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ABSTRACT
        Beginning users often exhibit confusion about what it
means to be "on" the Internet, and they would likely benefit from a
discussion of the scope and structure of Internet connectivity. The
problem lies in creating a meaningful visual which would accompany
the verbal information. This document discusses an exercise whereby
graduate students who had completed 5 weeks of an Internet-related
course were asked to draw a diagram of the Internet as they
understood it. Thirty-four drawings ranged from very simplistic to
very technical, but several patterns emerged, with the Internet
variously represented as a client-server scenario, a giant loop, a
spoke and hub configuration, or a container. The client-server
depiction had already been presented in the class by the instructor,
and it ended up appearing most often in the exercise. Only three
drawings focused on the global nature of the Internet. When the same
exercise was administered to non-users, 31 drawings more frequently
included some visual reference to the world, perhaps because the
notion of global connectivity is one that the media likes to hype.
Visual aids may help beginning users sort through confusing
terminology and misleading metaphors, although many participants in
the first exercise whose drawings did not appear to represent the
Internet in any reasonable way still retained accurate verbal
knowledge of the Internet's character. Further study is recommended.
Six student illustrations are included in a total of eight figures.
(BEW)

Visualizing The Internet: Examining Images Constructed By Beginning Users

by Thomas J. Philleo

While working with graduate education students in a course aimed partially at providing them with basic skills in using the Internet, a frequently asked question was, "Am I on the Internet yet?" This was viewed as a problem in concept learning which might be addressed from an informal, action research approach.

The basic problem seemed to be that students did not have an adequate understanding of the structure of the Internet and were therefore not able to comprehend what it means to be "on" the Internet. With so much coverage in the media about the information superhighway, the infobahn, and so forth, it seemed important that these students, most of whom are teachers or in pre-service training, should have a clear understanding of what constitutes the Internet and what does not.

It also seemed important that they understand what it means to be connected to the Internet and therefore be able to answer the question "Am I on the Internet yet?" In order to do so it was felt that beginners might be aided by an understanding of these four aspects of the Internet: (a) it is a network of networks, (b) a connection to any one of these networks is a connection to any other user on the Internet, (c) the Internet provides connections to networks all around the world, and (d) when connected to a network which is part of the Internet, the user is also connected to the Internet. Although there are certainly many other characteristics which might also be added to these, it was felt that simplicity was desirable.

Creating a visual

The first part of the problem appeared to be the creation of a visual which would accompany the verbal information. Simply attempting to expand the verbal explanations might lead to further problems since many of the students were first time computer users. "Verbalism—the use of words which are not understood—is a disease usually caught in school" (Dale, 1946) and it was felt this might be avoided through the use of a visual. The importance of visuals in concept learning may vary according to the material, but in this case, because of the complexity of the concept and its relative unfamiliarity to most students, it was felt that a meaningful visual in the form of a diagram would offer students an additional building block in their construction of this concept.

