Preliminary Findings of Usability Studies on an Ontology-Aware Taxon-by-Character Matrix Editor

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Abstract

Taxonomic treatments start with the creation of taxon-by-character matrices. Systematics authors recognized data ambiguity issues in published phenotypic characters and are willing to adopt an ontology-aware authoring tool (Cui et al. 2022). To promote interoperable and reusable taxonomic treatments, we have developed two research prototypes:

1. a web-based application, Character Recorder (http://chrecorder.lusites.xyz/login), to faciliate the use and addition of ontology terms by *Carex* systematist authors while building their matrices, and
2. a mobile application, Conflict Resolver (Android, https://tinyurl.com/5cfatrz8), to identify potential conflicts among the terms added by the authors and facilitate the resolution of the conflicts. We have completed two usability studies on Character Recorder.

In the one-hour Student Usabiilty Study, 16 third-year biology students with a general introduction to *Carex* used Character Recorder and Excel to record a set of 11 given characters for two samples (shape of sheath summits = U-shaped/U shaped). In the three-day Expert Usability Study, 7 established Carex systematists and 1 graduate student with expert-level knowledge used Character Recorder to record characters for 1 sample each of *Carex* canesens and *Carex* rostrata as they would in their professional life, using real mounted specimens, microscope, reticles, and rulers. Experts activities were not timed but they spent roughly 1.5 days on recording the characters and the rest of time discussing features and improvements.

Features of Character Recorder have been reported in 2021 TDWG meeting and we included here only a few figures to highlight its interoperability and reusability features at the time of the usability studies (Fig. 1, Fig. 2, and Fig. 3). The *Carex* Ontology accompanying Character Recorder was created by extracting terms from *Carex* treatments of Flora of China and Flora of North America using Explorer of Taxon Concept (Cui et al. 2016) with subsequent manual edits. The design principle of Character Recorder is to encourage standardization and also leave the authors the freedom to do their work.

While it took students an average of 6 minutes to recover all the given characters using Microsoft® Excel®, as opposed to 11 minutes using Character Recorder, the total number of unique meaning-bearing words used in their characters was 116 with Excel versus 30 with Character Recorder, showing the power of the latter in reducing synonyms and spelling variations. All students reported that they learned to use Character Recorder quickly and some even thought their use was as fast or faster than using Excel. All preferred Character Recorder to Excel for teaching students to record character data. Nearly all of the students found Character Recorder was more useful for recording clear and consistent data and all students agreed that participating in this study raised their awareness of data variation issues.

The expert group consisted of 3, 2, 1, 3 experts in age ranges 20-49, 50-59, 60-69, and >69, respectively. They each recorded over 100 characters for two or more samples. Detailed analysis of their characters is pending, but we have noticed color characters have more variations than other characters (Fig. 4). All experts reported that they learned to use Character Recorder quickly, and 6 out of 8 believed they would not need a tutorial the next time they used it. One out of 8 experts somewhat disliked the feature of reusing others' values ("Use This" in Fig. 2) as it may undermine the objectivity and independence of an author. All experts used Recommended Set of Characters and they liked the term suggestion and illustration features shown in Figs 2, 3. All experts would recommend that their colleagues try Character Recorder and recommended that it be further developed and integrated into every taxonomist's toolbox.

Student and expert responses to the National Aeronautics and Space Administration Task Load Index (NASA-TLX, Hart and Staveland 1988) are summarized in Fig. 5, which suggests that, while Character Recorder may incur in a slightly higher cost, the performance it supports outweighs its cost, especially for students.

Every piece of the software prototypes and associated resources are open for anyone to access or further develop. We thank all student and expert participants and US National Science Foundation for their support in this research. We thank Harris & Harris and Presses de l'Université Laval for the permissions to use their phenotype illustrations in Character Recorder.

Keywords

software evaluation, FAIR phenotype data, Carex ontology, taxonomic education

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Conflicts of interest

References

- Cui H, Xu D, Chong S, Ramirez M, Rodenhausen T, Macklin J, Ludäscher B, Morris R, Soto E, Koch NM (2016) Introducing Explorer of Taxon Concepts with a case study on spider measurement matrix building. BMC Bioinformatics 17 (1). https://doi.org/10.1186/s12859-016-1352-7
- Cui H, Ford B, Starr J, Reznicek A, Zhang L, Macklin JA (2022) Authors' attitude toward adopting a new workflow to improve the computability of phenotype publications. Database 2022 https://doi.org/10.1093/database/baac001
- Hart S, Staveland L (1988) Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research. Advances in Psychology139-183. https://doi.org/10.1016/s0166-4115(08)62386-9

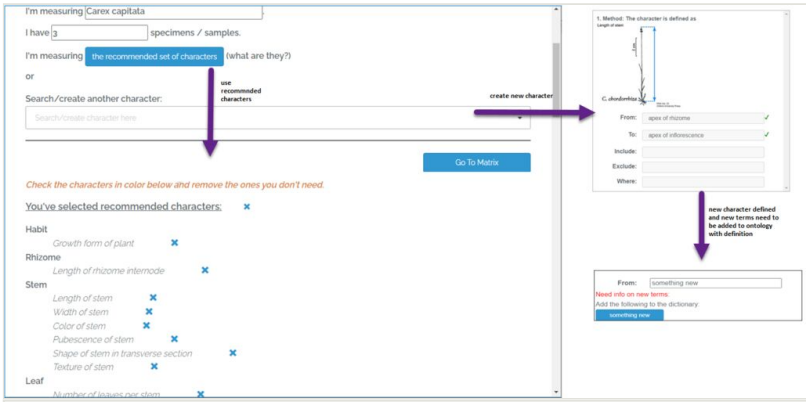

Figure 1.

