Evaluation Report: National Field Test

The Signing Earth Science Dictionary

June 30, 2012

Project Description

The evaluation findings reported here focus on the Web-based version of the Signing Earth Science Dictionary (SESD), developed by TERC and Vcom3D and funded, in part, by the National Science Foundation, Grant #0913675. The SESD is being developed to serve the approximately 36,000 students in grades 9-12 who are deaf or hard of hearing and require services under the Individuals with Disabilities Education Act (IDEA). For use with a Windows Operating System, the SESD is a complete assistive tool. 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]).

Evaluation Goals

The primary intent of this field-test evaluation was to assess the degree to which students who used the SESD to perform activities related to a standards-based Earth science unit in place in their school develop knowledge of the unit's key vocabulary and of the content. A secondary intent of the evaluation was to inform any necessary revision of the SESD before publication.

Research Design

The research design for the evaluation builds on the methodology TERC has established for similar studies. The evaluation was coordinated by TERC and conducted by teachers solicited from a pool of teachers of students who are deaf or hard of hearing with a range of hearing loss. The pool included teachers who taught in specialized schools for the deaf and in classrooms in which students were included with hearing students.

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 with 7th through 12th grade students to ascertain the types of learning gains that are possible with use of the SESD. Although the dictionary was developed for grades 9-12, it includes a set of terms (designated as Level 1) that students should encounter in the middle grades before entering high school. As such, the research design also sought to find out about the learning gains of this younger group of learners. Findings in this report address learning outcomes demonstrated by changes in students' mastery of key vocabulary for the unit of study as indicated by pre- and post-unit questions related to students' ability to sign/fingerspell, understand, and communicate (define or use) the terms identified as important for mastering the unit content. Content outcomes were assessed by responses on pre- and post-unit tests normally administered at the beginning and end of the unit. 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 SESD; (b) their thoughts about usability and feasibility; and (c) what they liked and disliked about the SESD.

The research procedure for the field test involved placing the SESD in the designated classroom context with students who are deaf or hard of hearing at the intended grade levels.

Research studies extended over the course of approximately 18 months from January 2011 through May 2012. The intent of the field test was to examine effectiveness of the SESD under normal use conditions. To this end, each teacher identified at least one Earth science unit to use for data collection. Pre- and post unit vocabulary lists, questionnaires, and scoring criteria were then developed by the teachers in collaboration with TERC. Tests normally administered at the end of the unit served as pre- and post-unit content questionnaires. These were submitted to TERC prior to beginning the unit and modified as needed. Teachers and students were given opportunities to provide qualitative and quantitative feedback and suggestions regarding ease of use, teacher/student gain, and likes and dislikes through post-use surveys. Teachers also tracked and rated each student's ability to work independently for a two-week period while using the SESD as High (3), Medium (2), or Low (1). Survey data provided additional information about use of the SESD and independence. The pre- and post unit vocabulary and content questionnaires and teacher and student post-use surveys are described in more detail in the following section.

Research Instruments

Student Pre- and Post Unit Vocabulary Questionnaire: A Pre-unit Vocabulary Questionnaire, which is identical to the Post-unit Vocabulary Questionnaire, was administered to obtain a baseline assessment of students' initial knowledge of their ability to sign/fingerspell, understand the meaning of, and use those terms that are important for developing ideas related to the unit content. Comparison of the scores on each questionnaire was used to ascertain changes in students' knowledge of the vocabulary.

To develop the questionnaires, teachers completed a Pre-Teaching Survey in which they listed the unit they intended to do using the SESD, its goals, and the key Earth science terms students should know before and after doing the unit activities. They then communicated with TERC to share and refine the methods to be used to identify students' knowledge of these terms. Before doing the unit, teachers met with each student to identify those terms the student could sign or fingerspell, recognize, and accurately describe the meaning of and/or use when answering a question related to the unit of study. At the end of the unit, teachers repeated the process. Scores for each student were reported to TERC. The text of the survey follows.

Unit/Activity Topic: _____ **Goals:** _____

I. List the 10 most important Earth science terms students need to know to do the unit/activities.			
Term	Able to Sign/Fingerspell the Term (yes/no)	Able to Understand the Sign for the Term (yes/no)	Able to Define/Use the Term (yes/no)
1)			
2)			
3)			
4)			
5)			
6)			
7)			
8)			
9)			
10)			

Student Pre- and Post Unit Content Questionnaire: A Pre-unit Content Questionnaire, which is identical to its post-unit counterpart, was administered to obtain a baseline assessment of students' initial knowledge about the unit topic selected for the field test. Comparison of the scores on each questionnaire was used to ascertain changes in students' mastery of the content.

To develop the questionnaires, teachers listed the learning goals of the unit on the Pre-Teaching Survey. They then shared the test they usually administer at the end of the unit and the scoring criteria that would be used. The tests and scoring criteria were refined as required to ensure that they aligned with the learning goals and key unit vocabulary. Before doing the unit, teachers administered the test and sent the scored tests to TERC. At the end of the unit, teachers repeated the process.

Post-unit Teacher Survey: Completed after the unit, the Post-unit Teacher Survey asks teachers for feedback about their experiences using the SESD. The text of the survey follows.