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Figure 1
THE INTERNET: A LOCAL SECTION
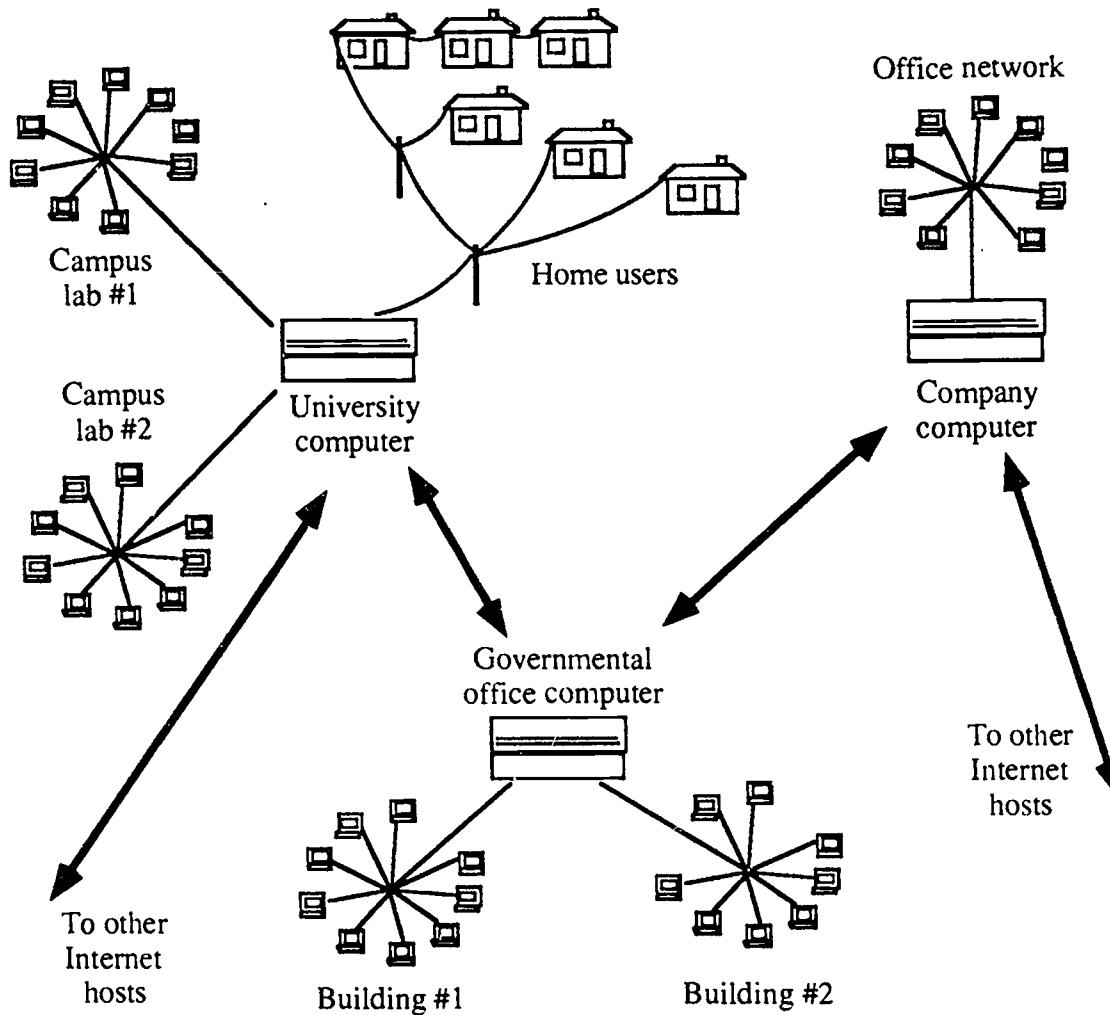
What should the visual look like? After some examination of the problem it appeared that there might not be an easy answer to this question. Several diagrams and illustrations from published materials were examined, but none seemed to provide adequate information for this purpose. An adequate representation of the Internet would require an immense amount of detail in order to provide student with one of the key facts needed to grasp its essential character—it is a world-wide network of networks. Given this definition, the Internet might be more accurately described as a construct rather than a concept. Lowe (1993) suggests that a good diagram should contain five to seven elements and that any nonessential visual information be eliminated. Considering the complexity of the Internet, this seemed problematic.

Figure 1 is an attempt to create a diagram showing how individual users are connected to host computers

and how these hosts are connected. This diagram illustrates only a small, sample section of the Internet and, although it contains the basic elements, it fails to give an overall view of the way in which networks are connected world-wide. This inadequacy might possibly be overcome by the use of a second diagram which would include some representation of the first diagram as a small inset.

The diagram in figure 1 is strictly experimental and is not intended to be absolutely accurate nor is it the work of anyone but an amateur illustrator. Its purpose here is to offer the reader a look at the kinds of problems that were encountered in the process of attempting to produce a usable diagram for the classroom and to offer a comparison between the kind of visual that might be prepared for instructional use. It will also serve as an interesting contrast to the drawings discussed below.

