Signing High School Science

(NSF, Grant #DRL-1019542)

Evaluation Report: Web-based Dictionaries

June 2014

Project Description

The evaluation findings reported here focus on the Web-based version of the Signing Life Science Dictionary (SLSD) and Signing Physical Science Dictionary (SPSD), developed by TERC and Vcom3D and funded, in part, by the National Science Foundation, Grant #1019542. The SLSD and SPSD are being developed to serve the approximately 36,000 students in grades 9-12 who are deaf and hard of hearing and are required under the Individuals with Disabilities Education Act (IDEA) and No Child Left Behind Act (NCLB) to have access to the same content as hearing students. For use with a Windows Operating System, the Web-based versions of the SLSD and SPSD are complete universally designed assistive tools that can be used independently of the curriculum in place. Each illustrated interactive dictionary has an audio component and includes ~750 standards-based terms in English and Spanish text that can be signed or listened to on demand. An animated interactive viewer—the SignSmith® player—allows users to select from a range of Avatar characters with different personalities and facial expressions; to adjust the speed of signing; and to sign a selected word, its definition, or part of speech in American Sign Language (ASL) or as a word-for-word translation (Signed English [SE] or Signed Spanish [SP]).

Goals and Research Questions

The primary intent of the field-test evaluation was to begin to establish effectiveness of the Web-based SLSD and/or SPSD. A secondary intent was to find out about usability and teachers' and students' likes and dislikes. To begin to establish effectiveness, the partners investigated two research questions: 1-What kinds of learning gains in life science are possible with use of the SLSD? 2-What kinds of learning gains in physical science are possible with use of the SPSD? Extrapolating from findings from evaluation of their signing science and math dictionaries for students in grades K-8, the partners' hypothesized that with the SLSD and SPSD, students will have assistive tools that help them 1) increase their ability to recognize, sign/fingerspell and/or voice, and use the vocabulary of life and physical science; 2) improve their science content knowledge as reflected in their increased knowledge of the meaning of terms.

Research Design

A mixed measurement pre- post design that combines quantitative and qualitative methods in which the outcome of interest was measured for participants only was used to ascertain the types of learning gains that are possible with use of the SLSD and SPSD. Findings in this report address learning outcomes related to vocabulary knowledge as demonstrated by changes in students' ability to recognize the English text version of a term; to sign/fingerspell and/or voice the term; and to use the term in a sentence. Findings address learning outcomes related to content knowledge as demonstrated by changes in students' ability to define or explain the meaning of the term. Qualitative feedback were supplied via written post-unit teacher and student surveys and analyzed to discern: (a) what teachers and students gained over the course of using the SLSD and SPSD; (b) their thoughts about usability; and (c) what they liked and disliked about the dictionaries. During use observation and documentation from teachers provided insight into how they incorporated the dictionaries into instruction.

Instrumentation and Data Management

The research instruments used for data collection are described below. They were sent as an email attachment to teachers along with an introductory letter that described the research protocols as a series of steps that teachers could check off as they completed each item. Teachers sent the completed instruments to TERC in hard or soft copy, based on preference, where the data were entered into spreadsheets, cleaned, and analyzed.

- **Site Data Form –** provides information about the school, teacher, and students and is completed prior to teaching the unit selected for the study.

- **Pre-use Vocabulary Assessment Form** – provides information for assessing each student's pre-use knowledge of the five terms identified.
- **Post-use Vocabulary Assessment Form** – provides information for assessing each student's post-use knowledge of the five terms.
- **Post-use Survey -** provides feedback about teachers' experiences in using the SLSD and/or SPSD as an assistive tool.
- **Student Post-use Survey -** provides feedback about students' experiences with the dictionaries.

Participants

The evaluation was coordinated by TERC and included teachers solicited from a pool of high school teachers of students who are deaf and hard of hearing with a range of hearing loss who taught in specialized schools for the deaf. Sources of teachers for the pool included the database of sites the TERC team had established for use with other Signing Math & Science projects, MADeafTerp Yahoo group listserv, EDUDEAF, and solicitations at conferences such as NSTA and Closing the Gap.

