

Evaluation Report

Increasing STEM Signing Knowledge of Undergraduate Student Interpreters
(NSF Award #1703343)

Judy Vesel, TERC, Principal Investigator

M. Diane Clark, Lamar University, Co-Principal Investigator

July 2019

PROJECT DESCRIPTION

With this 2-year *Increasing STEM Signing Knowledge of Undergraduate Student Interpreters* Exploration and Design project, TERC and Lamar University developed a prototype Signing Bioscience Dictionary (SBD). They then researched its use and effectiveness in increasing the American Sign Language (ASL) life science vocabulary of students enrolled in Lamar's 4-year Interpreter Training (ITP) program and in using it to interpret content.

Research and development involved: 1) Preparing the prototype SBD. 2) Evaluating use and potential effectiveness of the prototype in enabling undergraduate students in Lamar's Interpreter Training (ITP) program to develop an ASL life science vocabulary and use it to interpret content taught in undergraduate biology courses. 3) Identifying terms to include in an expanded version of the SBD and soliciting recommendations for improvement from participating Lamar students and interpreting instructors.

Preparing the SBD involved the Lamar team in reviewing the glossary entries in Campbell Biology, 8th Edition to identify an initial set of terms. This text was selected because it is used at Lamar for their undergraduate biology course. The review resulted in a list of 1,455 terms that were submitted to the TERC team with the terms organized by text chapter. The TERC team then identified those bioscience terms in the list that are included in video versions of TERC's Signing Life Science Dictionary (SLSD), Signing Physical Science Dictionary (SPSD), Signing Earth Science Dictionary (SESD) and/or Signing Science Dictionary (SSD). The dictionaries are available from <https://signsci.terc.edu/video/index.html>. This resulted in 648 of the terms identified in the Lamar list to include in the prototype SBD. It also resulted in the identification of an additional 932 signing dictionary terms that were not in the Lamar list and are necessary for fully understanding the meaning of a dictionary term or content directly related to a term. This resulted in a final list of 1,580 terms to incorporate into the prototype SBD.

The Lamar team then used the Campbell Biology chapter headings to create content categories for the 648 terms from the text that had been incorporated into the final list. Review of the additional terms drawn from the signing dictionaries with respect to their fit with a category, resulted in the TERC team creating a modified set of categories that included most of the terms identified for inclusion in the prototype SBD. It also resulted in 387 terms that did not clearly fit into a category and would appear in the letter list only. The final list of 12 categories that emerged and the number of terms in each category was as follows: Animal Structure & Function (252), Atomic & Molecular Structure (72), Cellular Structure & Function (84), Ecology & Ecosystems (141), Energy & Magnetism (18), Evolution & Diversity (92), Health (58), Heredity & Genetics (84), Matter & Substances (144), Plant Structure & Function (100), Reproduction (51), Scientific Methods, Measures & Tools (95).

TERC's Web Designer then adapted the existing video interface for the SLSD, as it was the source dictionary for the majority of terms, to create the interface for the SBD. The videos are compatible with Mac, Chromebook, and a wide variety of platforms and web browsers and with iPads. This means that the SBD can be used easily with the technology that most users have available. The prototype SBD that resulted from these activities and that was used for the SBD evaluation is available from <https://signsci.terc.edu/video/SBD.htm>.

As is the case for all of the versions of the signing dictionaries, the prototype SBD and all subsequent versions are being "universally designed" according to the Universal Design for Learning (UDL) framework. This means that the interactive features included in the video versions are being transferred to the SBD to provide users with multiple means of representing

information, multiple means for the expression of knowledge, and multiple means of engagement in learning. These features include options for users to access terms and definitions by typing them into a search box or selecting from alphabetical lists and/or categories. They can select information represented as static images, text, human voice narration and/or signing. They can increase or decrease size of the text and view a range of characters that were selected because results of usability testing conducted during field test evaluations rated them as the characters that are easiest to understand. These features provide options for student interpreters to acquire knowledge in different ways and to use the SBD in ways that make sense and are interesting to them. The images below are examples from the SBD that incorporate these “universally designed” features.

A Sample Category Page

Signing Bioscience Dictionary

- type or paste word - Search

HOME

Categories

- Animal Structure & Function
- Atomic & Molecular Structure
- Cellular Structure & Function
- Ecology & Ecosystems
- Energy & Magnetism
- Evolution & Diversity
- Health
- Heredity & Genetics
- Matter & Substances
- Plant Structure & Function
- Reproduction
- Scientific Methods, Measures & Tools

Aa Aa Aa

A Sample Dictionary Page

Signing Bioscience Dictionary

- type or paste word - Search

HOME

Categories

fission, noun

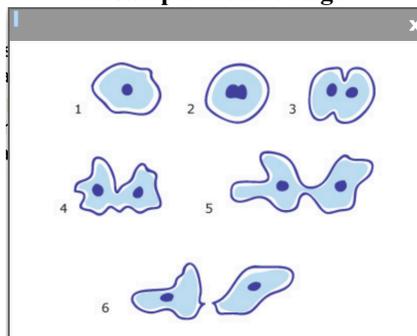
Fission is the process of splitting into two parts. Binary fission is a type of asexual reproduction common among prokaryotes in which a cell divides, giving rise to two cells, each having the potential to grow to the size of the original cell. [ASL](#)

Letter List

Previous Word (English)

Aa Aa Aa

A Sample Picture Page



OBJECTIVES and GOALS

To establish effectiveness and to find out how to make improvements with subsequent versions, research involved formative evaluation that investigated three primary research questions: 1) How do Lamar undergraduate ITP students use the SBD to learn life science terms? 2) How effective is the SBD in increasing Lamar undergraduate ITP students' knowledge of the vocabulary and ability to sign life science terms? 3) How effective is the SBD in increasing Lamar undergraduate ITP students' capacity to accurately and clearly interpret content typically taught in undergraduate biology courses? 4) What additions and/or changes would make the SBD more effective?