Drawings by users

At this point however, an interesting question arose. Could students who had already begun to use the Internet provide some insight into how a good diagram might be constructed? If students who had completed the five weeks of course work in this area were asked to make a sketch of the mental picture which they had when thinking about the Internet, what might be found? This intriguing prospect lead to the distribution among these students of a sheet of paper with the following instruction:

I would appreciate it if you would help me by drawing a diagram or illustration of the Internet as you understand it. You might imagine that you are going to use this to help a friend or student who has not yet used the Internet understand some basic ideas about its various parts and functions. Do not be concerned about the quality or accuracy of the drawing. The purpose is to represent what you see in your "mind's eye."

On the back of the paper students were asked to answer several questions related to the Internet and how it works.

Thirty-four drawings were collected. As might be imagined, there was an interesting variety in the way these users rendered the Internet on paper. The range varied from two boxes connected by a line to a complex drawing showing various organizations linked to each other and labeled with acronyms and technical terms.

Examination of the drawings revealed several patterns. The most dominant was related to a learning experience that students underwent about four weeks prior to the creation of these drawings. Students had been shown a rough sketch on the whiteboard which was drawn while explaining the difference between a terminal emulation connection with the university computer which treats the users own computer as a "dumb" terminal and a client-server connection which creates a temporary address for the user's computer and allows it to

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make a direct link to other Internet computers. Figure 2 shows the simplicity of this drawing and its highly abstract visual reference to the concept of "network of networks" or to the world-wide nature of the Internet.
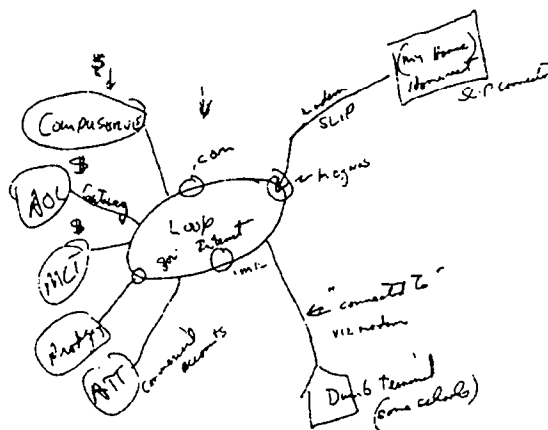
Figure 2
WHITEBOARD ILLUSTRATION
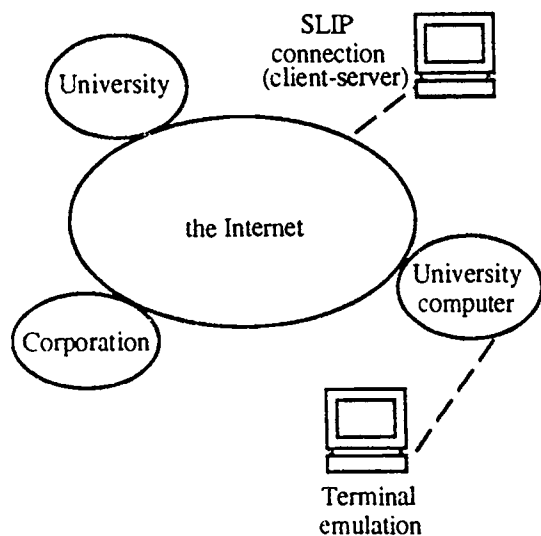
Of the thirty four drawings done by students, sixteen of them clearly reflected this drawing by including some sort of loop connecting parts of the Internet. This was a somewhat unexpected result since the impact of the whiteboard illustration was expected to be overshadowed by their subsequent personal experiences in using the network and by the construction of their own ideas about what it might look like. Although each student's drawing was a bit different— the labels, the way in which the loop was illustrated, or the types of computers connected—the quality of "loopness" was very apparent in each of the sixteen drawings.

