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CS6460 Educational Technology
Personal Question Assignment – 2017.10.01

# Concept Mapping Exploration

"In theory, there is no difference between practice
and theory. In practice, there is."
– Jan van de Snepscheut[1]

## 1 Introduction

### 1.1 Personal Question

"You have expressed interest in testing the effectiveness of concept mapping activities in teaching middle school CS concepts. For your personal question please find a CS concept that you could teach to a middle school student via a concept map. Create a sample concept map and include it in your submission. What tools did you use, and would they be accessible to middle school students? If not, what are some alternatives? What scaffolding and background knowledge would be needed for middle school students to create a map for the same topic? Finally, how can you make this a fun and engaging activity for the students?"

### 1.2 Project Background

In a Assignment 4, I defined a concept map as "a graph representation of a subject's underlying ideas, where nodes are concepts at different hierarchical levels and edges are relationships between concepts."[2] I went on in Assignment 5 to justify research into the effectiveness of having computer science students create concept maps to solidify their understanding, since research has shown the method to be successful in other education domains yet the exploration into concept mapping in computer science education is lacking.[3]

Figure 1 (from Novak & Cañas[4]) is an example of a concept map, where the subject of the map is concept mapping itself. This meta concept map provides both an example of the method and its underlying structure.
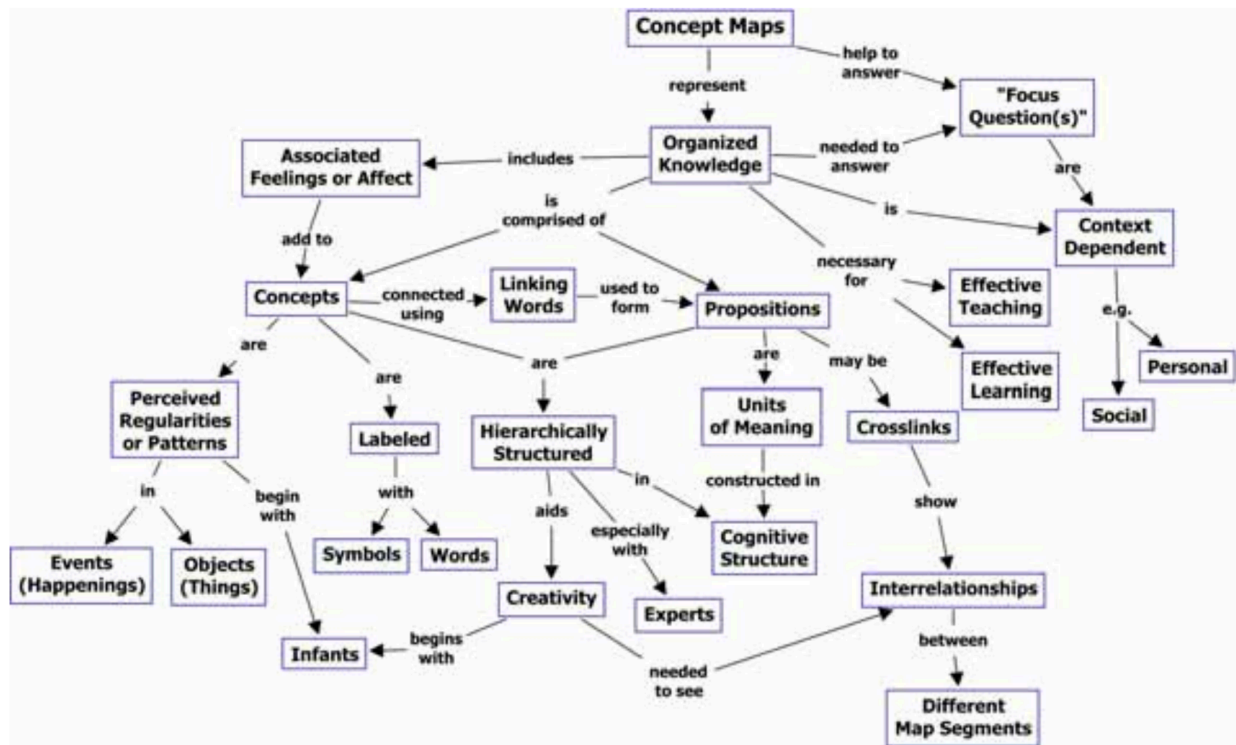
Figure 1. A concept map showing the key features of concept maps. Concept maps tend to be read progressing from the top downward.