METHODOLOGY

After preparing the prototype SBD, Lamar, in consultation with TERC, identified three topics and sets of terms to use for testing. These were Reproduction, Heredity & Genetics, and Ecology & Ecosystems. These topics were selected because they incorporate biology terms and content that interpreters are likely to encounter in a variety of academic and non-academic settings. Evaluation incorporated a mixed-measurement design that integrated qualitative and quantitative methods, in which the outcome of interest was measured for participants only.

The Lamar team, under the leadership of the Co-PI, had primary responsibility for all aspects of the research associated with incorporating the SBD into instruction and having students use it to learn signs and practice using them to accurately and clearly interpret material. They also had primary responsibility for data collection. Responsibilities for data preparation and analysis were shared among TERC and Lamar. The TERC team was responsible for report writing. The PI from TERC and the Co-PI from Lamar collaborated and provided guidance throughout the evaluation.

Pilot Study

Protocols—Prior to conducting the year-long evaluation during the 2018-19 academic year, the Lamar team ran a small pilot study during the summer to determine that the research design would provide the desired results. It used the 53 terms in the SBD category of Reproduction and included a pre-session, two study sessions, and a post-session. The pre- and post-sessions were approximately an hour in length, while the two study sessions were each two hours in length. Students were recruited by faculty in interpreting classes, who helped to select students for the pilot study.

For the pre-session, students completed a Consent Form and Participant Information Form. They also completed a Pre-Matching Quiz to see if they could match each of the terms with their definitions. For the two study sessions, participants used the interactive SBD features to learn, practice, and review the signs and content of terms from the list of terms in any order as often as they liked. As they worked, a research assistant observed and completed an Observation Form that incorporated what participants did and any comments they made. For the post-session, participants completed a Post-Matching Quiz. They also completed a Survey that provided information about their experiences with the SBD.

Participant Demographics— The Lamar Department of Deaf Studies and Deaf Education has a BA in ASL with three tracks that include ASL Teaching K-12, Educational interpreting, and Advocacy. The pilot study included four female undergraduate senior interpreting students. Each student had completed ASL VI and was in the Education Interpreting track. Participant 1 self-reported an intermediate ASL proficiency level, while the other three participants self-reported an advanced ASL proficiency level.

Results—Participants 2 and 3 completed all four sessions. Participants 1 and Participant 4 did not complete the Post-session. Scores and comments from the survey are provided below:

Participant 1—Pre- Post Vocabulary Matching Scores-30/53.

Participant 2— Pre- Post Vocabulary Matching Scores -42/53.

Observations/Comments-Cool. Interesting. Beneficial. Would use SBD again. Valuable resource. Learning many new signs. Avatar more difficult to understand than video of a live person. Avatar signing more English. Avatar follows word definition with sign, therefore hard to conceptualize. Enjoyed the learning experience. Surprised how well were able to recall the avatar's signs.

Post- Matching Score-45/53.

Survey-Participant disagreed that SBD made it easier to learn science words and definitions. Somewhat satisfied with accuracy of signs, understanding the avatar and with the avatar's facial expressions. While seeing the avatar sign the English definition was helpful, it did not help with the grasp of the actual concept.

Participant 3—Pre-Matching Score-42/53.

Observations/Comments-Difficult to understand the avatars, but became comfortable after a few repetitions. Avatars sign in English word order, more so than in ASL. Looked up other terms in the SBD.

Post Matching Score-49/53.

Survey-Participant stated being somewhat satisfied with accuracy of signs, understanding of the avatar, and with avatar's facial expressions. Would like SBD to be more ASL with classifiers. Sometimes pauses between signs were too long.

Participant 4—Pre-Matching Score-39/53.

Observations/Comments-Like it. Refresher for biology class, and learning how to interpret this information. Cool tool. Some videos used signs for terms that have not been exposed to, so took some time to figure those out. The avatar's signing is very English. More ASL, with classifiers would be beneficial. Inconsistency with signs, example sperm is signed two different way with no explanation.

Findings —The results of the pilot study demonstrated that the procedures would provide the desired information. It also gave the team insight into how to provide effective instruction and support participants in use of the SBD It also helped them understand that they needed to convey to students that they were not expected to know the meaning of many of the terms and their signs at the outset, but that this is what they would learn as they went. An additional finding was that the term *endometrium* was not in the SBD. For this reason, it was removed from the list of terms used for the formative evaluation.

Formative Evaluation

Protocols—The formative evaluation went from September 2018 to the end of April 2019. It was divided into three units. Each unit focused on terms for one of the SBD topics

identified for the study. Unit 1 focused on Reproduction. Unit 2 focused on Heredity & Genetics. Unit 3 focused on Ecology & Ecosystems. Each unit was done using computers within the Deaf Studies and Deaf Education labs in the department on computers equipped with ScreenFlow software to capture participants use of the dictionary. The evaluation included a pre-session, two study sessions, and a post-session. Each individual session was two hours long. To recruit participants, flyers were posted throughout the Department of Deaf Studies and Deaf Education building so that students were aware of the opportunity. Faculty also announced it in their classes and gave some students extra credit for participating. IRB approval for the study was obtained from both TERC and Lamar University's IRB.

In addition to the Co-PI, a faculty member from the Department, two Designated Interpreters, and several undergraduate research assistants were involved in data collection. At the beginning of the first pre-session, participants completed Lamar's requirements for working with human subjects. This involved reading and signing a consent form. They also filled out a Participant Information Form. This form provided information for use during analysis such as ASL course level and sign proficiency level. The remainder of the first pre-session, as well as all the other two pre-sessions, involved a brief introduction to the unit topic, a Matching Vocabulary Pre-test, a Signing Pre-test, and a Pre-Interpreting Sample.

The Matching Vocabulary Pre-test was a paper and pencil test that asked participants to match each of the terms for the unit topic with their definitions. Scores provided baseline information about participants' knowledge of the vocabulary for the unit prior to using the SBD. For the Signing Vocabulary Pre-test, each participant was asked to sign the terms for the unit topic while a researcher watched and recorded "yes" if the sign was correct and "no" if it was incorrect or if the participant said they did not know the sign for the term. Scores provided baseline information about participants' ability to sign the terms for the unit topic prior to using the dictionary.