1. How would you rate students' ability to find information in the SESD?
___very easy
___fairly easy
___possible with a little trial and error
___somewhat difficult
___impossible

2. How would you rate the SESD as a resource that complements and enriches instruction?
___Very Valuable
___Valuable
___Neutral
___Hardly Valuable
___Not at All Valuable

3. When did your students use the SESD?
___With a science activity
___For subjects other than science
___For homework or research
___Other (please specify):

4. How did your students use the SESD?
___Learn the definition of a word
___Learn how to sign a word
___Learn a part of speech
___Communicate the content being studied
___Do homework
___Other (please specify).

5. Do you think using the SESD improved students' self esteem and/or self-confidence?
___Yes
___No
If yes, give an example.

6. Do you think using the SESD changed students' attitude toward Earth science?
___Yes
___No
If yes, give an example.

7. How did you embed student use of the SESD into activities (pre-, during, at the end) and homework?

8. Did using the SESD help you accommodate different usages and learning styles? If yes, give an example.
9. Did using the SESD help you meet mandated curriculum frameworks? If yes, give an example.
10. Describe the value the SESD adds to teaching and learning – specifically in the areas of comprehending the content, communicating about a topic, and working independently.
11. What do you like about the SESD? What do you dislike?

***Post-unit Student Survey*:** Completed after the unit, the Post-unit Student Survey asks students for feedback about their experiences in using the SESD. The text of the survey follows.

1. How easy was it to find information in the SESD?
__Very easy
__Fairly easy
__Possible with a little trial and error
__Somewhat difficult
__Impossible

2. How did you use the SESD?
__Learn the definition of a word
__Learn how to sign a word
__Learn a part of speech
__See how things look
__Tell what I know
__Help me ask questions
__Do homework
__Other (please specify).

3. Why were you unable to find what you were looking for?
__It was not there.
__It was hard to find so I gave up.
__Other (please specify)

4. Tell us how you found information in the SESD?
5. Tell us what you like about the SESD? What do you dislike?

Demographics

The evaluation study included a sample of 56 students distributed among 7 treatment groups representing grades 7-12. A summary of demographic information about the treatment groups and about students' levels of hearing loss and academic ability gathered from a Site Data Form submitted by each teacher before beginning the study is presented in Table 1 on the next page. A copy of the Site Data Form is included in the Appendix. In support of TERC's policies for working with human subjects, identifiers have been removed to ensure confidentiality of the participants.

Table 1. Treatment Groups (N=56)

Treatment Group*	N	Region	Setting	Classroom Type	Hearing Loss	Academic Ability
Group 8:I	3	Southeast	Rural	Inclusion	3-Profound	3-Below Grade Level
Group 7-8: I	*8*	*Midwest*	*Rural*	*Specialized*	*5-Severe; 2- Profound; 1-Cochlear Implant*	*8-Below Grade Level*
Group 7-8: II	6	Northeast	Urban	Specialized	6-Profound	6-At Grade Level
Group 7-8: III	*9*	*Northeast*	*Urban*	*Specialized*	*9-Profound*	*9-At Grade Level*
Group 9-10: 1	15	Northeast	Urban	Specialized	2-Moderate/Severe; 5 Severe; 6-Profound; 2-Cochlear Implant	12 Below Grade Level; 3-At Grade Level
Group 9-12: I	*9*	*West*	*Suburban*	*Specialized*	*3-Severe; 6-Profound*	*9-Below Grade Level*
Group 9-12: II	6	Southeast	Urban	Specialized	2-Moderate/Severe; 3 Severe; 1 Profound	6-Below Grade Level

*- The Group Number identifies the grade. The Roman numeral identifies the class.

Unit Topics

As mentioned, the intent was to examine the potential value the SESD adds to Earth science teaching and learning when implemented in "real use" conditions. As such, teachers selected one of the units that they ordinarily teach to do using the SESD. The unit topics for each treatment group follow.

Group 8: I-Rocks and Minerals
Group 7-8: I- Layers of Earth
Group 7-8: II- Weathering
Group 7-8: III- Weathering
Group 9-10: I- The Periodic Table
Group 9-12: I- Astronomy
Group 9-12: II- Matter and Energy

Findings

As previously specified, student and teacher data were collected over the course of the study. Findings about use of the SESD and degree of mastery of the vocabulary and content being studied and students' ability to use the SESD independently are reported in the following pages.

Vocabulary Knowledge: Each group with an N greater than 1 had significantly improved post-unit vocabulary scores compared to their pre-unit results as tested by a paired *t*-test. For the paired *t*-test, a *p* level of ≤.05 indicates a treatment affect occurred (post-use scores are significantly higher than pre-use scores). Thus, each group's ability to sign, understand, and

define/use the key vocabulary for the unit increased significantly with use of the SESD, on average. The tables on the next several pages indicate these trends. Table 2 shows the percent positive change by group from pre- to post-unit assessment about the ability to sign key terms for the unit of study. Table 3 shows the change for each group about the ability to understand key terms. Table 4 shows the change in their ability to sign and use the terms.