It would appear that each of these students had readily adopted the loop and added their experience to it; they had not reconstructed another image to better fit these experiences. Figure 3 shows an example of a typical student's drawing which fits this pattern. This seemed to emphasize the way in which visuals encountered in the early stages of learning can become an integral part of student understanding and raised several questions about the role of visuals in instruction.
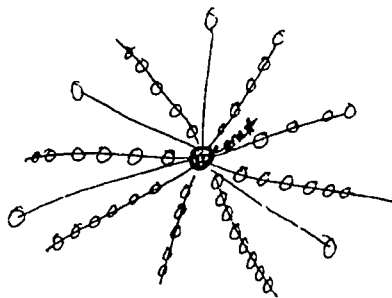
Figure 3
THE INTERNET AS A LOOP

Another interesting pattern which was evident in five of the thirty-four drawings depicted users surrounding the Internet in a spoke and hub configuration (figure 4). Their illustrations allowed little or no room for diagramming the structure of the Internet itself but implies that it is simply a connecting point between users. However, comments on the reverse sides of the drawings such as, "the Internet is a massive computer system that permits me to access

individuals," and "the Internet is a vast field of electronically retrievable information" indicate a slightly

Figure 4
THE INTERNET AS THE CENTER

Figure 5
THE INTERNET IS WORLDWIDE

Labeled points in this drawing indicate Japan, Australia, "You are here," Europe and Africa.
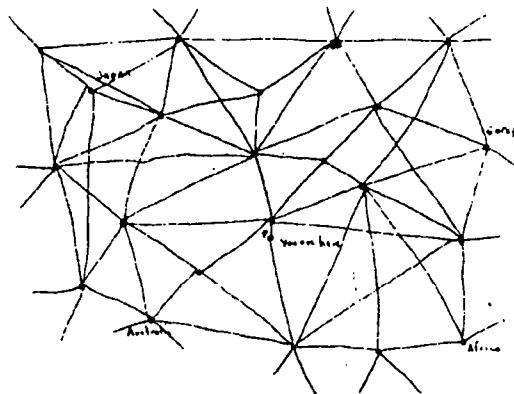
different view. Representing the Internet as a small, featureless point or block in their drawings while describing it as "massive" or "vast" raises some interesting questions about the relationship between what students draw and what they think.

Only three of the students' illustrations provided any visual clue as to the world-wide nature of the Internet. This was shown in two of the three by the inclusion of a sketch of the globe and in the third by indicating the location of several continents in a web of connecting lines (figure 5).

The remaining ten drawings generally showed the Internet as a box connected to the user's computer (figure 6), a series of boxes and circles connected by lines, or small drawings of computers with lines indicating their linkage. These renderings tended to reduce the Internet to its simplest elements—a computer linked to another computer or computers—but
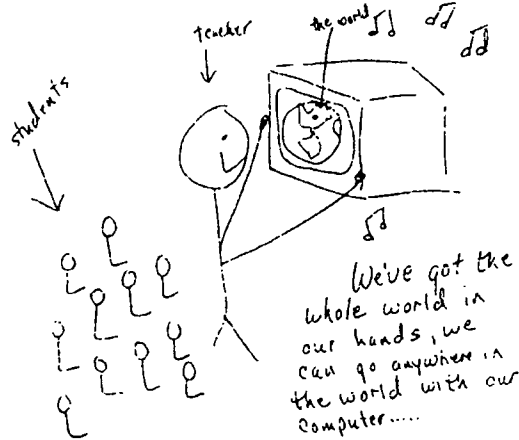
Figure 6
THE INTERNET AS CONTAINER
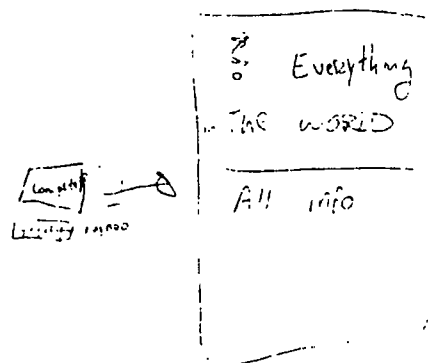
left out any visual information about networks or the world-wide character of the Internet.