For the Pre-Interpreting Sample, participants were asked to interpret content for the unit topic that was presented by one of the researchers as a spoken language presentation that included Powerpoint slides from a pre-recorded video to provide consistency across participants. The interpreting sample for each participant was video recorded, using Photo Booth, and used for coding and analysis. Scores provided baseline information about participants' ability to interpret material that incorporated the unit terms prior to using the SBD.

At the beginning of each first study session, one of the faculty members from the Department or one of the Designated Interpreters demonstrated use of the SBD and distributed a terms list. During the study sessions, participants used the SBD to study and practice terms in the vocabulary list for the unit while Screen Flow recorded which terms they looked up and what interactive features they used to practice signs and study the meaning of terms. The faculty observed each participant at work, and completed an Observation Form. The Screen Flow recordings and observations data provided information about use of the dictionary.

During the post-session participants completed a Matching Vocabulary Post-test, a Signing Vocabulary Post-test, and a Post-Interpreting Sample that were the same as those used for the pre-session. Scores provided information about change in participants' knowledge of the topic content and ability to sign relevant terms and interpret related material. They also completed a Student Participant Survey that provided information about their experiences in using the dictionary and thoughts about how it could be improved.

Appendix A provides the vocabulary lists that were used for each unit. Appendix B provides copies of the flyers. Appendix C provides copies of the Participant Information Form,

Observation Form, Student Participant Survey, and sample pages from the Powerpoint slides used for the interpreting sample.

RESULTS

We organized our results around each of our four research questions: 1) How do Lamar undergraduate ITP students use the SBD to learn life science terms? 2) How effective is the SBD in increasing Lamar undergraduate students' knowledge of the vocabulary and ability to sign life science terms? 3) How effective is the SBD in increasing Lamar undergraduate students' capacity to accurately and clearly interpret content typically taught in undergraduate biology courses? 4) What additions and/or changes would make the SBD more effective? Summaries of results are provided for questions 1-3.

Participant Demographics

The study sample was comprised of 31 students, five of whom dropped out before the end of the evaluation, for a total of 26 undergraduate ASL student participants who completed the evaluation. They represented Lamar's three Department of Deaf Studies and Deaf Education tracks. As mentioned, these tracks include ASL Teaching K-12, Educational Interpreting, and Advocacy. The Participant Information Forms provided information about the demographics of these students that is summarized below.

Student Participant Demographics

Participant #	Ethnicity	Gender	Year in Program	ASL Level	Interpreter	Dropped
1	White	Female	First	1	Yes	
2	Latino/Hispanic	Female	Second	?		
3	White	Female	Third	5		
4	AA/Black	Female	Fourth	4		
5	Latino/Hispanic	Female	Second	3	Yes	
6	White	Female	Second	3		
7	White	Female	Third	5		
8	White	Female	Third	5		
9	AA/Black	Female	Second	4		
10	Latino/Hispanic	Female	Third	5		
11	Latino/Hispanic	Female	Third	5		
12	White	Female	First	3		
13	White	Female	Third	4		
14	Latino/Hispanic	Female	Second	3		
15	AA/Black	Female	Third	6		
16	AA/Black	Female	Third	3		
17	White	Female	Second	4		
18	Latino/Hispanic	Female	Third	4		
19	Latino/Hispanic	Female	Fourth	4		
20	White	Female	Third	6		
21	Latino/Hispanic	Female	Second	2		
22	White	Female	Second	5		
23	White	Female	Third	6		
24	Latino/Hispanic	Female	First	1		
25	Latino/Hispanic	Female	First	1		
26	White	Female	?	1		

Research Question 1: *How do Lamar undergraduate ITP students use the SBD to learn life science terms?*

The Observation Form provided data for the results presented in Table 1a. The ScreenFlow recordings provided data for the results presented in Table 1b. The Survey for Student Participants provided data for the results in Table 1c. Each data set provides information about participants' use of the SBD.

Table 1a: Observed Use of the SBD

Units	Use of the Interactive Features*	Activities Related to Use	Researchers' Perceptions
1: Reproduction 2: Heredity & Genetics 3: Ecology & Ecosystems	Played Video/Watched Avatars-243 Signed with the Avatar-61 Found terms using alphabet bar-52 Found terms using search box-22 Found terms using categories-0** Use/scrolls terms list-10 terms- Read English definitions-151 Viewed pictures-22 Listened to audio-5 Used pause, play, rewind-23 Changed text size-1 Used Full screen-3	Followed written word list-79 Practiced signing (not watching the Avatar)-68 Fingerspelled-2 Took notes-107 Reviewed notes-38 Used flash cards-5 Highlighted-2 Drew pictures-1 Asked for clarification of signs-22	Comfortable with use-19 Struggled with understanding avatar or use of tool-13 Positive experience-10 Neutral experience-9 Nervous during experience-1 Bored with experience-3*** Seemed confused-1 Tired of the experience-3 Interested and Engaged-12

*-The numbers represent the total number of students the observers saw doing the action while circulating from computer to computer and observing students using the SBD to learn and practice terms during study sessions 1 and 2 for units 1-3.

** -This feature was not demonstrated during the part of the session that involved showing participants how to use the tool.