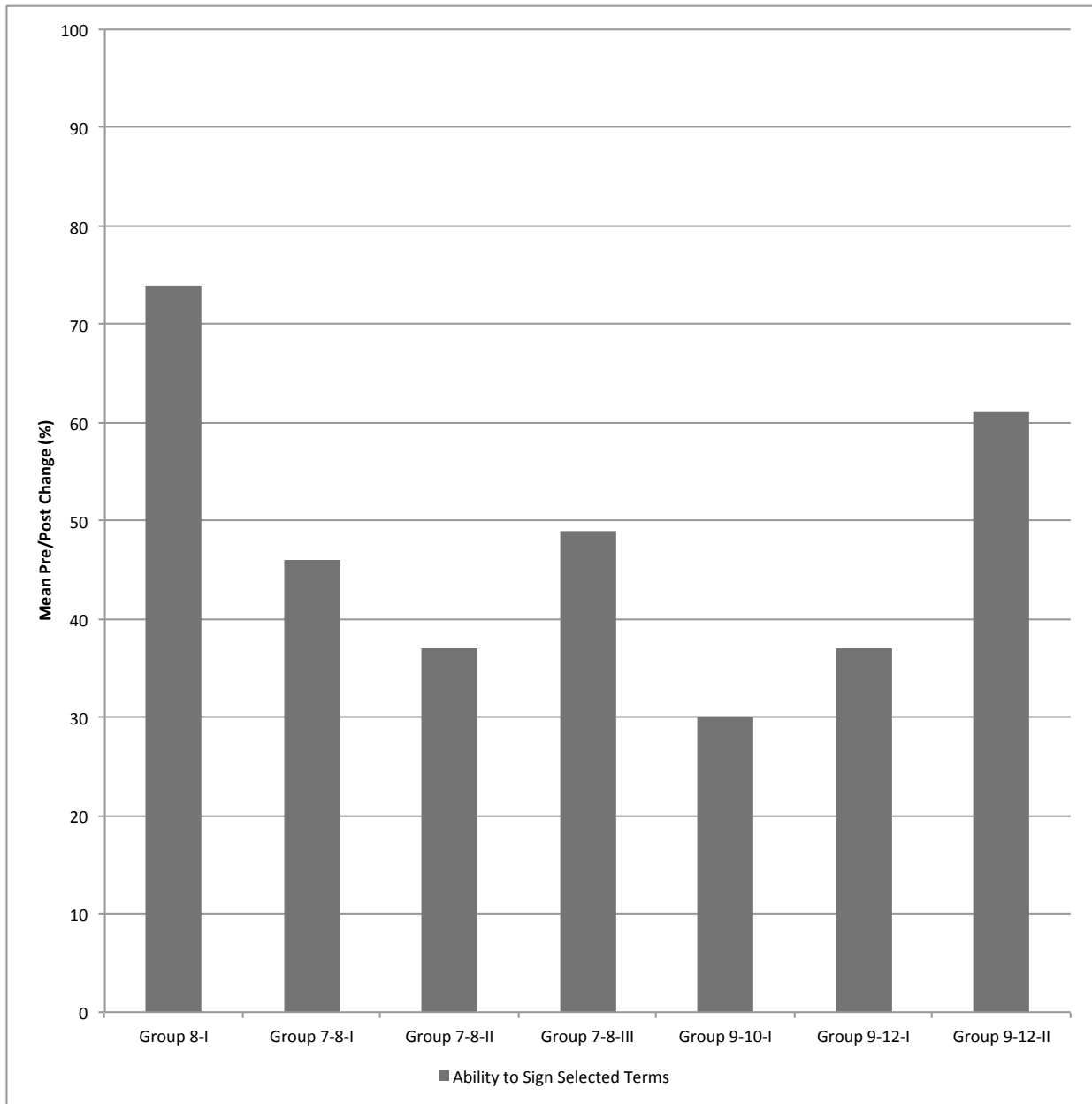**Table 2. Pre-/Post-unit Change in Ability to Sign Key Terms**

