

“The Internet is Broken”: Misinformed Mental Models of Networking Technologies

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Problem Statement

With a few exceptions, the seventh-grade students at Lakeside School lack a sufficiently sophisticated or accurate mental model of network technologies. As a result, they cannot solve, identify or even accurately describe problems. When something goes wrong with an e-mail or the Internet, a common response is to tell a teacher that “the Internet is broken” and to immediately give up in frustration. Not only is their model of this technology inadequate, students also lack basic vocabulary which would allow them to build more robust and flexible mental models.

Why it Matters

These superficial, inflexible mental models rupture when students confront complex problems that do not fit within their understanding of technology. For students comfortable with computer technology, this may lead to a reformulation of their model to encompass the new situation. For students who are less experienced or fearful of breaking the computer however, such a rupture often leads to further distrust of technology, distrust of their own abilities, and wariness about participating in further tasks. Even students who continue despite these failures are limited in their activities, often becoming proficient users and consumers of the Internet, but not creators and designers of Internet resources and technologies. Full participation in the economic, political and social discourse that takes place on-line requires an understanding of the Internet as a system, and the protocols and processes necessary to communicate flexibly and fluently through the medium. Students must also be able to articulate and build on this understanding through an accurate and flexible knowledge of relevant vocabulary. As middle-school age girls in most communities in the United States have significantly less experience with computer and network technology than boys, directly addressing students’ understanding of the Internet and how it works may afford girls with the knowledge structures required to participate equally, making the Internet their own.

Proposed Study

In order to design an intervention addressing seventh-grade students' understanding of how the Internet works, we must first determine both what they currently know as beginning users of Internet technology, and what they need to know to be "expert" users of technology at their grade level. This study involve three phases: documentation and assessment of beginning students' current skills, vocabulary and mental models of the Internet; documentation and assessment of "expert" users' skills, vocabulary and mental models at the seventh grade level; and comparison of these "expert" users' mental models and terminology with an accurate representation of the Internet.

Identifying What Students Know

In order to uncover students' current understanding of the Internet, and how and when their models break down, we will observe students interacting with the Internet in their classrooms with the computers they use from day-to-day. Specifically, we will focus our study in three ways: by conducting structured interviews with the students while they interact with their computers, organizing troubleshooting sessions, and observing sketch sessions.

Structured Interview

Interview questions will focused on actual use situations, so students models can be assessed and understood in the context of the technology with which they are interacting. Careful attention will be paid to their use of language to describe network technologies. Possible questions include:

- Please open the program you use for e-mail. What does e-mail actually mean? Why do we call it e-mail?
- Show me what you do when you send an e-mail. When you press send, where do you think your e-mail goes?
- How do you "log on" to the Internet? What does "log on" mean? Why does it take so long to load some pages, but not others? Why is it slower or faster depending on the time or day?

Trouble-Shooting

Observing students engaged in trouble-shooting situations will reveal their ability to use their mental models flexibly to identify, describe and solve problems. Examples of troubleshooting situations could include:

- When a student attempts to connect to the Internet, the computer sends error message that it cannot get a dial tone. What do the students do? Why do they think the modem might not be getting a dial tone? (If on a network, students could get a “no DNS” error).
- When attempting to send an e-mail, they get a message that the mail was “bounced.” Why did that happen? What can they do to fix it?
- When trying to connect to a site on the Internet, a message comes up that says: “Server not responding.” How do students respond? What does that mean? What can be done?

Sketch Session

Asking students to pictorially represent their current understanding of how email works or how they connect to a web site will reveal their underlying conception of how things connect, where information is stored and how it travels between their computer and their friend’s computer when a message is sent. Where does a message go? How are the computers “connected”?

These three studies will be conducted with the computer available as a reference, in order to uncover factors that may contribute to their construction of insufficient mental models. For example, the “Mail” icon in the email program looks like an envelope. We refer to it as “mail.” This may contribute to a students’ thinking that the message travels between two points, as mail does; that it is “private” as mail is; and that it “arrives” in the computer as mail does in the home. The same interface metaphors that enable users to link new experiences to familiar situations can be prime contributors to misunderstandings of how the technology actually works. If these factors can be identified, they can be explicitly addressed in student courses.

Identifying What Students Need to Know

Equally as important as uncovering students’ current understanding of a complex system such as the Internet is clearly identifying what students *need* to know in order to function at an “expert” level for

their grade. Students may need to have an understanding of IP addresses and URLs in order to post a web site, however, they may not need to understand how packets are sent, how routers work, or how their Internet Service Provider configures its servers to send email. In order to identify a sufficiently sophisticated mental model and vocabulary, we propose to find students we can consider “experts;” they not only use the Internet as a consumers, but also to use it creatively and flexibly as designers, generating and posting websites, actively seeking information, and fluently troubleshooting likely problems. We will evaluate these students’ models of the Internet (using the same structured interview, troubleshooting and sketch sessions as described above), to uncover what kinds of things they knows about the computer and the Internet that enables them to operate flexibly and fluently in that environment. The observations of these “expert” users must be compared to factual information about Internet technologies, so that representations are not developed that will suffice for this grade level and level of operation, but might later conflict and fail when they engage with more advanced experiences as the student progresses. We will also assess student use of language and terminology to ensure their technical vocabulary is sufficient to support further development and deeper understanding.

Conclusion

In the professional society of the 21st century, students need to be able to do more than use computers and network technology; they also need to understand how they work, why they work, and perhaps more importantly, what can go wrong. This new demand for better-trained students does not only apply to the college-bound: every student who will be entering the job market, in virtually every capacity, will be required to have some level of competence and fluency with these technologies. Therefore it is the responsibility of schools to begin to prepare their students for these changing demands. Unfortunately, some aspects of network technology that was designed to make it more understandable in fact may lead to representations that are both inaccurate and misleading. Although “working knowledge” of the Internet has been sufficient until this point, students now need to know more. Of further concern is that having only “working knowledge” can breed passivity in students inhibiting their ability to see themselves as designers, creators or inventors with this kind of technology. If students do not feel they can control this technology, they will be unable to fully participate in this changing economy and society.