A STUDY IN NODE-LINK CONCEPT MAP VISUALIZATION ENHANCEMENT

by Jonathan King

This research project investigated the relationship between the design and learning utility of concept maps. A concept map can be defined as "any node-link diagram in which each node represents a concept and each link identifies the relationship between the two concepts it connects" (Schroeder et. al, 2018, p. 431). The typical use setting of concept maps is educational. A conceptual framework for good concept map design was developed. Guided by this framework and roughly by usability engineering protocol to enable good user-centered design in described in Nielsen (1992) and Nielsen (1993), efforts were made to enhance the design of two existing node-link concept maps

Figure 2: Prototyped new visualizations for concept maps found in UT-ITC's digital publication The Living Textbook.

PROBLEM STATEMENTS

Universal problem: While concept maps' capacity to facilitate learning is widely recognized, research on enhancing their designs to encourage learning is still rare (Krieglstein et al., 2022; Schroeder et al., 2018). Concept map designers lack guidance regarding how to best do their work.

Project-specific problem: The design of existing concept maps in UT-ITC's digital publication *The Living Textbook* (LTB) may not be ideal for learning.
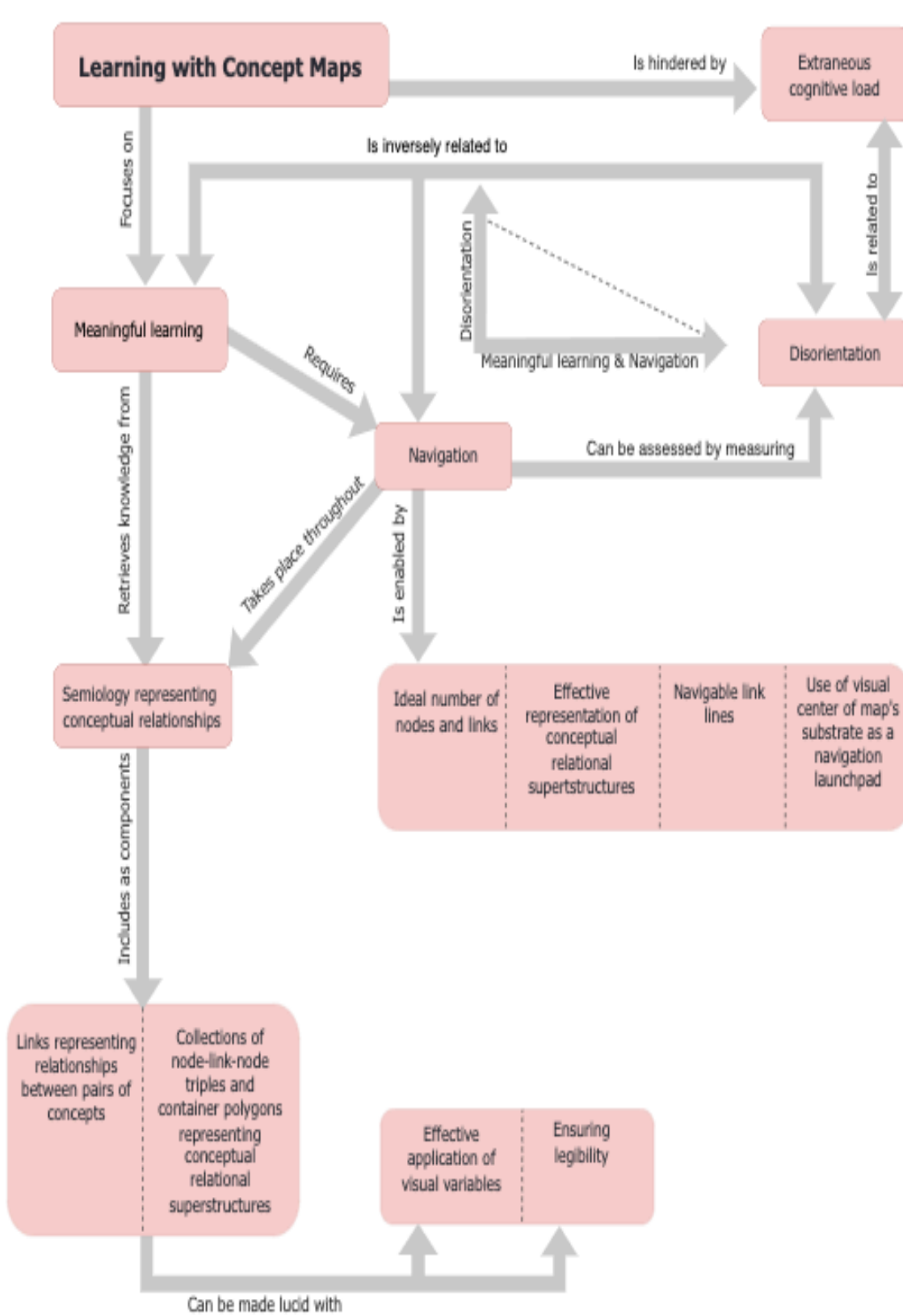
CONCEPTUAL FRAMEWORK

