries “very easy” to use; 32% found using them was “possible with a little trial and error.” The percentage of students who found them easy to use was higher among the older students. Teachers' comments confirmed these results. Teachers of grades K-3 commented: Our students were on a K/1 level, so they needed adult assistance the entire time. The students needed more help from me than if they didn't have the dictionaries. I see this as a positive point, because it caused us to elaborate on the discussion and to cement understanding. Teachers of grades 4-6 commented: They need more practice with the technology to truly be independent learners. Students needed strong teacher support to relate the words and meanings to the exhibit. Teachers of grades 7-11 commented: Being able to key in unfamiliar words and see the signs provided independence. The

students were just learning how to use the technology. With more opportunities, they would become more expert at using the dictionaries and be better able to utilize them.

Regarding helping students learn from the activities, more than half of the students commented that the dictionaries “helped them a lot”; slightly less than half said they “helped them a little bit.” Approximately three quarters of the teachers said that use of the dictionaries afforded their students access to the activity content. Most of the teachers said the dictionaries were a valuable resource that complemented and enriched their visit.

Key Findings for Research Question 1— *How do visitors, in grades K-8+ who are deaf or hard of hearing, integrate handheld dictionaries into their museum learning experience during school visits?*

Students at all grade levels used the dictionaries as a learning tool to look up the signs for terms they encountered at the various activities and did not know, especially if the terms were displayed on the Word Lists. They also frequently engaged in conversations with their classmates and teachers using the newly learned signs and, in many cases, information provided in the definitions and illustrations.

Evidence appears to point to the value of posting Word Lists. More than 80% of the student groups observed used the Word Lists to look up terms and subsequently engage in discussions with other students and/or teachers about the activity. Only a handful of student groups visited activities without Word Lists. In fact, none of the school groups visited any of the *Take a Closer Look* activities without Word Lists. This may have been due to time constraints that were compounded by the researcher’s suggestion that they visit as many of the activities with Word Lists as they could. However, those few who did visit activities without Word Lists used the dictionaries to look up key words and find out about their meaning. Slightly more than half engaged in some discussion with other students and/or with their teachers about the activity.

In sum, school visitors used the dictionaries to help them read labels, look up terms, use the ASL sign, and engage in discussion. Students of all ages with varying levels of reading and signing ability, found that the dictionaries were relatively easy to use and that having on-demand access to their UDL features made learning from the activities more accessible. This was particularly true for older students.

Data for Research Question 2— *What kinds of learning are made possible with use of the dictionaries and how do they affect engagement, and involvement and interest?*

To help us answer this research question, we organized our results around the three sub-questions listed below. Results that emerged from analysis of the data for sub-questions 1 and 2 are provided in Tables 14-18. Results for sub-question 3 are provided in narrative form. These results are then summarized as key findings for our second research question.

- 1) How much time do school groups spend at activities?
- 2) What do students learn with use of the dictionaries?

3) What do student groups say about use of the dictionaries and their level of engagement, involvement, and interest?

Sub-question 1: *How much time do school groups spend at activities?* —Observation data provided the evidence for these results.

Table 14. How Much Time Do School Groups Spend at *Science in the Park* Activities With Word Lists?

Name of Activity	Number of Groups	Less than One Minute	One to Two Minutes	More than Two Minutes
Big See Saw	5	0	2/5, 40%	3/5, 60%
Jump	1	0	0	1/1, 100%
Race	5	0	1/5, 20%	4/5, 80%
Slide	1	0	1/1, 100%	0
Spin	3	0	1/3, 33%	2/3, 67%
Swing	9	0	2/9, 22%	7/9, 78%
Turn	2	0	1/2, 50%	1/2, 50%
TOTAL	26	0	8/26, 31%	18/26, 69%

Table 15. How Much Time Do School Groups Spend at *Science in the Park* Activities Without Word Lists?

