

Visualize Different: Towards Researching the Fit Between Taxonomy Visualizations and Taxonomy Tasks

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Abstract. Yet despite the great interest in taxonomies, there is virtually no guidance on how to purposefully visualize them. Interestingly, taxonomies are visualized in ways as diverse as morphological boxes, hierarchies and mathematical sets, to name three typical examples. As a result, taxonomy builders face the following question: Which type of taxonomy task is best supported by which type of taxonomy visualization? This short paper raises the awareness of the problem and lays ground for conducting controlled experiments that have the potential to purposefully leverage taxonomy visualizations. We present an experimental design that allows to investigate the cognitive fit between the different types of taxonomy visualizations and taxonomy tasks. Thus, we contribute towards researching whether taxonomy visualizations make a difference when performing certain tasks by using taxonomies.

Keywords: Taxonomy, Visualization, Cognitive Fit Theory, Experiment.

1 Introduction

Taxonomies describe and classify existing or future objects of a domain and, as such, form an important prerequisite for academics and practitioners to understand and analyze a domain [1, 2]. There is a great and steadily growing interest in taxonomies (for a reviews see [3, 4]) and taxonomies play an important role as structure-giving artefacts, for instance, in the exploitation of new research fields in information systems (IS) (e.g., [5, 6]) as well as the development of novel software artefacts (e.g., [7–10]).

Despite the widespread interest in building and using taxonomies, to the best of our knowledge there is currently neither prescriptive knowledge [11] that advises taxonomy builders on which type of taxonomy visualization (e.g., morphological box, hierarchy, mathematical set) is best suited for which type of taxonomy task (e.g., describing, understanding, analyzing and classifying objects of a domain of interest). This is surprising because (1) there are very different taxonomy visualizations available [3], (2) reasonably selecting visualizations that fit a task to be solved has shown a non-trivial decision [12–14], and (3) taxonomies are (mostly unconsciously) accessed through visualizations. This was already the case when taxonomies were still built and

used with paper-based methods [15]. In addition, visualizations have already been shown relevant for other structure-giving artifacts (such as ontologies [16]), which also applies for having different visualizations for different tasks [17].

For exploring how taxonomy visualizations affect users' performance while using taxonomies, we combine taxonomies with insights from previous research on visualizations. This research informs that "human information processing is highly sensitive to the exact form information is presented to the senses [and] apparently minor changes in visual appearance can have dramatic impacts on understanding and problem solving performance" [18, p. 758]. Furthermore, "the structure and content of the visualization should correspond to the desired mental structure and content as well as the structure and content of the visualization should be readily and accurately perceived and comprehended" [12, p. 37]. Moreover, "performance on a task will be enhanced when there is a cognitive fit (match) between the information emphasized in the representation type and that required by the task type" [19, p. 219].

Given the heterogeneity of taxonomy visualizations (see Figure 1) and tasks, this short paper seeks to raise problem awareness to leverage the currently untapped potential of a good fit between taxonomy visualizations and taxonomy tasks. Consequently, our research objective is, in the long run, to provide design-relevant knowledge on taxonomy visualizations. This results in the following research question: *Which type of taxonomy task is best supported by which type of taxonomy visualization?* Towards answering the research question, we present an experiment design that serves as the starting point for a series of experiments to generate empirical evidence.

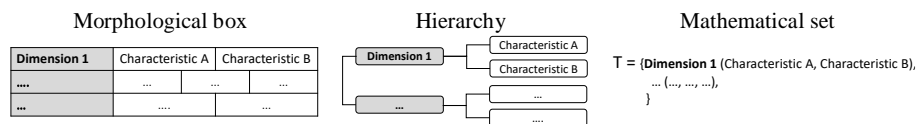


Figure 1. Taxonomy visualizations

2 Theoretical Background and Research Model

For exploring how the visualization of a taxonomy affects user performance, we contextualize the cognitive fit theory (CFT) from Vessey [19], which has already been confirmed in numerous contexts [20]. We aim to provide empirical evidence on where the fit between a taxonomy task and a taxonomy representation is highest and seek to understand the underlying cause-effect relationships between them. Applied to the context of taxonomies, the interplay between the visualization of a taxonomy and a given task to be solved by means of a taxonomy determines the resulting taxonomy performance (see Figure 2). In the following, we briefly describe typical tasks:

Taxonomy Task 1: Understanding a domain of interest. For this, a taxonomy provides a structure consisting of characteristics and dimensions to describe a domain.

Taxonomy Task 2: Finding an object from a taxonomy. On the basis of the taxonomies' characteristics and dimensions an object can be identified from a set of objects.

Taxonomy Task 3: Classifying an object according to a taxonomy. On the basis of the taxonomies' characteristics and dimensions an object can be categorized.

Taxonomy Task 4: Comparing objects with a taxonomy. On the basis of the taxonomies' characteristics and dimensions two or more objects can be analyzed.