***-Observers noted that boredom or tiring might be due to the study sessions being for too long (2 hours each).

Table 1b: ScreenFlow Recorded Use of the SBD

Unit: Study Session Number	Use of the Interactive Features	Terms Looked Up	Average Time per Term	Terms Looked Up*
Reproduction: 1	Typed terms into the search box. Watched the term and definition signed in ASL. Sometimes paused the video and restarted it. Occasionally watched the video 2 or 3 times.	41	2 minutes	amniocentesis, cleavage, asexual reproduction, egg (1), estrogen, fertilization, fetus, gestation, menstrual cycle, ovary, ovulation, placenta, fetus, placenta, scrotum, semen, sexual reproduction, sperm, testes, testosterone, uterus, vagina, vas deferens, endoderm, fission, follicle, gonad, mammary gland, mesoderm, progesterone, blastocyst, blastula, follicle stimulating hormone (FSH), oocyte, oviduct, amnion, ascus,

				corpus luteum, ovulation, ectoderm, epididymis
Reproduction: 2	Found terms using the alphabetical list. Watched the term and definition signed in ASL. Sometimes paused the video and restarted it. Occasionally watched the video 2 or 3 times.	47	2.5 minutes	reproduction, amniocentesis, asexual reproduction, cleavage, egg (1), egg (2), egg (1), estrogen, fertilization, fetus, gestation, menstrual cycle, ovary, ovulation, placenta, scrotum, semen, testes, testosterone, uterus, vagina, vas deferens, endoderm, fission, follicle, gonad, mammary gland, mesoderm, progesterone, blastocyst, blastula, follicle stimulating hormone (FSH), oocyte, oviduct, amnion, ascus, corpus luteum, ectoderm, epididymis, fertile, gastrula, germ cell, in vitro, in vivo, luteinizing hormone, ovum
Heredity & Genetics: 1	Users found terms using the alphabetical list; watched the term and definition signed in ASL; Sometimes pauses the video and restarts it; occasionally watches the video 2 or 3 times.	44	1.3 minutes	chromosome, clone, chromatin, codon, cytokinesis, conjugation, chromatid, deoxyribonucleic acid (DNA), dihybrid cross, DNA polymerase, diploid 2n, gene, genetics, genome, gamete, gene expression, genetic engineering, genotype, heredity, hybrid, haploid, heterozygous, mutation, messenger RNA (mRNA), monohybrid cross, sex chromosome, sex linkage, trait, transcription, transfer RNA (tRNA), translocation, allele, karyotype, nucleic acid, phenotype, Punnett square, polyploid, ribonucleic acid (RNA), ribose, oncogene, dominant, genetic code, genetic material, hereditary
Heredity & Genetics: 2	Typed terms into the search box. Watched the term and definition signed in ASL. Sometimes paused the video and restarted it. Occasionally watched the video 2 or 3 times or enlarged the signing window several times.	18	5 minutes	haploid, heterozygous, karyotype, messenger RNA (mRNA), nucleic acid, Punnett square, ribonucleic acid (RNA), sex-linkage, transcription, transfer RNA (tRNA), DNA polymerase, oncogene, translocation, genetic code, intron, RNA polymerase, translocation, oncogene
Ecology & Ecosystems: 1**	Found terms using the alphabetical list. Watched the term and definition signed in ASL. Sometimes	32	3.7 minutes	climate, competition, consumer, ecology, ecosystem, food chain, food web, greenhouse effect, hibernate, host, parasite, producer, symbiosis, biome,

	paused the video and restarted it. Occasionally watched the video 2 or 3 times.			biosphere, biotic, decomposer, heterotroph, habitat, hydrologic cycle, abiotic, colony, carbon cycle, commensalism, carbon cycle, nitrogen cycle, eutrophication, decomposition, environment, erosion, estivate, eutrophic
--	---	--	--	--

*- Participants looked up terms in an order that suited them. The list of Terms Looked up is presented in the order which terms appeared in the Screen Flow data.

** - There are no ScreenFlow recordings for Study Session 2 for Ecology & Ecosystems as researchers neglected to turn ScreenFlow on.

Table 1c: Participants' Perceptions of SBD Use

Question	Responses*
How easy for you was it to find information?	very easy-20, 22, 24; fairly easy-5, 4, 2; possible with trial and error-1, 0, 0
How easy was it for you to use without help?	no help-19, 22, 21; some help-6, 4, 5; a lot of help-1,0, 0
How helpful was the dictionary?	a lot-25, 23, 25; a bit-1, 3, 1
How did you use the dictionary?	learn new signs-26, 26, 24; learn science-16, 18, 21; be able to discuss/explain things-18, 16, 16; understand written information-14, 14, 9; to help do homework-0, 1, 0; hear definitions-14, 20, 7; look up words in English-4, 2, 1
How did you look at words?	ASL-26, 23, 24; English text-26, 24 5; voiced-26, 4, 2
How did you look at definitions?	ASL-25, 24, 26; English text-24, 26, 25; illustrations-9, 8, 9; voiced-2, 3, 1
How did you find terms?	search box-12, 13, 15; alphabet bar-19, 17, 20; categories-1, 1, 1
Would you like to use the dictionary again?	yes-26; 26; 26
Using the signing dictionary was fun.	agreed-25, 26, 26; disagreed-1, 0, 0
It made it easier to learn science words/ definitions.	Agreed-26; 26, 26
Using the dictionary helped me learn on my own.	agreed-25, 26, 26; disagreed-1, 0, 0
Did you use the dictionary to learn new signs?	yes-26 (reproduction-9; all terms-8; mammary gland-5; sperm-5; scrotum=4; fertilization-4; embryo-3); 26 (chromosome-10; all terms-8; genetics-4; haploid-4; trait-3; DNA/RNA-3); 25 (predator-8; all terms-1; environment-4; ecosystem-3; resources-2
Did you use it to learn the meaning of a word that you did not know or were not sure about?	yes- 24 (all terms -6; amniocentesis-4; ascus-2); 25 (all terms-7; all terms-7; chromatid-3; oncogene-20); 22 (all terms-7; estivate-6; heterotroph-2)

*-Data are grouped for Reproduction; Heredity & Genetics, Ecology & Ecosystems

Summary of Results for Research Question 1— Participants used the SBD during the study sessions in ways that met their individual needs. Specifically, they used the Alphabet Bar and Search box to look up terms. They used ASL and/or English text to learn signs and learn content. Occasionally, they viewed the ASL definition for a term several times in a row. They also paused and restarted the signing. Generally, they found the dictionary useful, fun, and easy to use.