Name of Activity	Number of Groups	Less than One Minute	One to Two Minutes	More than Two Minutes
Small Balances	2	0	0	2/2, 100%
Lift	1	0	0	1/1, 100%
Run	1	0	1/1, 100%	0
Speed Up	1	0	1/1, 100%	0
TOTAL	5	0	2/5, 40%	3/5, 60%

Table 16. How Much Time Do School Groups Spend at *Take a Closer Look* Activities With Word Lists

Name of Activity	Number of Groups	Less than One Minute	One to Two Minutes	More than Two Minutes
Hot or Cold	7	0	1/7, 14%	6/7, 86%
How Long is a Minute?	3	0	2/3, 67%	1/3, 33%
Seeing Heat	4	0	0	4/4, 100%
Vibration Patterns	2	0	0	2/2, 100%
Vibration Sensation	5	0	0	5/5, 100%
TOTAL	21	0	3/21, 14%	18/21, 86%

Sub-question 2: *What do students learn with use of the dictionaries?* —Observation and follow-up survey data provided the evidence for these results.

Tables 17 and 18 are direct evidence from observation of groups using the dictionaries to learn the definitions of terms they looked up.

Table 17. What Do Students Learn at *Science in the Park*?

Activity	Observation Notes for Grades K-3
Swing	The teacher and one student were standing near the activity information panel and were using the word card to identify words to look up in the dictionaries. After looking up the term “pendulum” and watching the signed definition in ASL, the teacher pointed to the swing and said, “See, it [the swing] is swinging back and forth?”
Swing	After the teacher and a student both looked up the term “long” and watched the signed definition of the term, the teacher pointed to the swings and asked the student, “Which one is longer?” The student identified the longer swing.
Turn	Two students worked with the teacher to identify terms on the list, look them up, and viewed the terms and their definitions in ASL. Then they did the activity. The definition for momentum was too difficult for students to understand on their own, but it helped teachers to explain the concept to the students.

Table 18: What Do Students Learn at *Take a Closer Look*?

Activity	Observation Notes for Grades 4-6
Vibration Sensation	The teacher was leading a discussion with group of 2 students about the activity. One student was trying to get the vibration graph on the screen to read 200 Hertz exactly. He/She explained that if the movement of the wave is slow then it is a low number (Hertz) but if it is fast, the number gets higher. The teacher asked if the students knew what “Hertz” was, and the students replied that they were not sure. They each looked it up individually and watched the signed definition in ASL. Then, one student said, “1 Hertz equals 1 cycle per second.” The group continued to discuss the meaning of Hertz and the activity.
Seeing Heat	At first the two students went directly to list and began looking up each term in order. Both students would look at signed terms and definitions in ASL. The teacher was encouraging them to discuss meanings with each other. One of the students said that temperature had something to do with a balloon. The teacher intervened and asked the other student if he/she agreed. Then both students looked up “temperature” and watched the signed definition. Then they each explained the meaning of temperature to the teacher. The researcher approached and asked students to try to explain the connection between the terms that they looked up, and the activity. Then the teacher intervened again and asked a few questions to guide the students to make the connection. One of the students explained that the white areas on the screen were warm and the cold areas were green.

Survey data supported these observations. More than three quarters of the students indicated on their follow-up surveys that they used the dictionaries to learn the meaning of a word that they did not know or were not sure about. Their comments are direct evidence of this type of learning. I never knew what “nerve” meant before I used the dictionary. It [using the dictionaries to look up terms] helped me to ask questions and talk about the science. I learned the meaning of hot, cold, and warm. Then, I was able to identify which plates were hot, warm and

cold. One teacher also noted that learning the definitions of the terms was a good start that opened the door for further conversations about the science.

The majority of students also indicated on their surveys that they used the dictionaries to learn new signs. Additionally, almost half said they used them to learn new science. Examination of the grade bands supports this perception. It also indicates that new science learning with use of the dictionaries increases with increase in grade level. Results show that approximately half of the K-3 teachers said the dictionaries helped their students learn more about science or math. More than three quarters of the grades 4-6 teachers said this was true for their students. Whereas 100% of the grade 7-12 teachers said that the dictionaries helped their students learn science or math content.

Sub-question 3: *What do student groups say about use of the dictionaries and their level of engagement, involvement, and interest?* —Follow-up survey data provided the evidence for these results.

Students and teachers alike said on their follow-up surveys that they would like to use the dictionaries elsewhere in the museum and at other museums. Most of the teachers said the dictionaries enhanced the museum field trip experience for their students; 70% said the use of the dictionaries made the visit more fun for their students.

Teachers' comments provide direct evidence of the dictionaries' value in engaging and involving students and maintaining their interest.