Table 3. Pre-/Post-unit Change in Ability to Understand Key Terms
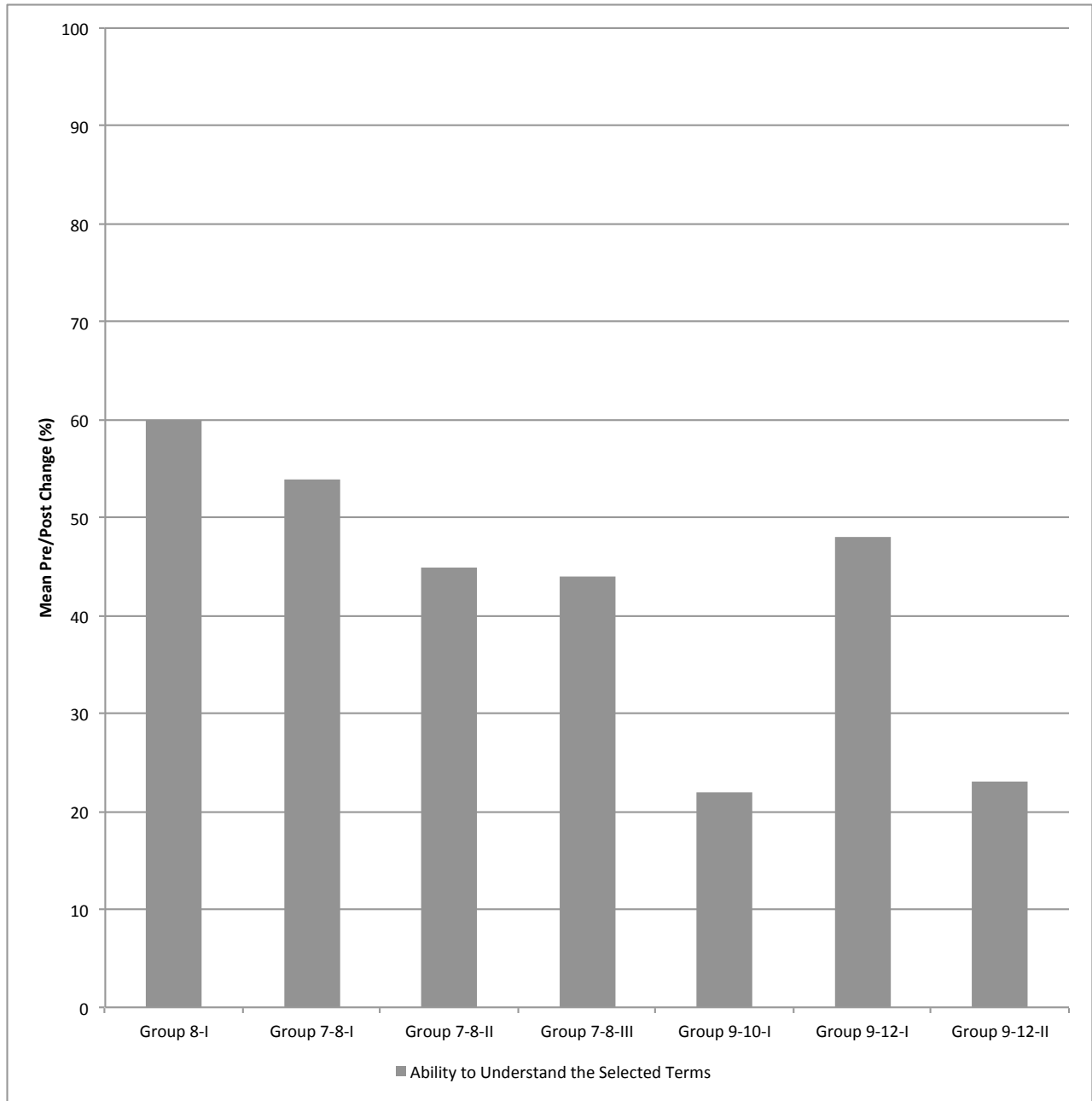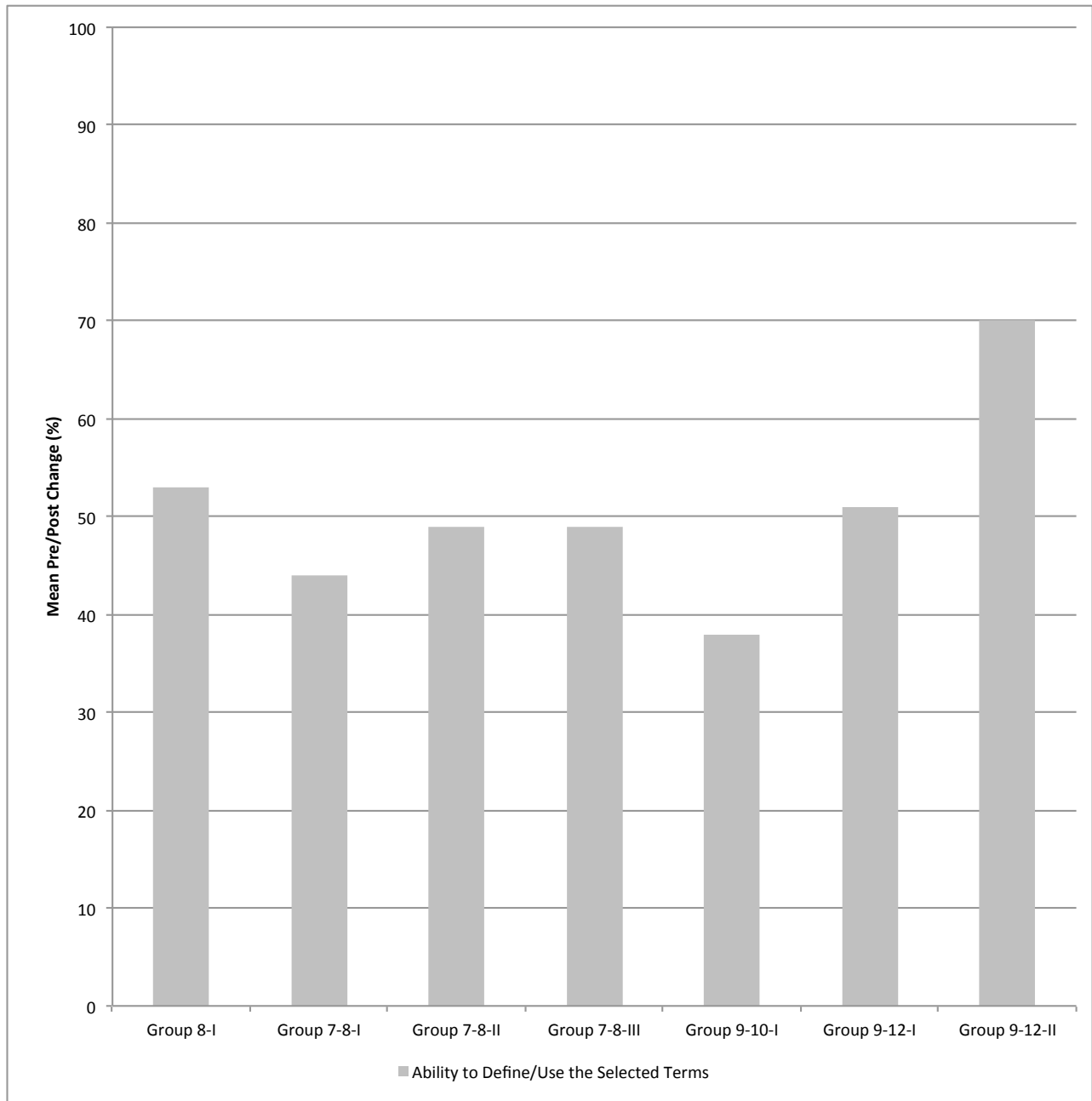
Table 4. Pre-/Post-unit Change in Ability to Define/Use Key Terms