The use of taxonomies in such tasks can be distinguished along two perspectives (see Figure 3): (1) Whether taxonomies are visualized with or without objects of a domain of interest, and (2) whether taxonomies are used for spatial or symbolic tasks.

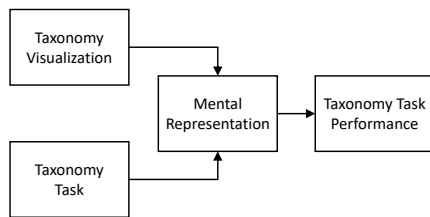


Figure 2. Research model contextualized on the basis of the cognitive fit theory [19]

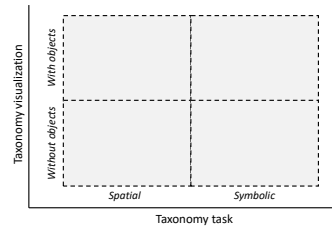


Figure 3. Research avenues for researching taxonomy visualizations

The first perspective distinguishes whether characteristics of already analyzed objects are available for a task. A taxonomy without objects offers a structure for understanding a domain of interest (e.g., mobile applications can have the characteristics of asynchronous or synchronous user interaction), whereas a taxonomy with objects additionally provides characteristic attributes of specific objects (e.g., the specific mobile application WhatsApp allows for synchronous user interaction). Thus, for understanding a domain of interest (see Taxonomy Task 1), a taxonomy can be used without objects (lower half of Figure 3; e.g., for answering questions such as *What is the nature of mobile applications in general?* For example, they can have asynchronous or synchronous user interaction.). In contrast, finding, classifying and comparing one or more objects (see Taxonomy Tasks 2-4) requires that the taxonomy has objects (upper half of Figure 3; e.g., for answering questions such as *Which mobile applications provide for asynchronous user interaction? Which for synchronous?*).

The second perspective is based on the CFT and broadly distinguishes two types of tasks: spatial and symbolic tasks. Spatial tasks assess the problem area as a whole rather than as discrete data values (left half of Figure 3). These tasks require making associations or perceiving relationships in the data. Symbolic tasks involve extracting discrete data values (right half of Figure 3). The distinction of spatial and symbolic tasks is also helpful in the context of taxonomies, as typical tasks that users solve by means of taxonomies can also be of a spatial or symbolic nature. It is important to note that each type of task (see Taxonomy Tasks 1-4) can take a spatial or symbolic nature, depending on the specific goal of the taxonomy task. In the following we give two examples for Taxonomy Task 4, which entails analyzing a taxonomy with objects. The taxonomy task of comparing takes a spatial nature when the goal is to identify which objects are (not) similar with regard to their characteristics, as this requires making associations and perceiving relationships among the objects (e.g., *What are similarities*

and differences among specific mobile applications?). In contrast, the taxonomy task takes a symbolic nature when the goal is to identify the characteristics of an object, as this requires extracting discrete data values (e.g., *Does WhatsApp allow for asynchronous or synchronous user interaction?*).

3 Experimental Design

We developed a between-subject designed online experiment to be conducted on the crowdsourcing platform Amazon Mechanical Turk [21]. We will carry out a pre-test with a few participants to ensure the understandability of the experiment instructions and procedure. Afterwards, we will randomly assign 100 participants to one of three conditions in which the taxonomy is visualized differently: a morphological box (condition 1), hierarchy (condition 2), or mathematical set (condition 3). The experiment will involve three steps lasting a total of 30 minutes: (1) reading instructions, (2) reading descriptions of the taxonomy (including its visualization), and (3) answering questions about the taxonomies' structure and content and about potential mechanisms that may have affected the perception of the taxonomies' visualization.

We conceptualize taxonomy task performance by accuracy and speed [22]. We measure accuracy of performance through the number of questions answered correctly. Questions are dichotomous per taxonomy task type and there is one question per taxonomy task type. As an incentive, the payment of the experiment participants partly depends on the number of correct answers. For measuring speed, we will take the time participants needed for completing step 3. Furthermore, we suggest to control for age, gender, profession, familiarity with taxonomies and the domain of mobile applications.

4 Expected Contributions and Outlook

Despite taxonomies being one of the prevailing forms of classification schemata in IS, so far it is unclear which visualizations are conducive for working on certain tasks with taxonomies. This study creates awareness for taxonomy visualizations and for how to exploit their potential in future research by means of controlled experiments. A limitation of the experimental design is the measurement of the constructs on the basis of self-reported data. As part of the further development of this research-in-progress we can imagine leveraging the rich body of knowledge on NeuroIS. This would enable both extending the CFT with new constructs (e.g., mental workload [23]) and complementing physiological measurement (e.g., eye-tracking [24, 25]). In this way, we hope to lay the ground for enabling academics and practitioners to make informed decisions about taxonomy visualizations and to purposefully leverage taxonomies and their corresponding visualizations.

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