Research Question 2: *How effective is the SBD in increasing Lamar undergraduate ITP students' knowledge of life science vocabulary and ability to sign life science terms?*

Increasing Knowledge of Life Science Vocabulary—As described previously, the Matching Vocabulary Pre- and Post-test asked participants to match each of the terms for the unit topic with their definitions prior to and after using the SBD. Change in scores provided data for the results in Table 2a. They provide information about effectiveness of the SBD in increasing participants' knowledge of the vocabulary for each of the units of study.

Table 2a: Vocabulary Knowledge (N=26)

Pair	Mean Score	Std. Deviation	Std. Mean Error	95% Confidence Interval of Difference*
Reproduction: Pair 1				
Matching Pre-test	18.50	8.377	1.643	
Matching Post-test	31.73	9.804	1.923	
Pre- Post- Difference	13.23	7.112	1.395	Lower: 10.358; Upper: 16.105
Heredity & Genetics: Pair 2				
Matching Pre-test	13.58	10.041	1.969	
Matching Post-test	23.38	12.293	2.411	
Pre- Post- Difference	9.808	5.933	1.164	Lower: 7.411; Upper: 12.204
Ecology & Ecosystems: Pair 3				
Matching Pre-test	29.46	10.277	2.016	
Matching Post-test	41.96	10.348	2.029	
Pre- Post- Difference	12.500	6.288	1.233	Lower: 9.960; Upper: 15.040

*-See Paired Differences below.

Paired Differences

Pair	t	Df	Significance (2 tailed)
Reproduction: Pair 1	9.486	25	.000
Heredity & Genetics: Pair 2	8.429	25	.000
Ecology & Ecosystems: Pair 3	10.136	25	.000

Increasing Ability to Sign Life Science Terms—As described previously, the Signing Vocabulary Pre- and Post-test asked participants to sign the terms for the unit topic prior to and after using the SBD. As the individual signed, a researcher watched and recorded “yes” if the sign was correct and “no” if it was incorrect or if they said they did not know the sign for the term. Change in scores provided data for the results in Table 2b. They provide information about effectiveness of the SBD in increasing participants' ability to sign the unit vocabulary.

Table 2b: Signing Ability (N=26)

Pair	Mean Score	Std. Deviation	Std. Mean Error	95% Confidence Interval of Difference*
Reproduction: Pair 1				
Signing Pre-test	8.92	12.293	2.411	
Signing Post-test	56.50	20.217	3.965	
Pre- Post- Difference	47.58	22.536	4.420	Lower: 38.475; Upper: 56.679
Heredity & Genetics: Pair 2				
Signing Pre-test	11.08	12.834	2.517	
Signing Post-test	46.19	17.915	3.513	
Pre- Post- Difference	35.12	24.382	4.782	Lower: 25.267; Upper: 44.964

Ecology & Ecosystems: Pair 3				
Signing Pre-test	15.85	15.309	3.002	
Signing Post-test	57.96	17.505	3.433	
Pre- Post- Difference	42.12	16.640	3.263	Lower: 35.394; Upper: 48.837

*-See Paired Differences below.

Paired Differences

Pair	t	Df	Significance (2 tailed)
Reproduction: Pair 1	10.765	25	.000
Heredity & Genetics: Pair 2	7.344	25	.000
Ecology & Ecosystems: Pair 3	12.905	25	.000

Summary of Results for Research Question 2—The standard deviations for participants/ pre- post- knowledge of the unit vocabulary and their ability to sign the terms show a high level of variability. However, as shown by the change scores, use of the SBD resulted in increased performance in both areas for each of the three units. The paired t tests for the vocabulary and signing change confirm that both knowledge of the vocabulary and signing ability increased with use of the SBD.

Research Question 3: *How effective is the SBD in increasing Lamar undergraduate ITP students' capacity to accurately and clearly interpret content typically taught in undergraduate biology courses?*

Scoring of the Pre- and Post-Interpretation. Two interpreters created an overall interpretation score for both the pre- and post-interpretation sessions. Each of the three sections were evaluated and then averaged into an overall score for both the pre-interpretation as well as the post-interpretation. Each video was scored on five measures, including; fluency, sign production and clarity, fingerspelling production and clarity, conceptual accuracy, and processing time. Each of the five measures were scored on a five-point scale, with one being poor and five being excellent.

Summary of Results for Research Question 3—The mean score for the pre-interpretation measure was 11.2 out of 25, with a range of five to 20. The standard deviation was 4.2 for this measure. The mean score for the post-interpretation measure was 11.0 out of 25, with a range of between 5 and 20. The standard deviation for this measure was 4.3. Participants were extremely consistent across the pre- and post-interpretations, with little variation in terms of individual change scores.

Next, correlations were conducted on the post-interpretation scores as there were no changes across the participants. Spearman correlations were calculated as the background variables were categorical. The only significant correlation was year in program and ASL level ($r=.66$, $p=.01$; two tailed). This relationship is colinear in that for many of the students, year in program was related to their class level of ASL; it is not perfectly colinear as many students entered the program with higher levels of ASL skill while others entered having never taken an ASL class prior to enrolling in the program.

Both variables were entered into a regression analysis using SPSS. Only ASL level was significantly related to the outcome; therefore, a simple regression was re-run and is shown below.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		
	B	Std. Error	Beta			Lower Bound	Upper Bound	
1	(Constant)	6.051	2.250		2.689	.013	1.385	10.717
	ASL level	1.285	.537	.455	2.395	.026	.172	2.398

a. Dependent Variable: Post Interpreting Scores

The R for this model is .455 and the R Square is .207. Therefore, ASL level predicts a bit more than 20% of the variance in the post-interpretation measure.

Research Question 4: *What additions and/or changes would make the SBD more effective?*

The Survey for Student Participants related to their satisfaction with the dictionary provided data for the results in Table 4. They will be used to identify additions or changes to subsequent versions of the SBD to make it more effective.