Characters. Use Recommended Set of Characters and/or create new characters. The recommended set of characters is the minimal set of characters defined in the *Carex* Ontology that each *Carex* treatment should include. The large button encourages the user to use the recommended set of characters, but the user can also add specialized characters.

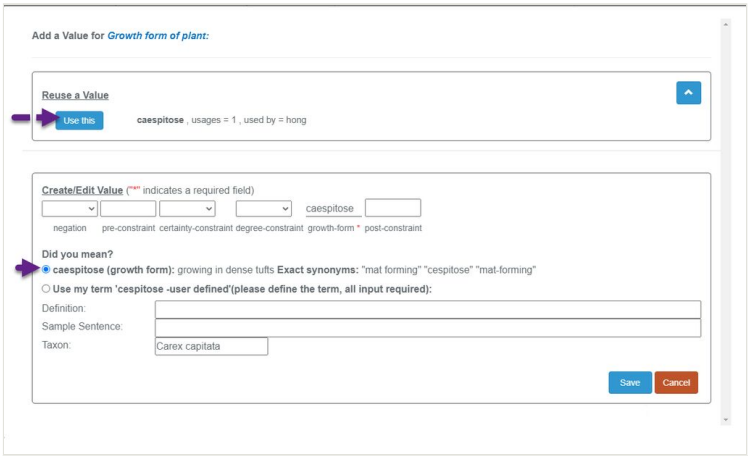

Figure 2.

Character values. Use existing ontology terms and/or add new terms to ontology. User's new values are *immediately* added to *Carex* Ontology and pushed to Conflict Resolver for review, to be either adopted or deprecated. Character values recorded by others for the same taxon and character are viewable and reusable by the user.

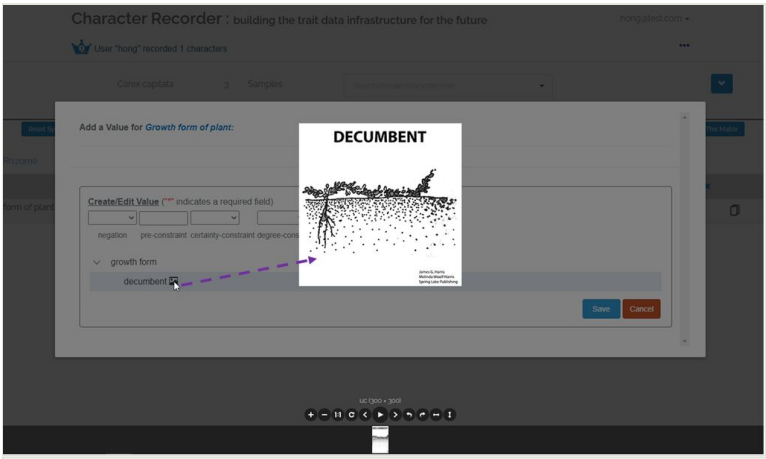

Figure 3.

The use of illustrations of character, character values, and color palettes. Definitions of characters are presented in verbal and graphical manners (Fig. 1), along with illustrations of character values. All the verbal definitions and illustrations are fetched from *Carex* Ontology. These help clarify the semantics of the character and character values.

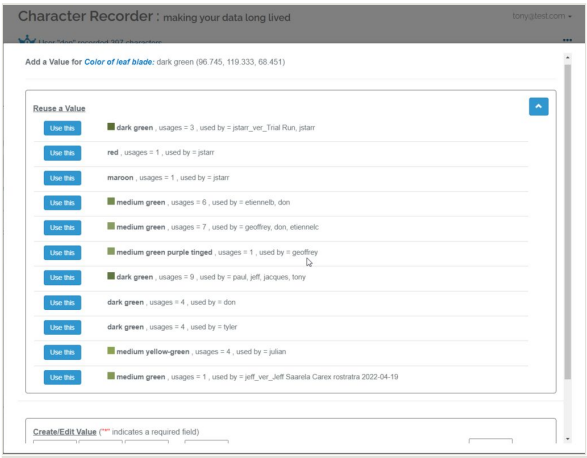

Figure 4.

Variation in recorded values for *Color of leaf blade*. Some users picked colors from Character Recorder's color palettes, while others chose to enter string values.

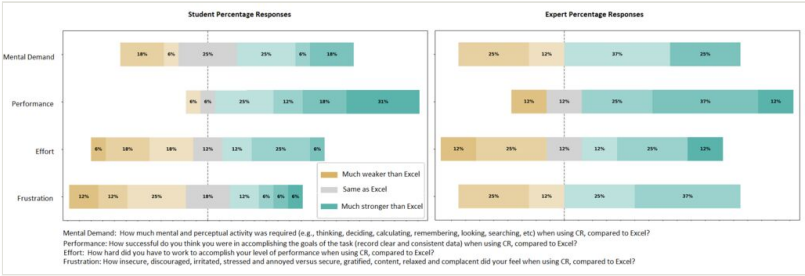

Figure 5.

Summary of student and expert responses to NASA-TLX questionnaire.