The test involved two cohorts of students. Data collection for Cohort 1 began in October 2012 and ended in June 2013. Data collection for Cohort 2 began in September 2013 and ended in March 2014. Characteristics of the groups that made up Cohort 1 are presented in Table 1. Characteristics of the students are presented in Table 2. Characteristics of the groups for Cohort 2 are presented in Table 3 and for students in Table 4. This information was gathered from the Site Data Form submitted by each teacher before beginning the study. In support of TERC's policies for working with human subjects, identifiers have been removed to ensure confidentiality of the participants.

Table 1. COHORT 1— GROUPS (N=5)

Cohort: Group	Grade	Subject Area	School Type	Region	Setting	Teacher's Hearing Status	Teacher's Signing Level
1: I	9	Biology	Specialized	Midwest	Rural	Hearing	Advanced
1: II	9	Physical Science	Specialized	Midwest	Urban	Hearing	Advanced
1: III	9	Biology	Specialized	East	Suburban	Deaf with Hearing Aid	Superior
1: IV	10/11	Biology	Specialized	East	Urban	Hearing	Advanced
1: V	7/8	General Science	Public	East	Suburban	Hearing	Advanced

Table 2. COHORT 1— STUDENTS (N=28)

Cohort: Group	N	English Reading Level	English Writing Level	Hearing Status/Onset	Hearing Loss Level (best ear)***	Signing Level
1: I	12	**12**-Below Grade	**12**-Below Grade	**7**-Deaf/<3 **5**-HH with Hearing Aid/<3*	**7**-Profound **3**-Moderate-Severe **2**-Moderate	**8**-Superior **2**-Advanced **2**-Intermediate
1: II	6	**6**-Below Grade Level	**6**-Below Grade Level	**4**-Deaf/<3 **2**-Deaf with CI /<3**	**3**-Profound **1**-Severe **2**-Mild	**4**-Advanced **2**-Intermediate
1: III	1	**1**-Below Grade	**1**-Below Grade	**1**-Deaf/<3	**1**- Profound	**1**-Intermediate
1: IV	7	**7**-Below Grade	**7**-Below Grade	**4**- Deaf/<3 **3**- Deaf with CI/<3	**3**- Profound **1**-Severe **2**- Mild	**1**-Advanced **5**-Intermediate **1**-Survival
1: V	2	**1**-Below Grade **1**-At Grade	**2**-Below Grade Level	**2**-HH with Hearing Aid/<3	**2**-Moderate	**2**-Survival

* HH=Hard of Hearing ** CI=Cochlear Implant *** Without CI or Hearing Aid

Table 3. COHORT 2— GROUPS (N=6)

Cohort: Group	Grade	Subject Area	School Type	Region	Setting	Teacher's Hearing Status	Teacher's Signing Level
2: I	10	Physics	Specialized	East	Suburban	Deaf with Hearing Aid	Superior
2: II	11	Chemistry	Specialized	Midwest	Urban	Hearing	Advanced
2: III	9/10	Biology	Specialized	East	Suburban	Hearing	Superior
2: IV	9 & 11	Biology	Specialized	Midwest	Rural	Hearing	Advanced
2: V	10/12	Biology	Specialized	East	Urban	Hearing	Advanced
2: VI	7	Life Science	Specialized	South	Suburban	Hearing	Advanced

Table 4. COHORT 2- STUDENTS (N=36)

Cohort: Group	N	English Reading Level	English Writing Level	Hearing Status/Onset	Hearing Loss Level (best ear)	Signing Level
2: I	1	**1**-Below Grade	**1**-Below Grade	**1**-Deaf/<3	**1**-Profound	**1**-Intermediate
2: II	6	**3**-Below Grade **3**-At Grade	**3**-Below Grade **3**-At Grade	**1**-Deaf/<3 **4**-HH with Hearing Aid/<3 **1**-Hard of Hearing/>3	**1**-Profound **1**-Moderate-Severe **4**-Moderate	**2**-Advanced **2**-Intermediate **1**-Survival **1**-None
2: III	3	**2**-Below Grade **1**-At Grade	**2**-Below Grade **1**-At Grade	**2**-Deaf with CI/<3 **1**-HH with Hearing Aid/<3	**2**- Profound **1**- Severe	**1**-Advanced **2**-Survival
2: IV	10	**8**-Below Grade Level **2**-At Grade	**8**-Below Grade Level **2**-At Grade	**4**-Deaf/<3 **6**-HH with CI/<3	**2**-Profound **2**-Severe **5**-Moderate **1**-Mild	**8**-Advanced **1**-Intermediate **1**-Survival
2: V	8	**6**-Below Grade **2**-At Grade	**6**-Below Grade **2**-At Grade	**3**-Deaf/<3 **1**-Deaf with Hearing Aid/<3 **1**-Deaf with CI/<3 **3**-HH with Hearing Aid/<3	**4**-Profound **1**-Severe **3**-Moderate-Severe	**3**-Superior **2**-Advanced **3**-Intermediate
2: VI	8	**7**-Below Grade **1**-At Grade	**7**-Below Grade **1**-At Grade	**5**-Deaf/<3 **1**-Deaf with Hearing Aid/<3 **1**-Deaf with CI/<3 **1**- HH with CI/<3	**2**-Profound **3**-Severe **2**-Moderate-Severe **1**-Moderate	**3**-Advanced **3**-Intermediate **2**-Survival

