There's a Creepy Guy on the Other End at Google: Tweens' Mental Models of Google's Inner Workings

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Abstract
Twenty-six middle school students who attend the HackHealth weekly after-school program (hackhealth.umd.edu) were asked to draw a picture of how they think Google works. Through a combination of open and axial coding, each drawing was assigned one or more codes from a 14-item coding dictionary, as well as one or more entries from a 6-item typology. We found that students' drawings commonly featured computing equipment and/or physical or virtual connections, such as wires or satellite dishes. Additionally, some form of anthropomorphism was a central feature in many students' drawings. In fact, 14 (54%) drawings were assigned to the typology entry "Google as people." In this poster, we will share a selection of students' drawings, as well as our central findings from this research.

1   Introduction

It is widely known that tweens and teens (ages 12 through 17) spend an increasing amount of time online (Lenhart, Purcell, Smith, & Zickuhr, 2010). They search the web for a variety of reasons, including getting news about current events and politics (62%) and finding critical information such as health information (31%). Since tweens, like adults, are using the Internet more to find information and answers to their questions, the primary way they look for the information they desire is through a search engine, such as Google (Lenhart et al., 2010). Understanding tweens' mental models of search engines, like Google, can reveal gaps in their understanding about how search engines work and identify any misconceptions that may need to be addressed in digital/media literacy instruction.

Mental models are constructs that reveal a person's cognitive understanding of a system based on their acquired knowledge about and experience with a particular system (Borgman, 1986; Brandt & Uden, 2003; Denham, 1993; Dinet & Kitajima, 2011; Jonassen, 1995; Westbrook, 2006). Research indicates that a person's behavior and degree of success in using a system is guided by his/her mental model of the system (Brandt & Uden, 2003; Holman, 2011; Jonassen, 1995; Li, 2007). Brandt and Uden (2003) state:

> When novices use search engines without strong mental models for information retrieval-especially in complex environments such as the Internet-they are not likely to achieve success at information gathering.

Mental models are not static and unchanging, but are dynamic and fluid and can change depending on a person's increased knowledge or altered situation (Li, 2007). Although mental models are incomplete pictures of a person's conception of a system, they can be useful in assessing system understanding and aid in the planning for and teaching about a system.

The HackHealth research team at the University of Maryland's iSchool, in conducting a 12-week after-school program with tweens to improve their ability to look for relevant and credible health-related information online, created and administered an activity with 26 tweens that enabled us to uncover their mental models of how Google works, with the central research question being: What are tweens/teens (ages 10-15) mental models of Google?

2   Methods

During the third or fourth week of the HackHealth program at each of four different middle schools in the mid-Atlantic region of the United States, the research team conducted an activity to discover how students, aged 10-15, understand Google's inner workings. Each participant was given a large piece of white construction paper and markers and asked to draw a picture or write words describing how they think Google finds websites for people (what happens "behind the scenes" when a user types a search query into the Google search box). Participants were given approximately 20 minutes to draw or write

their ideas. After participants finished their drawings, they were asked to share their drawings/writings with everyone present, including their peers and members of the HackHealth team. They were encouraged to share what they drew or wrote and explain their reasoning behind their drawings/writings. Their explanations were audio-recorded for transcription and analysis.

Using the students' drawings along with the transcriptions of the relevant audio segments, all four researchers on the HackHealth team independently came up with ideas for codes and for a typology that we could use to classify the drawings. The team then met and held a group-coding session where we juxtaposed codes/typology with one another. Based on this meeting, we formulated a finalized coding dictionary and a 6-item typology. Next, two research team members independently coded a subset of the drawings (four total, one randomly selected from each school), reaching an intercoder reliability rate (Scott's Pi) of 88% (Holsti, 1969). These two researchers then independently coded one-half of the remaining 22 drawings.