Content Knowledge: As Table 5 reveals, each of the 3 treatment groups that reported data demonstrated increased knowledge of the unit content from pre- to post-unit assessment. Of

the 4 groups that did not report data, unit tests were not a component of the curriculum as three sites used the dictionary to prepare for the state assessments and one group used it to do a unit that did not have an end-of-unit test. As described for vocabulary knowledge, each group with an N greater than1 had significantly improved post-unit content-related test scores compared to their pre-unit results as tested by a paired *t*-test.

**Table 5. Pre-/Post-unit Change in Content Knowledge**
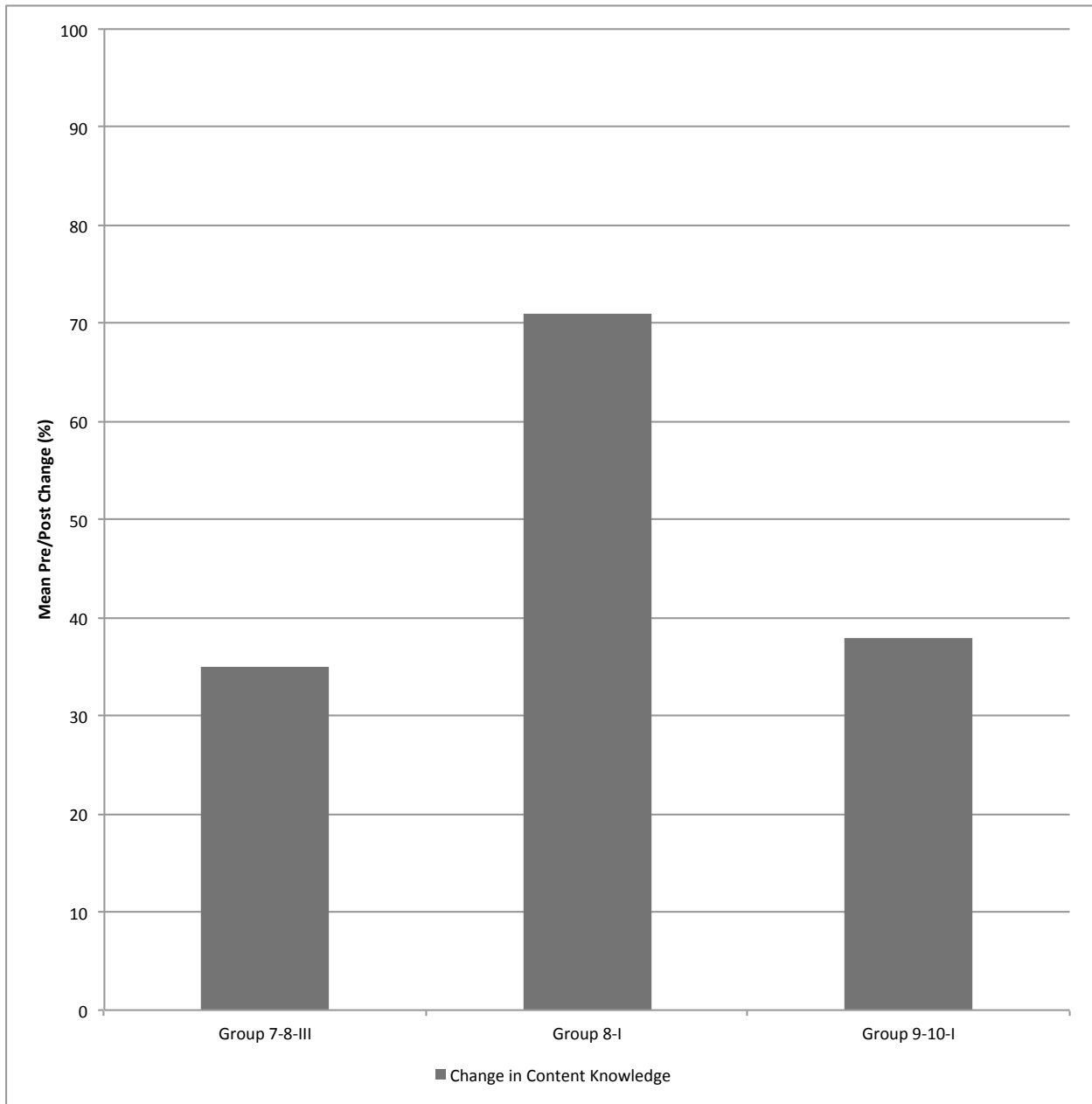
Ability to Use the SESD: As previously specified, teachers provided information about students' ability to work independently while using the SESD. They rated each student's ability