Procedure

The research procedure involved placing the dictionaries in the designated classroom context with students who are deaf and hard of hearing at the intended grade levels. The intent of the research was to examine effectiveness under normal use conditions. To this end, each teacher identified at least one science unit to teach using the SLSD and/or the SPSD. This was something that the teacher ordinarily taught. The only difference was that they used the SLSD and/or the SPSD as an assistive tool. The teacher also identified 5 terms that were important for developing an understanding of the content that was the focus of the unit. Each of these terms had to be in the SLSD or SPSD. Using the assessment forms described previously, the teacher then assessed each student's pre- and post-unit ability to recognize; sign/fingerspell and/or voice each term; explain its meaning and/or define it; and use each term in a sentence. Tables 5 and 6 specify the unit topics and key terms that teachers from each of the two cohorts selected for the study.

Table 5. COHORT 1— UNIT TOPICS and KEY TERMS

Cohort: Group	Unit Topic	Key Terms
1: I	Mitosis	cell cycle, chromosome, interphase, mitosis, replication
1: II	Electricity	anode; cathode; cathode ray; magnet; electron
1: II	Cells	nucleus; cytoplasm; organelle; allele; chromosome
1: IV	Genetics/Heredity	genetics; trait; gene; generation; allele
1: V	Life Science	recessive; evolution; dominant; speciation; ecosystem

Table 6. COHORT 2— UNIT TOPICS and KEY TERMS

Cohort: Group	Unit Topic	Key Terms
2: I	Physical and Chemical Changes/Heat	radiation; conduction; melting point; boiling point; diffusion
2: II	Solutions	solution; solvent; solute; dissolve, saturated solution
2: III	Interactions Among Living Things	competition; nitrogen cycle; mutation; parasite; predator
2: IV	Cells	diffusion; selectively permeable membrane; osmosis; active transport; passive transport
2: V	Cell Transport	osmosis; facilitated diffusion; active transport; transport; concentration
2: VI	Ecology	Predator; resource; symbiosis; extinct; endangered species

Results

Pre- Post-unit Vocabulary Knowledge—Each group in Cohort 1 and Cohort 2 showed pre- to post-unit improvement, on average, in the groups' ability to recognize the English text versions of the terms; sign/fingerspell and/or voice the terms; use each of the terms in a sentence; and explain the meaning of and/or define the terms. Tables 7-12 show this improvement as the mean pre-unit, post-unit, and pre- to post-unit change in ability for the number of positive (yes) responses out of the total possible. Tables 13 and 14 provide this information as the average score for the group out of a maximum score of 3. A score of 3 represents accurate and complete ability to explain the terms' meanings/definitions. A score of 0 represents no answer. A score of 1 represents familiarity with the terms but no knowledge of their meanings/definitions. A score of 2 represents incomplete knowledge of the meanings/definitions.

