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Concept Mapping

"When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; this is knowledge."
– Confucius, *The Analects*[1]

Definition and Justification

A concept map is a graph representation of a subject's underlying ideas, where nodes are concepts at different hierarchical levels and edges are relationships between concepts.[2] The edges are typically labelled with the concepts' relationship, such as "'Amount of Sunlight' causes 'Temperature Variations'" (Fig 1). Furthermore, the concept hierarchy is encoded on the y-axis, with the most general, encompassing concepts going above more specific concepts.

One theory to back up the usefulness of Concept Maps is based on the principle of human memory called "chunking". The idea of chunking is that short term memory is limited to holding 5-9 items at a time. So if someone is asked to remember a random string of letters (e.g., "S P B E C C R N I V E Q S") it quickly becomes very difficult, but if the person is able to group, or chunk, the letters together, then the chunks act as a single unit in short term memory (e.g., "C A T M O N K E Y H O R S E").[3] Novak and Cañas postulate that Concept Mapping provides similar memory benefits. "We believe one of the reasons concept mapping is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help to organize knowledge and to structure it, even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks."[4]

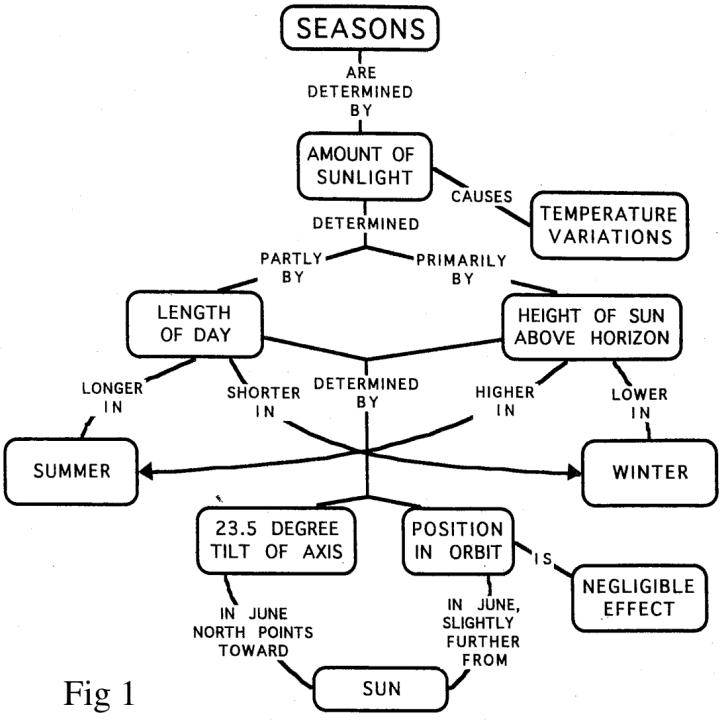

Fig 1

Khan Academy's Knowledge Map

Khan Academy is an online education company that has received much attention and many endorsements for its decade of providing free education resources.[5] One of its features is a Knowledge Map (Fig 2) that links all of its video lessons together. While it doesn't fit the exact formulation of a Concept Map above, it's the most widespread tool that uses a similar representation, so it's worth exploring.