Basically, the dictionaries provided each student with access to learn, have their needs met and be able to work independently. It gave my class an opportunity to learn how to be more independent in seeking answers to questions and in deciphering unfamiliar print. Hands on experience coupled with signed vocabulary and definitions were a huge help. I wish they had more time! The dictionaries allowed the students to take charge of learning by looking up unfamiliar words and seeing the signs, as well as the signed explanations. This helped to increase their independence in learning about new things.

It would be cool to have the students be able to use the dictionaries throughout the entire visit to the museum. Then they could look up words of their choosing as we went through different exhibits. We recently completed a science unit on rocks and fossils, so a dictionary in the dinosaur/rock area would have been helpful. [I would like to use the dictionaries] in the dinosaur/models exhibits. My students always like to explore those areas.

Students were equally articulate and enthusiastic about learning with support of the dictionaries. They commented: I learned a lot and I want to thank you so much! I learned how to use the dictionary when I saw a word that I didn't understand. It was very helpful. I wish I could have stayed longer and learned more.

Key Findings for Research Question 2: *What kinds of learning are made possible with use of the dictionaries and how do they affect the engagement, involvement and interest of visitors, ages 5-12+ who are deaf or hard of hearing, during school visits?*

The duration of time spent at each of the activities indicates that dictionary use contributed to engagement, involvement, and interest. The majority of student groups visiting both exhibits were engaged at the various activities for more than two minutes. But, duration of time engaged with an activity does not automatically equate to learning something from the activity. Said differently, spending more than a minimal amount of time at an activity is necessary, but not sufficient, to support learning. Yet, the evidence from the field test strongly supports the assertion that the dictionaries enabled students to learn new science content. The looking up and learning of new signs and the meaning of terms, and discussing activity content with classmates and teachers in ASL are all indicative of science learning. Teachers' wishes to use the dictionaries throughout the museum are also indicative of their adding value to the museum field trip experience.

DISCUSSION

Thirteen school groups that included 88 deaf or hard of hearing students ranging from kindergarten to eleventh grade participated in the field test. Among the students who visited the *Science in the Park* activities, 88% used their dictionaries to look up terms and/or definitions, many of which were listed on the Word Lists; 81% of the students engaged in conversations with fellow students or with teachers about the display they were visiting using the newly learned signs. Among the students who visited the *Take a Closer Look* activities, 100% of them used the dictionaries to look up terms and/or definitions, especially those included in the Word Lists; 90% engaged in conversations with classmates and teachers about the displays using signs they had looked up. Students and teachers found the dictionaries relatively easy to use and said they made learning more accessible.

On the follow-up surveys, 79% of the teachers said the dictionaries gave their students better access to the learning that the exhibits were designed to teach; 90% said the dictionaries were a valuable resource that complemented and enriched the visit for their students. They endorsed the UDL features embedded in the dictionaries that provide each student with access to the vocabulary that is needed to engage in and learn the content presented through the activity.

In sum, students of all ages used the dictionaries to support their learning. For older students, the dictionaries allowed them to become more independent learners than would otherwise have been possible.

Limitations of the Study. The results of this study reflect the experiences of a limited number of school groups. Therefore they cannot be generalized to *all* school groups. It is also important to note that the study was conducted in a limited number of exhibit areas, in a single informal educational setting, and using a limited number of activities within each of only two exhibit areas. Therefore, a larger-scale, study is required. This larger study needs to include more participants, take place in an expanded number of exhibits in the Museum setting, and include additional museum settings.

Implications for Practice. Participants suggested ways in which the dictionaries could be improved for use in museums. These included: adding more terms to those offered in the dictionaries or identifying additional terms at each activity that could be accessed in the dictionaries, adding video clips for some of the "harder" concepts, and offering the dictionaries on an iPad to accommodate the needs of students with visual impairments or fine motor challenges. Suggestions also included: providing additional introductory information, training,

and support for use of the dictionaries before the visit, limiting or eliminating distractions in the exhibit area and/or choosing exhibit areas that are less “chaotic” and “physically demanding,” and extending the length of the visit to allow for more in depth exploration and dictionary use.

Conclusions

School group visitors from grades K-11 used the dictionaries to learn the signs and definitions for terms that were new to them as they visited the display activities during their visit. Students then engaged in discussions about the science and math content included in the activities. In the context of the two museum exhibits used for this field test, the data strongly support the assertion that the dictionaries are valuable learning tools for school group visitors who are deaf or hard of hearing. It would be important to conduct additional studies in more exhibits at the MoS and in additional informal science education venues such as zoos, aquariums, and natural history museums, to confirm the dictionaries would also be valuable learning tools for these other kinds of settings.