Table 7. COHORT 1—ABILITY to RECOGNIZE ENGLISH TEXT VERSIONS

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
I: 1	12	SLSD	41/60 (68%)	59/60 (98%)	18/60 (+30%)
I: 2	6	**SPSD**	18/30 (60%)	30/30 (100%)	12/30 (+40%)
I: 3	1	SLSD	0/5 (0%)	5/5 (100%)	5/5 (+100%)
I: 4	7	SLSD	19/35 (54%)	35/35 (100%)	16/35 (+46%)
I: 5	2	SLSD	5/10 (50%)	10/10 (100%)	5/10 (+50%)

Table 8. COHORT 2—ABILITY to RECOGNIZE ENGLISH TEXT VERSIONS

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
II: 1	1	**SPSD**	0/5 (100%)	5/5 (100%)	5/5 (+100%)
II: 2	6	**SPSD**	6/30 (20%)	30/30 (100%)	24/30 (+80%)
II: 3	3	SLSD	8/15 (53%)	15/15 (100%)	7/15 (+47%)
II: 4	10	SLSD	5/50 (10%)	50/50 (100%)	45/50 (+90%)
II: 5	8	SLSD	14/40 (35%)	40/40 (100%)	26/40 (+65%)
II: 6	8	SLSD	17/40 (42%)	31/40 (77%)	14/40 (+35%)

Table 9. COHORT 1—ABILITY to SIGN/FINGERSPELL and/or VOICE TERMS

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
I: 1	12	SLSD	16/60 (27%)	47/60 (78%)	31/60 (+52%)
I: 2	6	**SPSD**	10/30 (33%)	30/30 (100%)	20/30 (+67%)
I: 3	1	SLSD	0/5 (0%)	5/5 (100%)	5/5 (+100%)
I: 4	7	SLSD	13/35 (37%)	35/35 (100%)	22/35 (+63%)
I: 5	2	SLSD	1/10 (10%)	10/10 (100%)	9/10 (+90%)

Table 10. COHORT 2—ABILITY to SIGN/FINGERSPELL and/or VOICE TERMS

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
II: 1	1	**SPSD**	0/5 (100%)	5/5 (100%)	5/5 (+100%)
II: 2	6	**SPSD**	14/30 (47%)	27/30 (90%)	13/30 (+43%)
II: 3	3	SLSD	3/15 (20%)	15/15 (100%)	12/15 (+80%)
II: 4	10	SLSD	5/50 (10%)	50/50 (100%)	45/50 (+90%)
II: 5	8	SLSD	13/40 (33%)	34/40 (85%)	21/40 (+53%)
II: 6	8	SLSD	5/40 (13%)	26/40 (65%)	21/40 (+53%)

Table 11. COHORT 1— ABILITY to Use TERMS in a SENTENCE

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
I: 1	12	SLSD	5/60 (8%)	40/60 (67%)	35/60 (58%)
I: 2	6	**SPSD**	27/30 (90%)	30/30 (100%)	30/30 (+10%)*
I: 3	1	SLSD	0/5 (0%)	5/5 (100%)	5/5 (+100%)
I: 4	7	SLSD	11/35 (31%)	28/35 (80%)	17/35 (+49%)
I: 5	2	SLSD	2/10 (20%)	5/10 (50%)	3/10 (+30%)

* Group 2's pre-use means were higher than those of the other groups leaving less room for improvement.

Table 12. COHORT 2— ABILITY to Use TERMS in a SENTENCE

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
II: 1	1	**SPSD**	0/5 (0%)	3/5 (60%)	3/5 (+60%)
II: 2	6	**SPSD**	7/30 (23%)	30/30 (100%)	23/30 (+77%)
II: 3	3	SLSD	4/15 (27%)	9/15 (60%)	5/15 (+33%)
II: 4	10	SLSD	0/50 (0%)	4/50 (8%)	4/50 (+8%)
II: 5	8	SLSD	5/40 (12%)	20/40 (50%)	15/40 (+38%)
II: 6	8	SLSD	5/40 (12%)	24/40 (65%)	19/40 (+48%)

Table 13. COHORT 1—ABILITY to EXPLAIN the MEANINGS and/or DEFINITIONS

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
I: 1	12	SLSD	0.6/3	2.6 /3	2.0/3 (+67%)
I: 2	6	**SPSD**	0.4/3	2.7/3	2.3/3 (+77%)
I: 3	1	SLSD	0.0/3	2.4/3	2.4/3 (+80%)
I: 4	7	SLSD	0.7/3	2.0/3	1.3/3 (+43%)
I: 5	2	SLSD	0.5/3	1.8/3	1.3/3 (+43%)