## 2 Concept Map Implementation

Most uses of concept mapping is in service of some other subject and is not focused on concept mapping itself, like in Figure 1. Therefore, to allow the concept mapping exercises to "get out of the way," it is advantageous for the teacher to give the students the necessary tools and instruction for the students to generate the map.

### 2.1 Concept Map Tools

Much of the past research on concept mapping focuses on the idea of concept mapping and analyzes its effectiveness versus using no concept mapping. This builds up the theory of concept mapping as an effective teaching method, but leaves the implementation details ambiguous. This focus on theory leaves questions about the effectiveness of various implementations unanswered. Unfortunately, a full analysis of the available tools is also outside of the scope of my research, but I will need to weigh

the options to find the optimal tools to use for my experiments, if I decided to have the participants generate their own concept maps.

As I laid out in Assignment 5, I plan on running two experiments: one in-person with middle schoolers, the other online and open to a wider audience. I will explore a few tools for creating a concept map on the topic of functions in computer science to weigh the pros and cons in each experimental setup.

### 2.1.1 Google Drawings

The first tool I tried out was Google Drawings, which is part of G Suite[5], which is already widely used in classrooms around the world.[6] Aside from already being widely used, G Suite offers many other educational benefits, as noted by Denton, in that "the features of constructivism and cooperative learning are enhanced with cloud-based technologies."[7]

In order to figure out if Google Drawings would meet my needs, I used it to create a concept map of my own, seen in Figure 2. There were a few compromises with using Google Drawings. First, Google Drawings is not limited to concept maps, so there are a lot of shapes and drawing options that are not relevant, which can be overwhelming
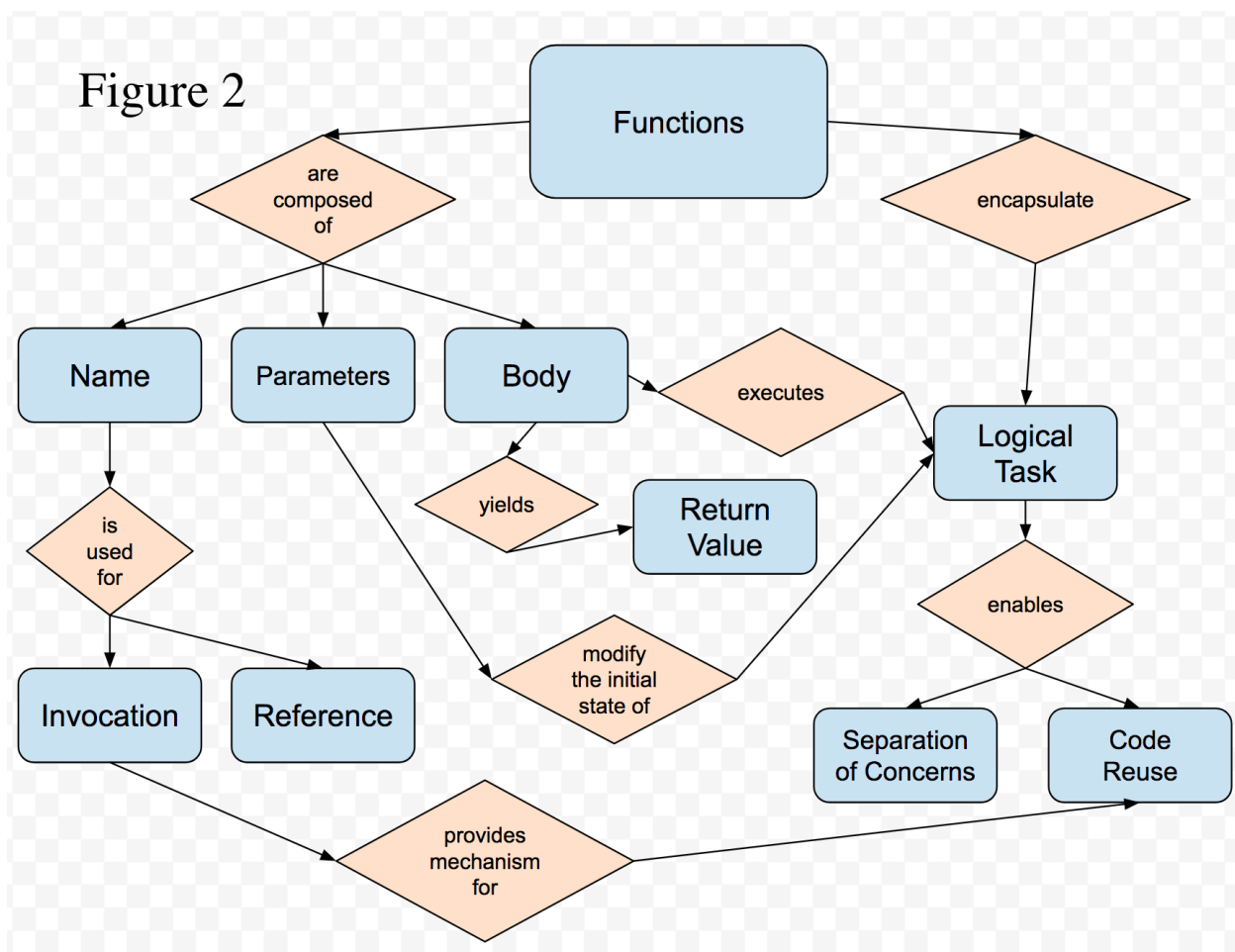