Appendix

Site Data Form

Name of school: _____

School Classification Urban Suburban Rural

(Lead) Teacher Name: _____

What unit/activity/topics are you currently working on with these students in class?

Complete the following for each student who will visit the museum:

1. Student's gender, race/ethnicity:

- Female
- Male
- American Indian
- Alaska Native
- Asian American
- African American, Black
- Latino, Hispanic
- European American, White
- Other (If other, write in race/ethnicity):

2. Student's grade level:

3. Student's academic skill level:

- Reading and writing below grade level
- Reading and writing at grade level
- Reading and writing above grade level

4. Student's use of "Signing Math and Science" Dictionaries at school or at home?

- Yes
- No
- Don't know

5. Student's hearing status, age of onset:

- Hearing
- Hard of Hearing
- Hard of Hearing with hearing aide(s)
- Deaf
- Deaf with cochlear implant
- Deaf with hearing aide(s)

- Age of onset <3
- Age of onset >3

6. Student's degree of hearing loss with a cochlear implant and/or hearing aid, if applicable:

- Mild (27-40 dB)
- Moderate (41-55 dB)

- Moderate-Severe (56-70 dB)
- Severe (71-90 dB)
- Profound (>91 dB)

7. Student's signing skills:

- None
- Novice
- Survival
- Intermediate
- Advanced
- Superior

8. Communications' systems used at school (may check more than one):

- Spoken English
- Spoken Spanish
- ASL
- Signing Exact English
- Fingerspelling
- Simultaneous Communication
- Manually Coded English System
- Cued Speech

9. Teacher's, Aide's, or Chaperone's gender, hearing status:

- Female
- Male
- Hearing
- Hard of Hearing
- Hard of Hearing with hearing aide(s)
- Deaf
- Deaf with cochlear implant
- Deaf with hearing aide(s)

10. Teacher's, Aide's, or Chaperone's signing skills

- None
- Novice
- Survival
- Intermediate
- Advanced
- Superior

An Example from *Science in the Park* of a Student Activity Sheet

Activities with Word Lists

RACE

Words I Looked Up

Acceleration (SSD)

Potential Energy (SSD)

Kinetic Energy (SSD)

Fast (SMD)

Slow (SMD)

Notes About What I Learned:

SWING

Words I Looked Up

Pendulum (SSD)

Gravity (SSD)

Angle (SSD)

Long (SMD)

Short (SMD)

Notes About What I Learned:

SPIN

Words I Looked Up

Spin (SSD)

Inertia (SSD)

Mass (SSD)

Speed (SSD)

Notes About What I Learned:

BALANCE (Big See Saw)

Words I Looked Up

Lever (SSD)

Fulcrum (SSD)

Weight (SSD)

Distance (SSD)

Heavy (SMD)

Light (SMD)

Notes About What I Learned:

SLIDE

Words I Looked Up

Friction (SSD)

Push (SSP)

Pull (SSP)

Air (SSD)

Notes About What I Learned:

JUMP

Words I Looked Up

Jump (SSP)

Gravity (SSD)

Graph (SSD)

Up (SSP)

Down (SSP)

Notes About What I Learned:

TURN

Words I Looked Up

Turn (SMD)

Rotate (SSD)

Momentum (SSD)

Opposite (SMD)

Force (SSD)

Notes About What I Learned:

Activities Without Word Lists

Activity Name: _____

Words I Looked Up

-
-
-
-
-

Notes About What I Learned:

Follow Up Survey for Teachers

How would you rate students' ability to find information in the dictionaries?

- Very easy
- Fairly easy
- Possible with a little trial and error
- Somewhat difficult
- Impossible

How would you rate the dictionaries as a resource that complements and enriches the visit?

- Very Valuable
- Somewhat Valuable
- Hardly Valuable
- Not at All Valuable

Which of the following best describes the way your students used the dictionaries?

- Looked up words to learn new signs or see terms signed.
- Looked up words to learn more about science and math concepts.
- Looked up words to be able to discuss and explain what was happening.
- Looked up words to help understand the instructions or information presented in writing.
- Looked up words to hear their definition and learn what they mean, understand instructions, and /or communicate in English.
- Combination of the above or other (please explain and give examples below)
 - Please comment here on combination of the above or other.