Table 14. COHORT 2—ABILITY to EXPLAIN the MEANINGS and/or DEFINITIONS

Group	N	Dictionary	Mean Pre-Ability	Mean Post-Ability	Mean Pre-Post Change
II: 1	1	**SPSD**	0.0/3	2.6 /3	2.6/3 (+87%)
II: 2	6	**SPSD**	0.9/3	3.0/3	2.1/3 (+70%)
II: 3	3	SLSD	0.8/3	2.3/3	1.5/3 (+50%)
II: 4	10	SLSD	0.0/3	2.1/3	2.1/3 (+70%)
II: 5	8	SLSD	0.3/3	1.9/3	1.6/3 (+53%)
II: 6	8	SLSD	0.6/3	1.8/3	1.2/3 (+40%)

Use, Effectiveness, Likes and Dislikes— Tables 15 and 16 provide a summary of the combined information for Cohorts 1 and 2 from the written surveys. Since participants used the SLSD and SPSD interchangeably, the information in the tables applies to both dictionaries. Table 15 summarizes the teachers' perspective. Table 16 summarizes the perspective of students. Likes and dislikes for each group are listed after their respective tables.

Table 15. Teachers' Perspective About Use and Effectiveness (N=11)

Student Use	**Teachers' Responses**
Ability to Use	-Very easy (6) -Fairly easy (5)
Ability to Use Independently	-Require no assistance (8) -Require some assistance (3)
When Used	-With a science activity (3) -To learn unfamiliar/new vocabulary (11) -To review new vocabulary (8) -For homework or research (5)
How Used	-To learn the definitions of words (11) -To learn new signs or see terms signed (11) -To be able to discuss and explain (9) -To help understand written information (3) -To listen to voiced words and definitions in English (3) -To help communicate in English (3)
Features Used	-Illustrations (11) -Signing speed bar (8) -Avatar character selection (6) -ASL, SE, English (11) -SS, Spanish (2) -English human voice narration (5) -Ability to zoom or rotate the avatar (8) -Text size selection (1)
Overall Value Added	**Teachers' Responses (N=11)**
Complements and Enriches Instruction	-Very valuable (6) -Valuable (5) *Using the dictionaries as a preview of material made the actual teaching of the content faster and smoother.* *These dictionaries helped with language-specifically the skill of explaining how things work. The pictures show what it (the term) is and sometimes location.* *It gave me a tool for students to use to research information, which is a developing skill at this time. For ELA, students also can learn dictionary skills.*
Changes Students' Attitude toward Science	-No (2) -Yes (9) *They find science more accessible.* *He already loved science. This gave him the opportunity to do more research (and, if applicable, develop prediction skills).* *It made it more fun to do vocabulary.* *I have one student who is new to signing and often tried to hide her signs because she is not sure she is signing correctly. After using the dictionary she held her hands high and signed freely.* *Students thought it was cool to see their language in avatar form and made them more engaged with the topic.*
Improves Students' Content Knowledge	-Yes (11) *The definitions are in a language they can understand and the*

	pictures support the definitions. *It made it easier to review frequently with independence.* *Some definitions lead to other new words and definitions. This made the definition more clear.* *The definitions are in a language they can understand and the pictures support the definitions.* *We argued over some of the signs and meanings. To me this is a thinking process to be exploited. It meant they had a basic understanding and were forming opinions and making decisions.*
Specific Benefits for Students	**Teachers' Responses (N=11)**
Accommodates Different Learning styles	-Yes (11) *Students had a choice of how to get the information.* *With the definitions presented in ASL and SE, it gave a clear explanation in the language the student was most comfortable with.* *Students were able to read the definitions in English and Spanish. This worked well for students who are not proficient signers.* *Students could work at their own speed.* *Changing the avatar's appearance (zooming/rotating) and signing speed helped to accommodate different students' needs and preferences.* *For students who benefit from repetition I was able to play the definition over and over. For students who process information more slowly I was able to slow down the speed of the avatar.* *Listening to the definitions and also reading in English was good for HH students. The Spanish was good for one student.*
Enables Access to Content	-Yes (11) *This is a great tool to introduce a term and its sign. Sometimes I take it for granted that students know a sign. I use it and realize later they had no clue as to what the sign means.* *Students can see the information in their first language and also be exposed to the English.* *Some definitions lead to other new words and definitions. If there was an unknown word in the definition, students could click on it and explore new words. This made the definition more clear.*
Enables Communication	-Yes (11) *Students have the vocabulary to describe the science they are learning.* *Reviewing words helped them to better explain meanings as well as to use the correct sign. It helped with language development.* *My students struggle to demonstrate their content knowledge, but the dictionary did help them try instead of just giving up.* *It develops language and the ability to explain words and use them properly.* *I really think the discussions went deeper and faster. Plus, it was clear that all students were on the same page in terms of understanding each other.*
Enables Independence	-Yes (11) *Because they love using it, they DO use it.* *Students can access the material while reading the textbook instead of waiting for the teacher to explain a word.* *Students no longer rely solely on the teacher to get vocabulary information. They can replay the signing avatar or re-read the definitions starting the process of making meaning of the vocabulary definitions on their own.* *I don't have to explain vocabulary over and over again. I can tell*