Figure 2

when trying to make a concept map. Second, and more importantly, there is no good way to annotate the arrows, like in Figure 1. I found three options to represent arrow annotations (which represent the concept relationships). First, I could add a text box next to the arrow. I decided against this because it creates a formatting headache when you want to move concepts around, since the text box must be moved independently of the arrow it annotates. Second, I considered using the comments feature that all G Suite apps use, and while this would couple a description with the arrow, the comment would be in the margins to the right of the document, which is visually too distant. I settled on a third option, using a different shape and color to represent the relationships between concepts.

Pros of Google Drawings:
- G Suite is widely used in schools; likely that students have a Google account
- Easy saving, sharing, and submitting to teacher

Cons of Google Drawings:
- Too many options not related to concept maps
- No good way to annotate arrows for concept relationships

### 2.1.2 Lucidchart

Another online option is Lucidchart. It has built-in functionality for concept maps. However, you need to create an account to use it, and I think this creates a barrier to participants completing my experiment. In the case of the middle school experiment, signing up for a new account takes up class time, and there are typically security measures in place on school computers, preventing access to unknown websites, which is a blocker in using Lucidchart in this context. As for the online experiment, it will be hard enough to get participants to complete the experiment, and adding extra friction into the process will not help. For these reasons, I will not pursue this option.

### 2.1.3 Pencil and Paper

As a fallback for the in-class experiment, I will consider just having the students use pencil and paper to create their concept maps. While this creates a discrepancy between the in-person and online experiments, it might be the easiest way to get any concept mapping data from the middle school students. Having data at all is more important than only considering identical tools for both experiments. I will take all of this into consideration for my upcoming proposal.

## 2.2 Concept Map Instruction

Another thing I learned when using the various tools to practice making concept maps is that, the task of concept mapping itself is a skill that needs to be developed. Hartmeyer, et al., lay out a framework[8] for incorporating concept mapping in the classroom as such:

1. Teacher constructs example concept maps, preferably more than once
2. Students create concept maps after grasping the concept
3. Teacher gives feedback on student concept maps, including the addition of concepts, corrections on inaccurate relationships, and corrections on the misuse of the concept mapping framework

For the in-class experiment, I will start showing concept maps and discussing them at the end of a lesson to accomplish Step 1 above. This direct instruction will serve to build the scaffolding and background knowledge the students will need to complete their own concept maps on later lessons.

For the online experiment, teaching concept maps will be trickier, because I only have a limited amount of time that I can expect an online participant to spend learning about concept maps. Therefore I will have to come up with a good, quick tutorial for them to grasp the idea before asking them to construct one on their own.

As an alternative experiment, I might decide that it's necessary to adjust my design such that the experimental groups are only presented with concept maps (that is, they wouldn't have to construct their own). I may do some preliminary testing in order to see how well someone can grasp concept mapping in a single sitting, and if it proves to be too difficult, then this alternate design might be preferable.

# 3 Conclusion

When I had the idea of testing concept mapping's effects on computer science education, I thought the details of the experiment implementation would be straightforward. However, after actually using the tools and considering the cognitive load that performing the new skill of concept mapping requires from the student, I realized that there were still a number of things that I need to figure out to make my experiments work. In my full proposal, I will address these issues more fully.

# References

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