Table 4: Satisfaction with the SBD

Question	Responses*
How satisfied were you with: the information available for each term? accuracy of the signs? understanding of the avatar? avatar’s facial expressions?	completely satisfied-20, 24, 25; somewhat satisfied-4, 2, 1; not satisfied-0, 0, 0 completely satisfied-17, 15, 15; somewhat satisfied-7, 11, 10; not satisfied-0, 0,1 completely satisfied-10,9,8; somewhat satisfied-13, 16, 17; not satisfied-1, 1, 1 completely satisfied- 16, 12, 15; somewhat satisfied-6, 14, 10; not satisfied-2, 0,1
What are examples of signs that were not accurate or made them hard to understand?	signs varied for some words which was confusing-3, 4; struggled to understand a sign-3, 2 (sign for “sugar” as it was old),
What do you like about the dictionary?	options for learning-11, 4,0 bilingual (available in ASL and English)-11, 8,10 learning independently at own pace-3,1,0 can rewatch/replay as often as you want-3, 3, 3 accessibility-3, 3, 0 ease of use-11, 8, 6
What do you dislike about the dictionary?	avatars are difficult to understand-8, 5, 7 (choppy; lack of contrast in skin color and clothing) no way to slow the video-2, 6, 5 do not like avatars, prefer a person-2, 0, 0 not all terms within the definitions were not included-2, 0, 2 signing more English than ASL-0, 2, 0

*-Data are grouped for Reproduction; Heredity & Genetics, Ecology & Ecosystems

Summary of Results for Research Question 4— Most participants were generally satisfied with the information that was available for each term, with the accuracy of the signs, with their ability to understand the avatar, and with the avatar’s facial expressions. Some preferred a human signer to an avatar or found the avatar difficult to understand. Some found the signing choppy and the contrast between clothing and skin color to be insufficient and that this interfered with seeing the signing. Others mentioned not being able to change the signing speed. Some would like all of the terms in the definitions included in the word lists.

KEY FINDINGS

Research Question 1: *How do Lamar undergraduate ITP students use the SBD to learn life science terms?*

The results for the Reproduction, Heredity & Genetics, and Ecology & Ecosystems unit indicate that most of the study participants found the SBD helpful and easy to use. They used it, to look up terms and definitions in ASL and English; see words signed; view illustrations; learn new signs; and learn more about science. Only a few used the Category look up or audio feature. Most participants used the SBD to learn new signs and to learn the meaning of a term either because they did not know it or to help them review their knowledge of an aspect of biology content. They were generally satisfied with the information that was available for each term, with the accuracy of the signs, with their ability to understand the avatar, and with the avatar’s facial expressions. All of the participants found that use of the dictionary made learning science terms and definitions easier. It also helped them learn on their own. Most had fun using the dictionary and would use it again.

Research Question 2: *How effective is the SBD in increasing Lamar undergraduate ITP students’ knowledge of life science vocabulary and ability to sign life science terms?*

As stated previously, the standard deviations for participants’ pre- post-knowledge of the life science vocabulary for each of the three units and their ability to sign it show a high level of variability. As shown by the change scores, use of the SBD resulted in increased performance in participants’ knowledge of the life science vocabulary and related content presented in the definitions for each of the three units. The paired t tests for the vocabulary and signing change confirm that both knowledge of the vocabulary and signing ability increased with use of the SBD.

Research Question 3: *How effective is the SBD in increasing Lamar undergraduate ITP students’ capacity to accurately and clearly interpret content typically taught in undergraduate biology courses?*

Given the level of the students in the program, only two were able to produce a fluent interpretation. They incorporated classifiers into interpretations and demonstrated an effective

use of space. This was due to their having a better sign vocabulary to augment the STEM vocabulary and were more effective in the use of fingerspelling.

The other 24 participants were unable to effectively follow the typical pace of a biology lecture. Many had not taken interpreting coursework prior to participating in the study and made many sign production errors while interpreting. In addition, they were not conceptually accurate, used almost no classifiers, and were unable to effectively set up items in a spatial grammar. Their fingerspelling was also choppy.

These two sets of findings suggest that being able to keep up with the pace of a typical biology lecture and interpret it is a two-step process. The first step involves learning the content for the terms and the sign vocabulary related to this content. Next is learning how to integrate this knowledge into the process of interpreting. Many of the participants in the study were in lower level ASL classes and had not yet started the upper level interpreting classes. Therefore, the skills they needed to learn signs were strong. However, they had not yet developed the ability to produce a coherent interpretation.

Research Question 4: *What additions and/or changes would make the SBD more effective?*

As stated previously, most participants were generally satisfied with the information that was available for each term, with the accuracy of the signs, with their ability to understand the avatar, and with the avatar's facial expressions. Some preferred a human signer to an avatar or found the avatar difficult to understand. They also found that in some cases the signing was choppy and the contrast between clothing and skin color was insufficient and interfered with seeing the signing. Others mentioned not being able to change the signing speed. Some would like all of the terms in the definitions included in the word lists.

IMPLICATIONS of FINDINGS

Following completion of data collection, the Lamar team members who were worked with students during the study considered how effectiveness of the SBD might be improved. Their thoughts about changes to the SBD and to its classroom implementation follow.

Integration of New Knowledge into the Interpreting Process—A protocol to help students learn how to include chunking with the many vocabulary words that are fingerspelled needs to be developed and incorporated into the ASL interpreting program. This could be a curriculum component that is integrated into a course to help the students become more proficient at fingerspelling.

A solution to the problem of interpreting biology lecture content might be to connect a Biology class to an Interpreting class and design a curriculum to help interpreting students learn how to take biology content and interpret it accurately and effectively.

The interpreter track should strongly recommend, or consider requiring, science courses that are more typical to high school students and college students rather than more “trendy courses” that are fun and easy to pass, but often do not include the traditional science content they need to know to interpret classroom science content .

Resolving SBD Issues—One issue that emerged is that some of the Avatars are difficult to read because the contrast between their hands and clothes is not clear. This issue can sometimes make it difficult to see some of their movements clearly. In such cases, it might be preferable to use motion capture or humans to produce these signs.