Figure 1: According to the research project's conceptual framework, the learning utility of a concept map depends on its lucid representation of conceptual relationships and its navigability.
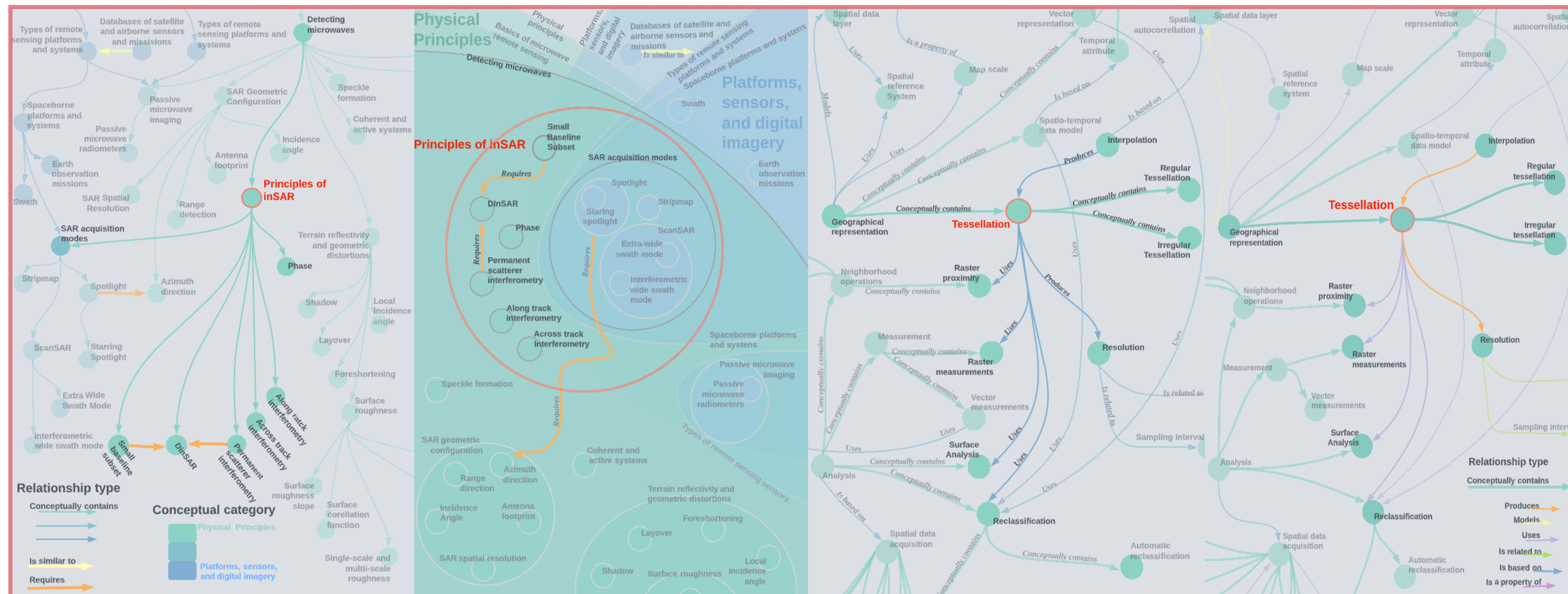
IMPORTANT DIFFERENCES BETWEEN LTB'S THE CORE AND BOK CONCEPT MAPS

