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ABSTRACT

The interpretation of information and the generation of knowledge is dependent on the existing metaphorical conceptual frameworks or mental models of the learner. Metaphorical mental models are both a method of representing and a way of organizing knowledge, and summarize an individual's beliefs about a system. Since the particular metaphors underlying an individual's understanding of the Internet serve to stimulate or limit the human imagination, it is essential to explore students' mental models in order to appropriately design the learning experience. Following a review of previous research eliciting metaphorical models or conceptions of the Internet, a structured questionnaire was developed and used to explore the metaphors employed by a sample of pre-service teachers in Singapore; this provided insights into their conceptual understanding of the nature and uses of the Internet. Findings indicate that the Internet is perceived more as a depository of information (passive) rather than as an interactive environment (active). The "Metaphors of Internet Questionnaire" is appended. (Author/AEF)

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Enhancing Leaning: Challenge of integrating Thinking and Information Technology into the Curriculum

Insights into Singaporean pre-service teachers' Mental Models of the Internet

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Abstract

> [Models]..carry the picture with which everyone, schoolboy, student, engineer and research worker, operates in dealing with problems in his field.
> Rom Harrè (1961: 56), *Theories and Things*

The interpretation of information and the generation of knowledge is dependent on the existing metaphorical conceptual frameworks or mental models of the learner. Metaphorical mental models are both a method of representing and a way of organising knowledge, and summarise the individual's beliefs about a system. Since the particular metaphors underlying the individual's understanding of the Internet (e.g. spider web, highway *etc.*) serve to stimulate or limit the human imagination it is essential to explore students' mental models in order to appropriately design the learning experience.

Following a review of previous research eliciting metaphorical mental models or conceptions of the Internet (e.g. Jonassen, 1995; Levin *et al.*, 1996) a structured questionnaire was developed. The *Metaphors of the Internet Questionnaire* was used to explore the metaphors employed by an opportunity sample (n = 35) of pre-service teachers in Singapore, and thereby obtain insights into their conceptual understanding of the nature and uses of the Internet.

Key words: mental models, Internet

Bio-data

Dr Azam Mashhadi is a lecturer in the School of Education (Nanyang Technological University, Singapore). His doctoral thesis (University of Oxford) investigated science students' cognitive structures or perceptual worldviews of quantum physics. Following degrees in Physics and Astrophysics (*University of London*) and Astronomy (*University of Sussex*) he taught for several years in London (UK) before completing a MSc in Educational Research Methodology (*Oxford*). His research interest includes student cognition, teacher education, use of IT in education, research methodology and philosophy of science education.

> [Models]..carry the picture with which everyone, schoolboy, student, engineer and research worker, operates in dealing with problems in his field.
> Rom Harrè (1961: 56), *Theories and Things*

1 Introduction

The explosion of the information and communication technologies is resulting in knowledge becoming the most important of commodities, with the world fast becoming a knowledge based economy. Lifelong learning will be required as skills (and knowledge) become obsolete and are replaced with those necessary for new products and services. Central to this phenomena is the exponential growth in the use of the Internet, with it being estimated that there are currently over 40 million users world wide. The Internet has major implications for both education and teacher education (Bates, 1996). In order for technology to have the impact on education that it, arguably should have, Mashhadi and Han (1996: 7) point out that a number of issues need to be addressed:

1. Equitable access to the on-ramps leading to the information highway (i.e. anywhere, anytime access to the Internet).
2. Universal access to the computers needed to travel on the information highway.
3. Worthwhile places or web-sites to explore (i.e there are an enormous number of web-sites, but quantity does not necessarily assure quality).
4. Developing the necessary information retrieval skills among both faculty staff and research students.
5. Understanding how the tools of the communication age can be used to build the future, and not simply reproduce the past.

A number of questions need to be addressed. What is the Internet? Why is knowledge about metaphors important? In what ways is the Internet being thought about by pre-service teachers?