during the period of use as 1: Low— Able to complete activities and homework with much assistance; 2: Medium— Able to complete activities and homework with some assistance; 3: High— Able to complete activities and homework with little to no assistance. As shown in Table 6, less than 20% of students required considerable assistance. The remainder of the students were able to use the SESD independently or with some assistance.

Table 6. Ability to Use the SESD Independently
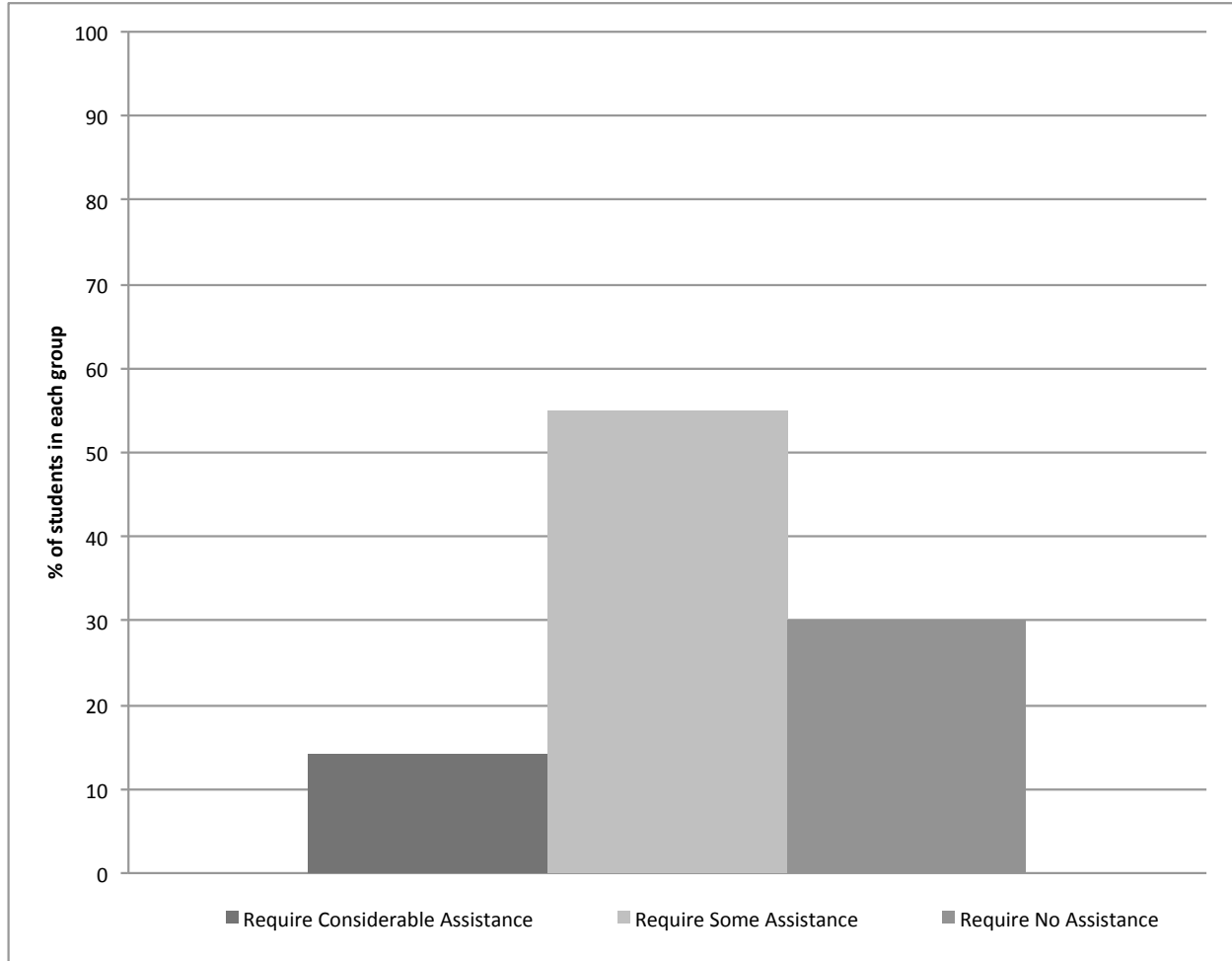
Overall Findings: Results of the field-test evaluation indicate that the SESD serves as a bridge to help fill the language gap many students in grades 7-12 who are deaf and hard of hearing experience in doing Earth science. These overall findings are summarized in Table 7 on the next page.