3   Findings

There were 26 tweens who participated in this activity. Table 1 shows the number and percentage of drawings to which each code was assigned. The most prevalent codes were "computing equipment," "anthropomorphism," and "connections" with 20, 17, and 16 codes, respectively. More than half of the participants represented Google with the hardware that they use to access it; thought of Google as a human being or having human characteristics; and/or emphasized the physical or wireless connections (such as satellites) that enable Google to provide information to users. "Google worker" was represented in almost half (12, 46.2%) of the drawings, as was "trust" (11, 42.3%). Table 1 below shows the distribution of codes applied to the mental model drawings (n=26):

3.1   Codes Applied to Mental Model Drawings

Code	Total number	Percentage (%)
Computing Equipment	20	76.9
Anthropomorphism	17	65.4
Connections	16	61.5
Google Worker	12	46.2
Trust	11	42.3
Place	10	38.5
Query	9	34.6
Branding	7	26.9
Transparency	7	26.9
User	7	26.9
Features/Functionality	5	19.2
Computer Code	4	15.4
Intelligence	4	15.4
Gender Balanced	3	11.5

Table 1. Codes Applied to Mental Model Drawings

In addition to the 14 codes above, each drawing was assigned to one of 6 entries of a typology. In earlier studies that have explored participants' mental models of the Internet (e.g., Zhang, 2008), researchers created a typology to categorize the mental models and report on their findings in a systematic and organized way. However, our research team chose to create our own typology (six typologies emerged) because we found that none of the earlier typologies fully represented the range of drawings created by our participants. The six mental model typologies that emerged from our analysis of the participants' drawings are:

    a) Google as people: Drawings represent Google as a person or people, whether Google workers or scientists, who work on behalf of Google to find information for the user. Drawings also depict Google personified; objects that talk, think, or have other human characteristics.
    b) Google as equipment: Drawings have some form of computer hardware (such as monitor, keyboard, mouse, CPU, tablet, smartphone) as a main focus.
    c) Google as connections: Drawings focus on the connections that allow Google to work. Wires/cables connecting multiple computers together, a satellite/antenna transmitting signals,

and the connection between a user and how the participant views Google are examples of drawings in this category.

d) Google as codes: Drawings depict Google as a series of codes - whether numeric, alphabetic, alphanumeric or something else. These drawings explain how the participant thinks Google works from a technological standpoint.

e) Google as physical space: Drawings represent Google as a building (i.e. house, office building, Google headquarters, or office space).

f) Google as interface: Drawings show the Google interface and oftentimes a close depiction of the Google logo in color. Drawings include the features and functionality that Google has on its webpage, including the search box/bar, "I'm Feeling Lucky" button, page count, and amount of time the search took.

Table 2 shows our typology and the number of drawings assigned to each entry in the typology. All drawings were assigned a primary typology. In 21 drawings, a secondary typology was assigned and in 10 cases a tertiary typology was assigned. We assigned secondary and tertiary typologies to drawings that appeared to fit into more than just one of the categories in our typology.

3.2   Assignment of Drawings to Mental Model Typologies

Typology	Primary	Secondary	Tertiary	Sum
Google as people	10 (38.5%)	3 (11.5%)	1 (3.8%)	14 (53.8%)
Google as equipment	1 (3.8%)	8 (30.8%)	4 (15.4%)	13 (50.0%)
Google as connections	5 (19.2%)	4 (15.4%)	3 (11.5%)	12 (46.2%)
Google as codes	3 (11.5%)	1 (3.8%)	0 (0.0%)	4 (15.4%)
Google as a physical space	4 (15.4%)	4 (15.4%)	1 (3.8%)	9 (34.6%)
Google as an interface	3 (11.5%)	1 (3.8%)	1 (3.8%)	5 (19.2%)
None	0 (0.0%)	5 (19.2%)	16 (61.5%)	

Table 2. Assignment of Drawings to Mental Model Typologies

4   Study Limitations

Some of the limitations of this study include the fact that participants included just 26 students who attended our HackHealth afterschool sessions. Thus, our findings are not generalizable beyond this population. In future work, we would like to explore the relationships between students' mental models of Google and the ways in which they actually conduct their searches on Google, as well as the degree to which their searches are successful in retrieving relevant, credible information.

5   Conclusion

Understanding how tweens think about Google as a search engine and how they think it finds websites and information for the user can help educators know how best to explain and teach Internet search skills and rectify any incorrect, preconceived notions students may have. Mental models can also be a way to assess the accuracy and completeness of a student's understanding of how Internet search engines function, and thus, improve the success rates of tweens in finding relevant and credible information online.

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