The node-link concept maps found in LTB's The Core of GIScience 2020 (The Core) and EO4GEO Body of Knowledge (BoK) sections both visualize relationships shared among hundreds of concepts in the geo-information science and earth observation knowledge domains. While the maps have similar user interface and experience designs, their use cases differ. Thanks to these differences, their semantic foci also differ. The focus of The Core concept map's semantics is on pairwise conceptual relationships. By contrast, that of the BoK concept map is on relationships shared among groups of more than two concepts.
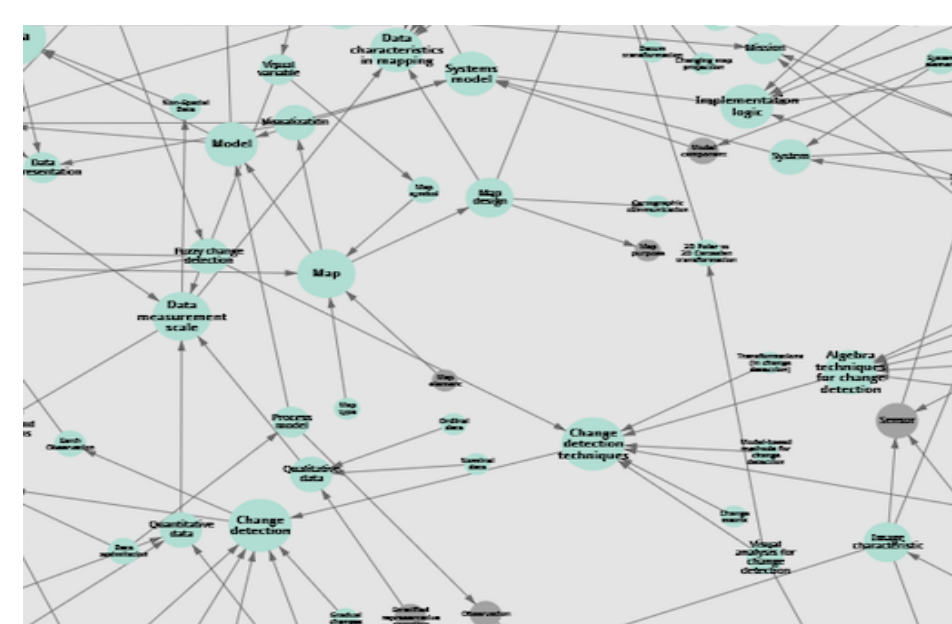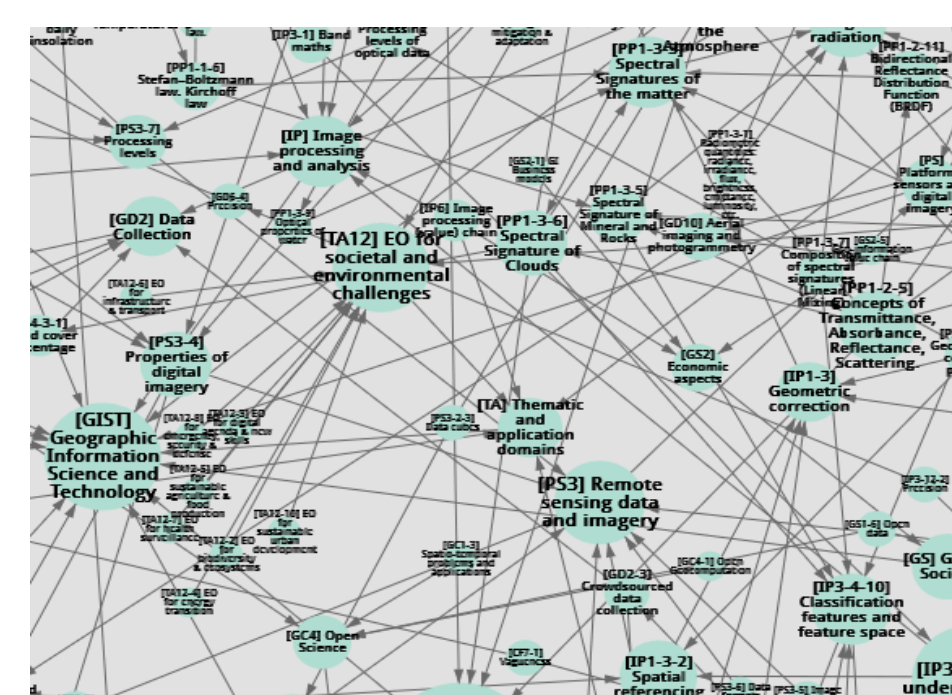

Figure 3: Existing LTB The Core concept map semiology

Figure 4: Existing LTB BoK concept map semiology

DESIGN ENHANCEMENT PROCESS

The design enhancement process roughly involved three stages of work:

Stage 1 involved two steps. First, the researcher assessed existing LTB map designs' compliance with principles of good concept map design identified in the conceptual framework and offered ideas for ways they could be improved upon in areas where compliance is lacking. Second, user needs assessment questionnaires were used to gather helpful information and ideas from other people

Stage 2: Guided by ideas and information generated in stage 1, visualizations conveying design enhancements suitable for typical use cases for each map were prototyped.

Stage 3: User tests were used to evaluate the learning utility of some of the visualizations prototyped during Stage 2. User testing included both a questionnaire and in-person usability study. For both the BoK and The Core maps, two different visualizations of an ideal typical interaction for each map given its use case were evaluated. Representation of the semantic focus of each of the two maps varied from visualization to visualization associated with the map: For The Core map, this variation lay in representation of pairwise conceptual relationships. For the BoK map, this variation lay in representation of hierarchical relationships shared among large groups of concepts. During user tests, the learning utilities of semiology found in prototyped new visualizations associated with a particular concept map were compared with each other as well as with that of the existing map.

REFERENCES

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