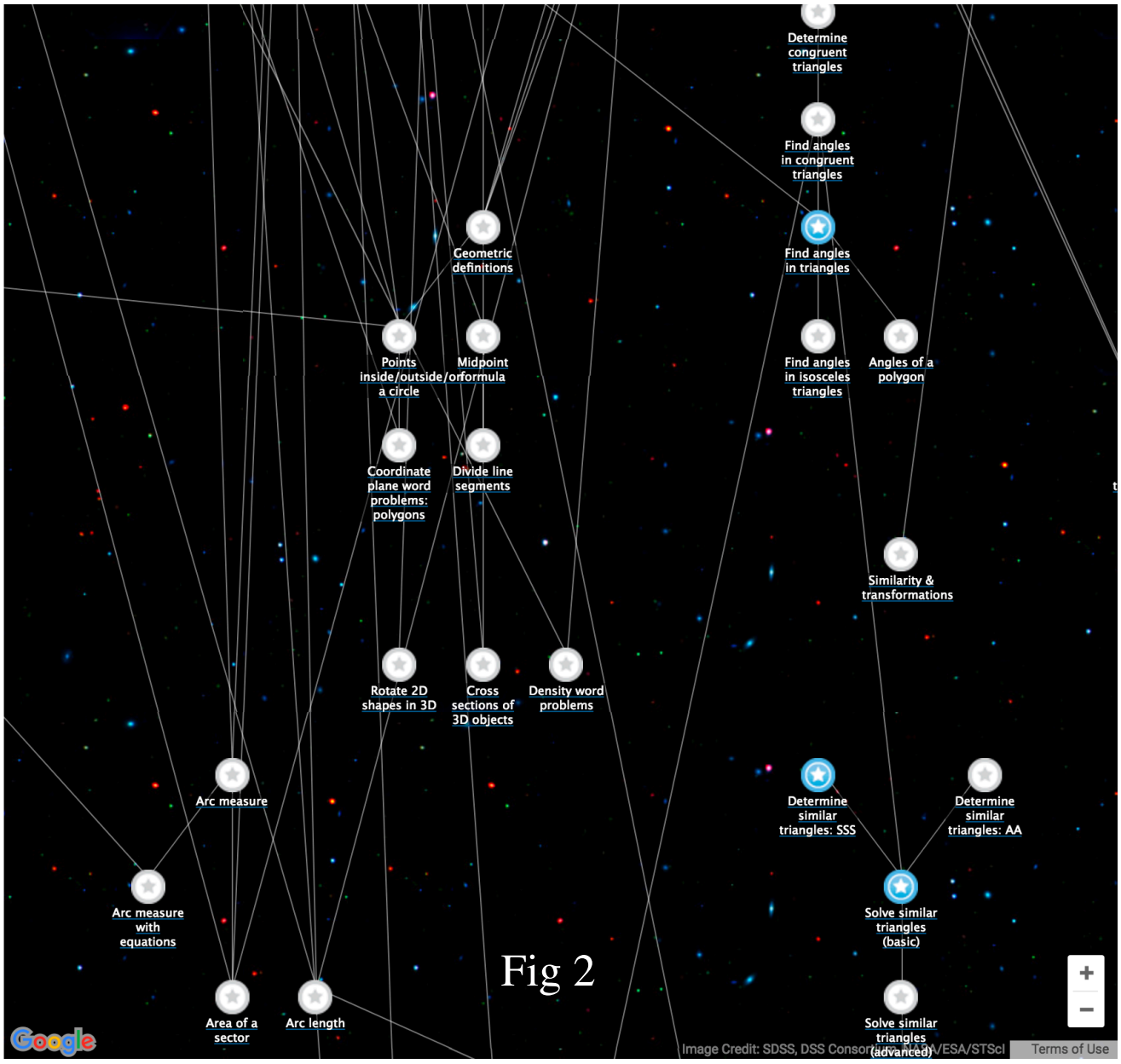

Fig 2

In playing with the tool myself, I found it hard to navigate, and several other researchers came to the same conclusion.[6,7,8] I am interested in analyzing how Khan Academy can close the gap and achieve the learning benefits laid out in "Definition and Justifications", and I'd also like to look at other tools to see if they are more effective.

My Research Question

For the rest of my project, I would like to examine further the current research on Concept Maps. I would also like to explore more tools like Khan Academy's Knowledge Map to see if any of the are successful implementations of a Concept Map.

I am planning to use this foundational research to do my own research into the effectiveness of Concept Maps on students' learning. I would ideally like to run two experiments on the topic. The first would be a case study on the group of middle schoolers to whom I will be teaching computer science after school, doing periodic Concept Map drawings on the abstract field of computer science to see how their knowledge progresses over the semester. However, since I don't want to split the students into a control group and an experimental group, I would also like to devise an online experiment where I can test the effectiveness of Concept Maps on learning in an actual experimental setup.

Some things I would like to measure are whether having participants draw their own concept map improves their performance over the control group as well as whether providing a canonical, pre-drawn Concept Map in between lessons has the same effect. Also, I would like to compare an abstract subject like math or computer science with a more tangible subject like natural science to see if there is a difference between the two subjects in terms of how effective Concept Maps can be.

As a stretch goal for my project, I am also very interested in Knowledge Tracing, "where a machine models the knowledge of a student as they interact with coursework"[9], and if such a machine representation can be effectively translated into a useful Concept Map to present to students and/or teachers.

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