Some of the signs within the dictionary are evolving and should again be checked by the ASL Science Experts to reflect these changes. For example, the sign for the term *cancer* is moving away from the traditional general sign to one that uses fingerspelling to include the type of cancer.

APPENDIX A

Unit 1: Reproduction Terms List

- | | | |
|-------------------------|------------------------------------|-------------------------|
| 1. amniocentesis | 19. follicle | 35. ovulation |
| 2. amnion | 20. follicle-stimulating hormone | 36. ovum |
| 3. ascus | 21. gastrula | 37. placenta |
| 4. asexual reproduction | 22. germ cell | 38. polar body |
| 5. blastocyst | 23. gestation | 39. progeny |
| 6. blastula | 24. gonad | 40. progesterone |
| 7. cleavage | 25. in vitro | 41. reproduce |
| 8. corpus luteum | 26. in vivo | 42. reproduction |
| 9. ectoderm | 27. incubate | 43. scrotum |
| 10. egg | 28. luteinizing hormone | 44. semen |
| 11. embryo | 29. mammary gland | 45. sex cell |
| 12. endoderm | 30. menstrual cycle (menstruation) | 46. sexual reproduction |
| 13. epididymis | 31. mesoderm | 47. sperm |
| 14. estrogen | 32. oocyte | 48. testes (testis) |
| 15. fertile | 33. ovary | 49. testosterone |
| 16. fertilization | 34. oviduct | 50. uterus |
| 17. fetus | | 51. vagina |
| 18. fission | | 52. vas deferens |

Unit 2: Heredity & Genetics

- | | | |
|--------------------------|----------------------|-----------------------------------|
| 1. allele | 19. genetic material | 37. phenotype |
| 2. chromatid | 20. genetics | 38. polyploid (polyploidy) |
| 3. chromatin | 21. genome | 39. Punnett square |
| 4. chromosome | 22. genotype | 40. recessive |
| 5. clone | 23. haploid (cell) | 41. replication |
| 6. codon | 24. hereditary | 42. ribonucleic acid |
| 7. conjugation | 25. heredity | 43. ribose |
| 8. cytokinesis | 26. heterozygous | 44. RNA polymerase |
| 9. deoxyribonucleic acid | 27. homozygous | 45. sex chromosome |
| 10. dihybrid cross | 28. hybrid | 46. sex-linkage (sex-linked gene) |
| 11. diploid | 29. intron | 47. substitution |
| 12. DNA polymerase | 30. karyotype | 48. trait |
| 13. dominant | 31. messenger RNA | 49. transcription |
| 14. gamete | 32. monohybrid cross | 50. transfer RNA |
| 15. gene | 33. mutation | 51. translation |
| 16. gene expression | 34. nucleic acid | 52. translocation |
| 17. genetic code | 35. nucleotide | |
| 18. genetic engineering | 36. oncogene | |

Unit 3: Ecology & Ecosystems

1. abiotic
2. autotroph
3. biome
4. biosphere
5. biotic
6. carbon cycle
7. colony
8. commensalism
9. competition
10. consumer
11. decomposer
12. decomposition
13. ecology
14. ecosystem
15. environment
16. erosion
17. estivate
18. eutrophic
19. eutrophication
20. evaporation
21. food chain
22. food pyramid
23. food web
24. geotropism
25. global warming
26. greenhouse effect
27. greenhouse gas
28. habitat
29. heterotroph
30. hibernate
31. host
32. hydrologic cycle
33. mesosphere
34. natural world
35. nitrogen cycle
36. nonrenewable resource
37. ozone
38. ozone layer
39. parasite
40. pollutant
41. predator
42. prey
43. producer
44. renewable resource
45. resource
46. scavenger
47. sedimentation
48. succession
49. symbiosis
50. trophic level
51. troposphere

APPENDIX B

Participation Solicitation Flyer 1

RESEARCH OPPORTUNITY

Are you an American Sign Language major who wants to enhance their interpreting skills? Do you like learning new signs? Do you gain satisfaction from enhancing the field of interpreting?

Incorporating STEM into Undergraduate Sign Language Interpreter Programs is the study for you!

The purpose of the research is to evaluate the effectiveness of a signing dictionary to increase knowledge of life science vocabulary for student interpreters. Come participate in the future of interpreting!

Benefits

- + Improve your ASL skills
- + Exposure to new signs
- + Extra credit in ASL/interpreting classes
- + \$20 gift card to the LU bookstore
- + Participate in research that will advance your field and benefit others

Requirements

- Current enrollment in an undergraduate DSDE course
- 3-4 hours available per week for 6 weeks
- Interpreting student (freshman-seniors)

Want to participate or
have questions?



Contacts:

Mandane Sweeten
msweeten@lamar.edu

Dr. Amber Marchut
amarchut@lamar.edu

Dr. Diane Clark
diane.clark@lamar.edu

Participation Solicitation Flyer 2

RESEARCH OPPORTUNITY

Incorporating STEM into Undergraduate Sign Language Interpreter Programs is the study for you! The purpose of the research is to evaluate the effectiveness of a signing dictionary to increase knowledge of life science vocabulary for student interpreters. Come participate in the future of interpreting!

Benefits:

- Improve your ASL skills
- Exposure to new signs
- Extra credit in ASL/Interpreting classes
- \$20 gift card to the LU bookstore
- Participate in research that will advance your field and benefit others

Requirements:

- Current enrollment in an undergraduate DSDE course
- 3-4 hours available per week for 6 weeks
- DSDE major

**Are you an
American Sign
Language Major?**

**Want to learn new
signs?**

**Want to enhance
the field of
Interpreting?**

**STEM research is
for you!**

QUESTIONS?

Contact us!