	them to look up the word and put the responsibility for learning on their shoulders. *Utilizing the dictionaries gives students an avenue for being more independent when trying to understand new concepts*.
Teacher Use and Satisfaction	**Teachers' Responses (N=11)**
How Used	-Introduce the vocabulary (11) -Supplement discussion (9) -Review unit vocabulary (7) *I'd look up words or meanings myself and then use it in class. I introduced the dictionary by using it 'for myself' in class.* *We used it to look up words with the pictures and definitions.* *We used the dictionaries to start learning the most important words and definitions. We reviewed these during the unit and looked up all the words we did not know as we encountered them.*
Information for the Terms	-Completely satisfied (11)
Accuracy of Signs	-Completely satisfied (5) -Somewhat satisfied (6)
Understanding the Avatar	-Completely satisfied (9) -Somewhat satisfied (2)

Likes

Interactive Features

- *Students get the information in their first language.*
- *Students have exposure to the English.*
- *I liked that the signing speed could be adjusted and the type of avatar could be changed. I also liked the availability of pictures and that the words were identified as "noun", "verb", or "adjective".*
- *ASL!*
- *I like the fact that the dictionaries offer an avenue of independence AND that they are accurate.*
- *I particularly liked being able to listen to the definitions and read the definitions word-by-word as we watched the signing.*

Benefits

- *I like that this is a resource all my students can use, regardless of what level they are.*
- *Students can work independently.*
- *The dictionary supplements the information in class.*
- *Students no longer need to rely solely on the teacher to get vocabulary information. They can replay the signing or re-read definitions and make meaning of the terms on their own.*
- *Visual presentation of anything in the classroom is beyond beneficial. Adding in that the presentation is interesting and accurate will make students want to use the dictionaries again.*
- *The dictionaries are so easy to use that students could look up words they needed to know without having me be there to sign for them.*
- *They are great! We are using them for all of the science units during the year.*

Dislikes

- *Many words are fingerspelled instead of having a sign. This was very discouraging for my student who has some fine motor difficulties as well as difficulty in remembering the spelling of such words.*
- *The facial expression can be distracting and unnatural at times, though the exaggerated movements are better than a totally deadpan, expressionless face.*
- *I would like to have even more terms…but there is never enough when something is so good!*