2 What is the Internet?

The Internet is the public 'network of networks' which spans the world and can be accessed through dial-up connections or direct high-speed business links. The Internet carries several

kinds of services but for most users today it means two things: the World Wide Web and a universal channel for e-mail (Monahan and Dharm, 1995). The Web makes use of Uniform Resource Locators (URLs) to identify resources, often documents. The operation of the Web relies mainly on hypermedia structures as a way of navigation for users. This is done by anchoring links to other resources through the use of the HyperText Markup Language (HTML). Any resource can be linked by reference to any other.

The World Wide Web is an Internet-based hypermedia initiative for global information sharing, and is the incarnation of the concept of cyberspace. The author William Gibson in his futuristic novel *Neuromancer* invented the term 'cyberspace' to describe his vision of a global computer network, linking people, machines, and sources of information in a world through which one could navigate as through a virtual space:

> Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts... A graphic representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights receding...
> Gibson (1986: 49)

One interpretation of what is meant by the term 'cyberspace' is that it involves the annihilation of space. The information and communications revolutions that have resulted in the Internet have built a means of information exchange which has 'annihilated' distance and time, and accelerated the process of perhaps creating a global community of inquiry (Thornburg, 1994; Silvio, 1995). Marshall McLuhan (1964: 5) in the 1960s argued that:

> As electrically contracted the globe is no more than a village. After three thousand years of explosion, by means of fragmentary and mechanical technologies, the Western world is imploding. During the mechanical ages we had extended our bodies in space. Today, after more than a century of electric technology, we have extended our central nervous system itself in a global embrace, abolishing both space and time as far as our planet is concerned.

Cyberspace can be viewed, arguably, as the latest stage in the evolution of Karl Popper's World 3 (Magee, 1973) - the world of objective, real, and public structures. In wandering in the multidimensional virtual world of cyberspace people are navigating through a 'mental geography'. However the question does arise as to whether people situated in different cultural and philosophical traditions are moving through the same mental geography.

3 Why are metaphors important?

The individual makes sense of the world through both language and through the process of active interaction with other individuals. Metaphors form the basis for taken for granted assumptions about the world. Metaphors provide models for explanation, and can transform meaning. As Haste (1993: 43) points out:

> Common metaphors are shared; meaning is easily communicated through them, and the novel is easily made familiar. Metaphors help us to communicate familiar ideas; they help us to generate novel ideas, and facilitate their transmission. Metaphors provide frameworks within which we are able to think, and to communicate. Metaphors are components of lay social theory which set the agenda for the way we will conceptualise the issues, and for the solutions we will find.

The appropriate choice of metaphor underlying a particular concept has consequences for how a particular technology is perceived and therefore fruitfully used (Hron, 1998; Strokes, 1997). The interpretation of the information and the generation of knowledge will be dependent on the existing conceptual frameworks of the learner, frameworks which may well be culturally mediated. Metaphors also serve as a tool for creative thought in that they can uncover relationships and even suggest new perspectives (Black, 1979). The particular metaphors underlying *conceptual models* serve to stimulate or limit the human imagination. The success of the marriage of technology and the ways in which technology is perceived will in the end determine the success of the incorporation of technology in education (see Jonassen, 1995).

In introducing the idea of cognitive models Kenneth Craik (1943: 13) stressed the use of models in thinking:

> If the organism carries a "small-scale model" of external reality and of its own possible actions within its head, it is able to try out various alternatives, conclude which is the best of them, react to future situations before they arise, utilize the knowledge of past events in dealing with the present and future, and in every way to react in a much fuller, safer, and more competent manner to the emergencies which face it.

Bliss (1995: 166) points out that teaching science, for instance, is a 'matter of conveying mental models of science'. Gentner and Stevens (1983) contain several cognitive studies based on the premise that the development of mental models is essential in order to understand the physical world. Bliss and Ogborn (1994: 8) also point out that:

> Current theories in cognitive science indicate the importance of mental models (Gentner & Stevens, 1983; Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991) and point (as does Piaget's theory) to the crucial role in reasoning of the mental manipulation of imagined objects.