Table 7. Summary of Findings for Vocabulary and Content Knowledge

Treatment Group	Change in Ability to Sign Terms	Change in Ability to Understand Terms	Change in Ability to Define/Use Terms	Change in Content Knowledge
Group 8: I	+74%	+60%	+53%	+71%
Group 7-8: I	+46%	+54%	+44%	
Group 7-8: II	+37%	+45%	+49%	
Group 7-8: III	+49%	+44%	+49%	+35%
Group 9-10	+15%	+30%	+22%	+38%
Group 9-12: I	+37%	+48%	+51%	
Group 9-12: II	+61%	+23%	+70%	

Post-use Teacher Feedback

As previously specified, teachers provided feedback via post-use surveys about their experiences with the SESD. The following summarizes their written responses to this inquiry (N=7).

1. How would you rate students' ability to find information in the SESD?
   Very easy—4; Fairly easy—3

2. How would you rate the SESD as a resource that complements and enriches instruction?
   Very Valuable—3; Valuable—4

3. When did your students use the SESD?
   With a science activity—7; For homework or research—5; Review—4; Completing notebooks—3

4. How did your students use the SESD?
   Learn the definition of a word—7; Learn to sign a word—5; Learn a part of speech—1; Do homework—5; Communicate the content being studied—4

5. Do you think using the SESD improved students' self esteem and/or self-confidence?
   Yes—7

   They were more confident because they read on their own and came prepared to answer class questions!

   Students in my class don't usually hold discussions around printed text. They aren't confident readers. But we could use the ASL definitions as a bridge to the text. They were more comfortable really being able to tease apart the definitions and more able to do so.

   The avatars are multicultural. They liked seeing hearing aids on the avatar

   Students seemed to be more confident when they could watch the characters sign the definition and show the sign for terms. They seemed to remember them better.

   It gives the students access to a visual description that otherwise would not be accessible without direct instruction.

6. Do you think using the SESD changed students' attitude toward Earth science?
   Yes—4; No—3

   Students told me they use it to do the required reading from the text. They don't understand a lot of science vocabulary on their own.

   I think it helps them to feel more comfortable with the vocabulary. The pictures help them to recognize things they may already have seen in the real world and enable them to connect their classroom learning to what they know from experience.

7. How did you embed student use of the SESD into activities (pre-, during, at the end) and homework?

   Avatar board work was to look up words that were in the lesson for the day-also for homework.

   Many students don't have access to the Internet at home, but I encouraged them to look at the dictionary during their free time as independent review. The SESD was used to introduce activities and to review the vocabulary.

   Students used the computers during classroom time individually to fill in a worksheet. They had to watch the word and definition signed, write the definition, and draw a picture.
   During teacher led activities the dictionary was used to support vocabulary during the lecture, as the teacher I showed the signing of the word/definition.

   The SESD was used for previewing vocabulary before instruction. The teacher used SESD within the classroom during activities.

   We used it with the Pre-form, throughout the unit, and as a BIG review tool just before the end of the unit and doing the Post-form.

8. Did using the SESD help you accommodate different usages and learning styles?
   Yes—7

   Those students who normally needed help were able to use the SESD and then ask another student to help them if they still didn't understand.

   The SESD allowed students who need to see definitions repeatedly review vocabulary on their own, instead of asking the teacher or paraprofessional to sign things again and again. For our newer signers it was nice to slow down the ASL, which is hard to do person to person.

    My students are very much visual learners. They were able to take the signed descriptions and match them to pictures for terms used.

    It exposed and gave the students an entirely new form of learning that they could do independently. Otherwise all that is available to them is to watch me.

9. Did using the SESD help you meet mandated curriculum frameworks? If yes, give an example.
   Yes—5; No—2

   It helped them do the unit and that is state mandated.

It helped in that they could gain knowledge of content standards through learning the vocabulary of the standard. For example: One standard focused on physical attributes of rocks and soils. The student was able to use the SESD to find terms, read definitions and see them interpreted, and view pictures of the terms. When these terms and concepts were taught in class, she could answer questions because she was familiar with the vocabulary of the standard.

It did help us meet the state frameworks that are outside of FOSS (the curriculum that we use throughout the school) as astronomy is part of the ones that are not included in it and that we must teach.

10. Describe the value the SESD adds to teaching and learning – specifically in the areas of comprehending the content, communicating about a topic, and working independently.

It allows students to take responsibility for their learning. OWNERSHIP is key. Using the SESD helped students understand passages by filling in vocabulary gaps.