Table 16. Students' Perspective About Use and Effectiveness

Student Use	**Students' Responses (N= 43)**
Ability to Use	-Very easy (22) -Fairly easy (19) -Possible with a little trial and error (2)
Ability to Use Independently	-I didn't need any help (22) -I needed some help (19) -I needed a lot of help (2)
When Used	-To learn new signs or see words signed (41) -To learn more about science (26) -To be able to discuss and explain something (15) -To help me understand written information (35) -To help me do my homework (20) -To hear the definitions and learn what they mean (27) -To communicate in English (9)
How Used	-To look at words and definitions in SE (14) -To look at words and definitions in ASL (35) -To look at words and definitions in English (12) -To listen to terms and definitions voiced in English (13) -To listen to terms and definitions voiced in Spanish (5) -To look at illustrations (22)
Features Used	-Illustrations (32) -Signing speed bar (20) -Avatar character selection (25) -ASL (28) -SE (18) -English text (8) -Voiced English text (16) -Voiced Spanish (3) -Ability to zoom or rotate the avatar (13) -Text size selection (10)
Methods Used to Find Terms	-Search box (26) -Alphabet bar (25) -Words within the definition (5) -Words below the definition (15)
Benefits of Use	**Students' Responses (N= 43)**
-Was Helpful	-Helped me a lot (40) -Helped me a little (3)
Would Use Again	-Agree (43)
-Was Fun	-Agree (43)
-Made learning science words and definitions easier	-Agree (43)
-Furthered Learning Independently	-Agree (43)
-Furthered Learning of New Signs	-Yes (32); No (11) *photosynthesis, chromosome (4), spindles, chromatids, mitosis (4), cell cycle, replication(2), nucleus (1), trait (2), heredity (2), allele (1), evolution (1), dominant (1), ecosystem (1), recessive (1), evolution (1); concentration (5); predator, resource, symbiosis, extinct, endangered species (8)*
-Furthered Learning Meanings	-Yes (32); No (11) *chromatid (2); cell cycle, mitosis(3); chromosome (2), nucleus (1); conduction (1); predator (3); nitrogen cycle (3); mutualism (3)* *I learned that evolution and change are almost the same (1). I learned that an ecosystem has living and non-living things. I never knew that (1).* *predator, resource, symbiosis, extinct, endangered species (8)*
Satisfaction	**Students' Responses (N=43)**

Information for the Terms	-Completely satisfied (37) -Somewhat satisfied (6)
Accuracy of Signs	-Completely satisfied (37) -Somewhat satisfied (6)
Understanding the Avatar	-Completely satisfied (28) -Somewhat satisfied (15)

Likes

Ease of Use

- *It help me understand, if I don't understand the sentences.*
- *It is easy see and clear what he said in dictionary.*
- *It fun and clear that I understand..*
- *I feeling like use to computer is signing dictionaries so easy for me*
- *It's easy and kinda cool.*
- *I like the way they show the signs.*

Interactive Features

- *I like that it provides pictures, ASL, and word information. There are "3" options to choose.*
- *I liked the signed definitions.*
- *Like slow sign, picture etc.*
- *Spanish also.*
- *I like I can listen and see the signs.*
- *I liked listening and reading together.*
- *My favorite was ASL.*
- *I liked that the dictionaries were "human".*
- *I like see the person sign.*
- *I like that I can repeat and be shown how to do the signs.*
- *I liked watching the sign and reading.*

Benefits

- *It helps me learn and I could get the signs and definitions.*
- *I understand the meaning.*
- *It's easier to learn new/more signs.*
- *Using ASL.*
- *I like when the avatar can show me SE.*
- *I love dictionaries learn words.*
- *It teaches me how to sign new words..*
- *I like [being able to] go to all the dictionaries. I want to get the dictionaries for home.*
- *It help me do my work independent.*
- *I love it!*

Dislikes

- *Sometimes it doesn't have the right ASL.*
- *The signing is robotic. Should have more smooth movements.*
- *Too many words were fingerspelled. Spelling is hard for me.*
- *The pictures were complicated.*

KEY FINDINGS

As described at the beginning of this report, the primary purpose of the field-test study is to begin to establish effectiveness of the dictionaries by investigating two research questions: 1-What kinds of learning gains in life science are possible with use of the SLSD? 2-What kinds of learning gains in physical science are possible with use of the SPSD? Our hypotheses are that with the SLSD and SPSD, students will have assistive tools that help them 1) increase their ability to recognize, sign/fingerspell

and/or voice, and use the vocabulary of life and physical science; 2) improve their science content knowledge as reflected in their increased knowledge of the meaning of terms.

From the testing described in the Results section, it appears highly likely that the SLSD and SPSD, when used as assistive tools, will contribute to giving students in grades 9-12 who are deaf or hard of hearing access to science vocabulary in their own language. In so doing, they will likely be able to better understand the grade-appropriate science content that they are studying. Such access may also enable this population to work more independently to develop a technical life science and physical science vocabulary and may result in teachers having more time to focus on the teaching and learning of the topic content. Results also indicate that the dictionaries' interactive features promote individualized instruction for a wide range of learners with varying levels of hearing loss and learning challenges. Teachers who used the SLSD and SPSD were able to easily integrate it into their instruction. The Avatar technology also appears to motivate high school students and fire up their curiosity and interest in learning science vocabulary.