Which of the following features were most useful for your students? (check all that apply)

- Terms in SE
 - Terms in ASL
 - Terms in English
 - Definitions in SE
 - Definitions in ASL
 - Definitions in English
 - Voiced definitions
- Please explain your choice(s) below

Rate how much you agree/disagree with the following [Strongly Agree, Agree, Disagree, Strongly Disagree]:

- a) Using the dictionaries during the visit made it more fun for my students.
- b) Using the dictionaries during the visit made it easier for my students.
- c) Using the dictionaries during the visit gave my students better access to the exhibits.
- d) Using the dictionaries during the visit helped my students learn more about science or about math.
- e) Using the dictionaries enhanced our museum field trip experience (We got more out of it.)
- f) Using the dictionaries during the visit helped students explore and learn on their own.

Please add your comments here.

Did using the dictionaries accommodate students' different needs and learning styles?

- Yes
- No

If yes, give an example.

Describe the value the dictionaries added to a field trip visit experience in the areas of comprehending the

content, communicating about a topic, and working independently.

Would you like to use the dictionaries during future field trip visits?

Yes

No

If so, were there any specific exhibit areas that you visited where you thought that having access to the dictionaries would have been particularly helpful for your students?

How might the dictionaries or the process (way they are used) be improved to help you and your students have a more valuable field trip experience?

Follow-Up Survey for Students

1. How easy was it for you to use the dictionaries?

- Very easy
- Possible with a little trial and error
- Difficult

2. How helpful were dictionaries during your visit to the museum?

- The dictionaries helped me a lot.
- The dictionaries helped me a little bit.
- The dictionaries didn't help me at all.

3. How did you use the dictionaries at the museum? (You may check more than one.)

- I looked up words to learn new signs or see terms signed.
- I looked up words to learn more about science and math.
- I looked up words to learn more about what was happening.
- I looked up words to be able to discuss and explain what was happening.
- I looked up words to help me understand written information.
- I looked up words to hear their definition and learn what they mean, understand instructions, and/or communicate in English.

4. What features did you look at? (You may check more than one.)

- I looked at words in SE.
- I looked at words in ASL.
- I looked at words in English.
- I looked at definitions of words in SE.
- I looked at definitions of words in ASL.
- I looked at definitions of words in English.
- I listened to voiced definitions.

5. Did the Word Lists help you use the dictionaries?

- Yes
- No

6. Would you want to use the dictionaries again if you went back to the museum?

- Yes
- No

7. Check whether you agree or disagree:

Using the dictionaries during the field trip... ..

Made it fun.

Made it easier.

Helped me learn.

Helped me explore and learn on my own.

8. Did you use the dictionaries to learn new signs? If so, please list the terms for which you learned signs explain what you were able to do once you learned the signs.

9. Did you learn the meaning of a word that you didn't know or weren't sure about? If so, please give an example and explain what you were able to do once you learned the meaning of the word.

An Example from *Science in the Park* of an Observation Log

Visitors: _____

Date: _____

Began with Word Lists? [For Family Visitors ONLY]

1. Yes
2. No

Activities with Word Lists

RACE

Visitors observed at this activity:

Order in which group visited the RACE activity (first, second, third, etc.)

Duration of time at RACE (Less than a minute, One to two minute, More than two minutes):

Terms looked up:

1. Acceleration
2. Potential Energy
3. Kinetic Energy
4. Fast
5. Slow

Group use of i-Pod

1. Looked at/used the Word List
2. Read the instruction labels and decided what to do
3. Read the content labels to understand the concept
4. Used the sign
5. Talked with others in the group

What did this group do at this activity? What did they discuss (if known)?

Note: An identical instrument with the terms from the Word List was used for SWING, SPIN, BALANCE, SLIDE, JUMP, TURN,

Activities Without Word Lists

Visitors observed at this activity:

Order in which group followed visited the activity (first, second, third, etc.)

Duration of time at this activity (Less than a minute, One to two minute, More than two minutes):

Terms looked up:

Group use of i-Pod

1. Looked at/used the Word List
2. Read the instruction labels, decided what to do
3. Read the content labels to understand the concept
4. Used the sign
5. Talked with others in the group

What did this group do at this activity? What did they discuss (if known)?