Dr. Amber Marchut

amarchut@lamar.edu

Dr. Diane Clark

Diane.clark@lamar.edu

APPENDIX C

Participant Information Form

Ethnic background

- American Indian/Alaskan Native
- Asian American
- African American/Black
- Latino/Hispanic
- American Indian/Alaskan Native
- White
- Other: _____

Which Year in the ASL Major are you currently?

- First Year
- Second Year
- Third Year
- Fourth Year

Please check each of the language, communication or sign system(s) that you use:

- Spoken English
- Spoken Spanish
- American Sign Language
- Signing Exact English
- Fingerspelling
- Simultaneous Communication (sign-supported speech)
- Manually Coded English Systems
- Cued Speech

Please list the level of ASL course that you are currently in or if you have completed ASL VI.

Level: _____

Please specify where you fall within the following “Sign Communication Proficiency Levels” (using guide on the next page):

- Superior
- Advanced
- Intermediate
- Survival
- Novice
- No Functional Skills

Guide to Sign Communication Proficiency Levels

Superior: Able to have a fully shared conversation, with in-depth elaboration for both social and work topics.

Advanced: Able to have a generally shared conversation with good, spontaneous elaboration for both social and work topics.

Intermediate: Able to discuss with some confidence routine social and work topics within a conversational format with some elaboration; generally 3-to-5 sentences.

Survival: Able to discuss basic social and work topics with responses generally 1-to-3 sentences in length.

Novice: Able to provide single sign and some short phrase/sentence responses to basic questions signed at a slow-to-moderate rate with frequent repetition and rephrasing.

No Functional Skills: (May be) Able to provide short single sign and “primarily” finger-spelled responses to some basic questions signed at a slow rate with extensive repetition and rephrasing.

Observation Form

Date:

Web Page being viewed:

Observer:

Length of Observation:

1. How is the tool introduced?
2. How do participants begin and proceed to use the tool? - i.e. where do they start, how do they decide which highlighted terms to click on?
3. Describe what participants are doing and saying as they click on terms and view the signed terms/definitions. Include examples of questions, responses and statements.
4. What features do participants use when they access the signed terms?
5. What are participants' reactions/actions in response to tool?

Survey for Student Participants

How easy for you was it to find information in the signing dictionary?

- very easy
- fairly easy
- possible with a little trial and error
- somewhat difficult
- impossible

How easy was it for you to use the signing dictionary without help from the research assistant?

- I didn't need any help
- I needed some help
- I needed a lot of help

How helpful was the dictionary?

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

How did you use the dictionaries? (Check all that apply.)

- I looked up words to learn new signs or see words signed.
- I looked up words to learn more about science.
- I looked up words to be able to discuss and explain something.
- I looked up words to help me understand written information.
- I looked up words to help me do my homework.
- I looked up words to hear their definitions and learn what they mean.
- I looked up words so I could communicate in English.

How did you look at words? (Check all that apply.)

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

How did you look at definitions? (Check all that apply.)

- I looked at definitions in ASL.
- I looked at definitions in English.
- I looked at illustrations in English.
- I listened to voiced definitions in English.

Which features did you use?

How did you find terms in the signing dictionary? (Check all that apply.)

- I typed words into the search box in English.
- I used the "alphabet bar" to click on the first letter of the word that I was looking for, and then found the word in the letter list.
- Other (please specify):

If you were unable to find something, was it because:

- It was not there.
- It was hard to find so you gave up.
- Other (please specify):

Would you like to use the dictionary again?

- Yes
- No

Using the signing dictionary was fun.

- Agree
- Disagree

Using the signing dictionary made it easier to learn science words and definitions.

- Agree
- Disagree

Using the signing dictionary helped me to learn on my own.

- Agree
- Disagree

Did you use the dictionary to learn new signs?

- Yes
- No

If yes, list the terms for which you learned signs:

Did you use the dictionaries to learn the meaning of a word that you did not know or were not sure about?

- Yes
- No

If yes, give an example:

Please indicate how satisfied you were with each of the following:

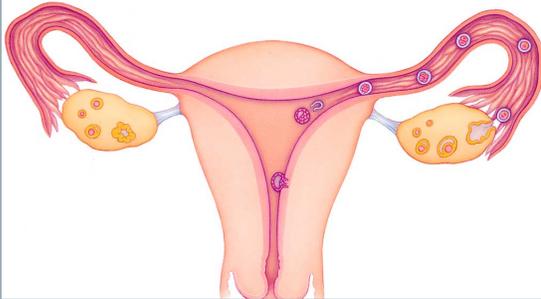
	Not Satisfied	Somewhat Satisfied	Completely Satisfied
Information available for each term	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Accuracy of the Signs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Understanding the Avatar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Avatar's Facial Expressions	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

If possible, please give examples of signs that were not accurate, and/or terms where the Avatar's facial expressions was incorrect or distracting:

What do you like about the signing dictionaries?

What do you dislike about the signing dictionaries?

Sample Page from the Reproduction Powerpoint Video



FERTILIZATION

The union of the nucleus of an ovum and the nucleus of a sperm to form a diploid zygote

- Internal (in vivo) fertilization: occurs inside the body of an organism (e.g. Humans)
- External (in vitro) fertilization occurs outside the body of an organism (e.g. Birds, Amphibians; a laboratory procedure in a test tube or petri dish)

Sample Page from the Heredity & Genetics Powerpoint Video

Cross: Aa x Aa

	A	a
A	AA	Aa
a	Aa	aa

PREDICTIVE MEASURES:

Punnett Square - a type of chart used to show combinations of alleles for gametes

Monohybrid Cross - genetic cross between two individuals that have different versions of a single-trait gene

Dihybrid Cross - genetic cross between two individuals that have two different traits

Dominant - has the most influence or control

Recessive - an allele or trait that is masked by a

Sample Page from the Ecology & Ecosystems Powerpoint Video

Earth's four different spheres

- ▶ Hydrosphere
- ▶ Lithosphere or geosphere
- ▶ Biosphere
- ▶ Atmosphere
 - ▶ Troposphere
 - ▶ Stratosphere
 - ▶ Mesosphere
 - ▶ Thermosphere

