



Figure 1. Components of ASL CLear with ASL based user interfaces: (a) Vocabulary Evaluation Tool, (b) Evaluation Screen and (c) Search Function: Handshape Screen

on English labels to ascertain meaning of ASL terms. The VET steers evaluators through a sequential protocol that repeats until all terms from a unit are evaluated: 1) view one complete micro-lecture, 2) view one ASL term from that lecture, 3) view ASL definition for that term, 4) view ASL example if provided, 5) respond to 7 ASL evaluation questions about the term by selecting from 5-part Likert scale or yes/no options (Figure 1b). In a small pilot ($n=5$), 16 of 20 terms scored at or above benchmark ($M=4$), suggesting potential for broad acceptance.

2.3 ASL CLear Search Function & Interface

The ASL *search function and interface* makes this a unique database that offers ASL search functionality via graphical representation of the string of visual building blocks that make up ASL signs, much like alphabetic print graphically represents the string of sounds that makes up a spoken word. ASL searches of tagged terms are conducted by selecting icons in three ASL feature arrays (Figure 1c). Clicking on any icon will bring up a results screen displaying all signs that contain the select feature, a design that provides instantaneous results and interactive training through use. Search results are presented in alignment with the principles of visual language. Freeze frames depict ASL STEM terms in recognizable form and hover play allows users to quickly scan, reject, and select terms from the results page. ASL CLear also provides STEM words in at least 3 ASL contexts to prevent the denotation and connotation confusion of single English word labeling. For example, a sign defined only with English word *table* could refer to an item of furniture, a chart, or a level (e.g. *water table*). Many users do not have the foundation to rely on contextual knowledge to bridge the information gaps, particularly early language deprived deaf children [8].

3. RELATED WORK

Seven U.S. online resources attempt to respond to the challenges faced by deaf students learning STEM (Table 1)¹. While five sites attempt to resolve denotation confusion by associating signed terms with English definitions, this does not address connotation, provide ASL context, or constitute a monolingual ASL dictionary entry. Existing resources do not answer questions often asked by deaf students and educators relating to ASL connotation and correct usage of STEM signs in instructional contexts. DeafTEC offers signed definitions of STEM terms, but these do not consistently adhere to ASL grammatical rules; rather English syntax is imposed on borrowed ASL lexicon. Another proof of concept

provides ASL-based search; however, the corpus of signs it uses have not been vetted by native signing Deaf STEM experts [3].

4. CONCLUSION

The ASL CLear provides complete, accurate, academically rigorous and standardized bilingual access to STEM material presented in instructional contexts by Deaf STEM experts, which will facilitate deeper understanding of academic content [4,5]. For K-12 deaf children, parents, and educators, the ASL CLear offers a rare opportunity to build understanding from the most basic STEM content to the most complex. The ASL CLear models consistent use of a single ASL term to represent a single concept such as *photosynthesis* in varying contexts. Deaf children deserve resources that build solid foundations in core STEM content and vocabulary, contribute to fundamental understandings of how the world works, foster logical, analogical and inference-making skills, open the door to post-secondary education, and lead to satisfying careers in STEM fields.

5. REFERENCES

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¹ ASL STEM Forum: aslstem.cs.washington.edu,
 RIT ASL: www.rit.edu/ntid/dictionary
 DeafTEC: www.deaftec.org/stem-asl-video-dictionary
 Deaf STEM: www.shodor.org/deafstemterms/
 Signing App: signingapp.com
 Signing Math & Science: signsci.terc.edu/,
 Embe Outreach: www.needsoutreach.org/