The term 'physical intuition' is used to describe the ability to construct such mental models. Cognitive development is described as the development of mental modelling abilities. Mental models are both a method of representing and a way of organising knowledge. The student's mental model of a system may be incomplete, confused and subject to sudden change (Redish, 1994). It may not even be internally consistent. However the possession of a model enables the student to save mental effort in coming to terms with a problem. As Arnold (1992) points out the model summarises the student's beliefs about a system, however unjustified they may be in scientific terms. The aim of the model is to enable predictions to be made about the likely future behaviour of a system. The student is unlikely to be concerned about aspects of the model that do not make sense. This study is , therefore, concerned with gaining insight into the ways that student-teachers' conceptualise the Internet.

4 What are the models for the Internet identified previously ?

Models for the Internet have been identified previously by Hert (1994), and Levin *et al.* (1996). Hert (1994: 40) points out the following conceptual schemes or metaphors for the Internet:

1. Internet as superhighway (the high-speed network backbone) with feeder routes (smaller networks)
2. Internet as geographic space or cyberspace
3. Internet as a socially constructed space such as a city
4. Internet as mine
5. Internet as ecosystem

Levin *et al.* (1996) identified a large number of diverse conceptual models - with 'web', and 'highway' as the most widely held. In comparing expert and novices models they point out that:

> 1. Experts' mental models of the Internet and the Web are much more elaborate and detailed than novices'.
> 2. Experts have multiple mental models of each area, and use the different models at different time when engaged in problem solving.
>
> Levin *et al.* (1996: 6)

5 What are the models for the Internet held by pre-service teachers in Singapore?

The conceptions or mental models of the Internet identified in the research literature (e.g. Hert, 1994; Levin *et al.*, 1996) were used to develop a structured questionnaire (see *Appendix A*). The students responded to each metaphorical model on a 5-point ordinal response scale. The *Metaphors of the Internet Questionnaire* was used to explore the metaphors for the Internet employed by an opportunity sample (n = 35) of pre-service teachers in Singapore

The student teachers largely agreed with all the metaphorical models suggested, although to varying extent. The metaphors agreed to most strongly were:

Encyclopaedia
Library
Cyberspace
Superhighway
Network of clients and servers

The metaphors that, on average, elicited no strong opinion were:

Foggy world

Computer chip

Nervous system

Fungus

The findings are partly similar to previous studies carried outside Singapore, but they do indicate that the Internet is being perceived more as an depository of information rather than as an interactive environment (i.e. a *passive* rather than an *active* perspective).

6 Conclusion

Metaphorical mental models are both a method of representing and a way of organising knowledge, and summarise the individual's beliefs about a system. Since the particular metaphors underlying the individual's understanding of the Internet (e.g. encyclopaedia, highway *etc.*) serve to stimulate or limit the human imagination it is essential to explore students' mental models further in order to appropriately design the learning experience.

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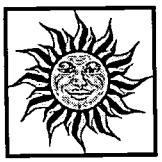
Appendix A Metaphors of the Internet Questionnaire



How do you think about the Internet?

Name:

1. People think about the Internet in a number of different ways (several of which are listed below).

For each of these models indicate whether you:

Strongly Agree (SA) with it
Agree (A) with it
have **No Strong Opinion (NS)** about it
Disagree (D) with it
Strongly Disagree (SD) with it

		Strongly Agree	Agree	No Strong Opinion	Disagree	Strongly Disagree
1	Superhighway					
2	Spider web					
3	City					
4	Geographic space					
5	Cyberspace					
6	Mine					
7	Ecosystem					
8	Encyclopaedia					
9	Community					
10	Computer chip					
11	Filing cabinet					
12	Foggy world					
13	Fungus					
14	Telephone system					
15	Solar system					
16	Octopus					
17	Lattice (interconnected)					
18	Library					
19	Network of clients and servers					
20	Neural network					
21	Brain					
22	Fishnet					
23	Maze					
24	Nervous system					
25	Tree					
26	Sea					
27	Supermarket					
28	Storeroom					
29	TV channel					
30	Wave					

If you think about the Internet in a way that is not listed please mention it below:

2. How do you think the Internet can be used in teaching/ education?

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