Most of the time, I MUST interpret dictionary definitions for my students in ASL. The SESD allows them to search for this information themselves. Also, in the bilingual setting, this resource allows us to build connections between English and ASL and have equal use for both languages.

Content is given in the student's first language and is available in ASL or SE depending on the student's preference. The dictionary is easy to use and students are able to find the words easily. Students can manipulate the character, speed, and distance to their own liking. Students can learn signs for science vocabulary and then incorporate that sign into communicating during a lab or other activity.

It gives some of the responsibility for learning the vocabulary to the student, instead of relying solely on the interpreter and/or teacher. If the student can understand the vocabulary of the content, then he/she will be able to participate in class discussions.

11. What do you like about the SESD? What do you dislike?

This dictionary adds a new dimension to a small body of existing research that supports the use of real people for older students. When that research was done, there weren't any avatars like those in the SESD with hand gestures and facial expression to support signing. This new innovation likely make the research that exists outdated.

I like that is formal ASL that is not from a human speaker. In this way, it's a lot more like a written text because it is less personal. Also, it can be frozen and viewed again and again. This is a rare resource for students learning in ASL who always depend on others to translate and interpret information for them. It is wonderful that this is a much more independent form of learning for my students. I would prefer not having two definitions rolled into one like "period" of a pendulum and "period" of the periodic table. It would be less confusing for students if all of the definitions were separated into period (1) and period (2) rather than just some of them.

The biggest concern I have about the dictionary is the discrepancy between how a word is signed when searching for that word and then how it is signed when the word is in a definition for a different word. For example: lithosphere. If I look up the word lithosphere, the word is fingerspelled. If I look up the word asthenosphere, lithosphere appears in the definition and has a sign. A student who has looked up lithosphere and learned that there is no sign, just fingerspelling will then not recognize the word when it is used in a different place. Words need to be fingerspelled or signed consistently throughout the

dictionary. Without this, there is no carry over and opportunity to apply learned information to different situations. (Note: The method of scripting in ASL and SE has been improved through integration of a program into the scripting process that cross checks each usage of a term within the dictionary to ensure that it is signed consistently throughout. Terms that were scripted inconsistently have been corrected.)

The program is really user-friendly. I just found out that there are more science related terms (more for Biology and Physical Science) for higher grades being developed. I can't wait to use them with the SESD.

I like the fact that it is a dictionary for science terms and that it can be an independent activity for the students. It is problematic that the signs are not standard throughout. For example, eclipse is fingerspelled, but not solar eclipse. I did not like the lizard...but the kids REALLY liked him. They called him the Lizard Man, and he was their favorite. (See the note above.)

Please add Spanish!!! I'm also using the Signing Physical Science Dictionary and having the terms and definitions available in Spanish in addition to English is just great!

I hope the plan is to add human voice. This will allow hearing students in mainstream classrooms to also be able to use the dictionary while the students who are deaf look at the signing. We do a lot of lab work in groups and that way ALL students (hearing and hearing impaired) could benefit from this great resource.

Post-use Student Feedback

As previously specified, students provided feedback via post-use surveys about their experiences with the SESD. The following summarizes their responses to this inquiry (N=47).

1. How easy was it to find information in the SESD?
   Very easy—34; Fairly easy—10; Possible with a little trial and error—3

2. How did you use the SESD?
   Learn the definition of a word—47; Learn how to sign a word—15; Learn a part of speech—7; See how things look—11; Tell what I know—10

3. Why were you unable to find what you were looking for?
    It was not there—40; It was hard to find so I gave up—7

4. Tell us how you found information in the SESD?
   All students reported that they used SEARCH (typed the letters of the word they were looking for) and/or used the alphabetical lists of terms.

5. Tell us what you like about the SESD? What do you dislike?

   I really like it. It's amazing. I don't have any negatives about the SESD. SESD is cool and I like the deaf avatar. It's better to use it (with our text).

   I like the simple small paragraphs that are easy to understand. I like that it includes signs and pictures.

I like the clear signing. I was able to find out what the word means to me.

I like the characters. The faces look like a real person on the computer. We liked the alien.

It's better to use the computer to learn and not the boring book dictionary.

I like to use computers and watching people sign. It's fun to watch people sign.

It can go fast or slow

It helps me more understand. I see and learn different signing.

It needs Spanish. There are Spanish look avatars. It's not right with them English. I looked at SPSD and saw Spanish. Why not SESD?

Avatars need to talk.

Appendix

<u>Site Data Form</u>

1. School Information

    Your Name: _____ Gender: __Male __☐ Female

    School Name: _____

    School Classification: __Urban   __Suburban   __Rural

2. Student Information

    What are the grade level(s) of the students who will use the SESD? _____

    Describe the ability of the student population that will use the SESD to read and write English.
    __Below grade level

    __At grade level

    __Above grade level

    Specify how many of the students who will use the SESD fall within the following levels of hearing loss:
    _____ Mild (27–40dB)

    _____ Moderate (41–55dB)

    _____ Moderate - Severe (56–70dB)

    _____ Severe (71–90dB)

    _____ Profound (91dB+)

    _____ Cochlear Implant