Of the thirty-four only one person chose to represent the Internet with a picture rather than a diagram and included representations of musical notes and a short verse to a familiar song (figure 7).

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Figure 7
PICTORIAL RENDERING

Drawings by non-users

As an extension of this work, it seemed that an interesting contrast to these drawings could be created if the same task was given to beginning students in the course who had not yet been given any instruction or exposure to the Internet. Although a small minority of these students had used e-mail, none had ever used the Internet for any other purpose and their ideas were likely based on interpretations obtained from the media or conversations with others.

Figure 8
NON-USER'S VIEW: WORLDWIDE
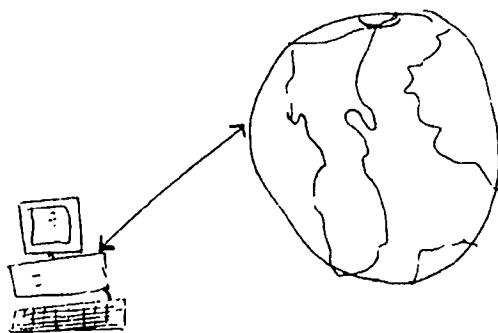
A look at these drawings showed that eleven out of thirty-one participants included some visual element to indicate the world-wide character of the Internet (figure 8). This is in sharp contrast to the drawings rendered by the first, more experienced group of whom only three included any visual reference to the world or the globe.

Five of the remaining twenty drawings followed a pattern previously referred to as hub and spoke, three used small boxes or circles connected by lines, and the rest were either blank or contained a drawing that did not communicate any particular meaning relative to the Internet, understandable since these were students who, as previously stated, had no real experience in using it. It should also be noted that none of these students chose to represent the Internet as a loop or as having any of the characteristics of a loop.

Conclusion

Is it really important for beginning users to have an understanding of what the Internet is in order to use it effectively? Is it necessary that they have some sort of picture of how the Internet looks in order to utilize it? Although learning to send e-mail, using Gopher, or transferring files from one computer to another is accomplished through a rule-learning process, it may be that in order to solve problems that arise with Internet use or to be fully empowered to explore its resources, some sort of realistic-looking mental image might prove helpful.

The recent popularity of the World Wide Web provides an example. If beginning users are to make clear judgements about how to use the "Web," they may need to understand that the Web does not exist as a separate entity apart from the Internet, despite the implication of its name.

If users understand the basic "network of networks" concept and can visualize the way connections are formed world-wide they may be better able to work through confusing terminology and misleading metaphors in order to accomplish what they want when using the Internet as a resource for teaching and learning.

The drawings made by the experienced group of students seems to indicate that when a visual was used in this context, nearly half retained its image and adapted it to their own varied experiences. If that is the case, then perhaps the visuals that we use are more important than we may sometimes think. If some students structure their experiences around a visual which is oversimplified or inadequate, it might impair their ability to build more meaningful knowledge structures by rejecting new knowledge which cannot be adapted to the existing visual model.

On the other hand, many of those whose drawings did not appear to represent the Internet in any reasonable way, still retained accurate verbal knowledge of its character. For these students, retaining a representative visual may not have been necessary for building a usable concept about the structure of the Internet. Naturally, it may also have been the case that they simply were not willing or able to reproduce their mental images of this concept on paper. Examining the relationship between what learners know and what they draw raises the kinds of questions which are well beyond the scope of an action research project but which could be a reminder that students learn and think in different ways, that their use of and preference for visual material varies, and that there are many unanswered questions relating to the ways in which learners visualize the concepts which they build.

Although the original intent of creating more effective instruction about the Internet by creating a meaningful visual has been overshadowed by the questions raised by looking at students' drawings, efforts to produce and implement a useful visual are currently underway. It is hoped that more work in this area might be helpful to educators who are involved in teaching learners of all ages about the Internet and its potential.

References

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