MENTAL MODELS OF TEACHING AND LEARNING WITH THE WWW

Lyn Henderson, Ian Putt & Geoff Coombs
School of Education
James Cook University, AUSTRALIA
Lynette.Henderson@jcu.edu.au, Ian.Putt@jcu.edu.au, Geoff.Coombs@jcu.edu.au

Abstract

Mental models are deeply ingrained assumptions or generalisations that are continuously being processed for each situation. The roots of success or failure are linked to mental models which profoundly influence how and why we act. Yet there is insubstantial research concerning the use of mental models in teaching and learning, especially with the Internet. The paper aims to inform our (mis)understanding of the multiplicity of mental models held by Master of Education distance education students. The paper analyses the students' mental models prior to (espoused stage), and at the end of, the course (reflectivity stage). There were significant changes to the students' mental models concerning learning and teaching with the WWW. The course and its assessment were instrumental change agents. The pedagogies allowed in their workplaces were also a significant factor.

Keywords

Mental models; teaching/learning with the WWW; distance education; flexible learning; higher education; constructivism

Mental Models

When interacting with our environment, we form internal mental models of ourselves, others, and the artefacts of technology with which we interact (Ehrlich, 1996; Norman, 1983). Mental model formation depends heavily on the conceptualisations brought to a task and includes our views, beliefs, and attitudes concerning: (a) the world, (b) ourselves as learners or teachers, (c) our capabilities and prior experiences, (d) the tasks we undertake, (e) the issues we confront, and (f) the strategies we employ (Norman, 1983). Simplistically, we carry small-scale models in our heads of the external reality of, for instance, learning with the Internet, and the possible actions we can take to facilitate that learning. Because internal mental models are cognitive representations, they have correspondence to the external real environment they represent (Johnson-Laird, 1983). Thus they have structure and are domain specific. Such representations can be analytic, analogic, or propositional (that is, "if ... then ... " thinking), and may contain or consist of images (Halford, 1993). For example, on receipt of the course materials for a distance education/open learning course, in our study, *Teaching and learning with the WWW*, students activate a mental model. This could include beliefs about themselves as a learner using the Internet; propositional strategies with respect to processing the materials to fulfil assessment requirements and learning outcomes; visualising an image of themselves carrying out the proposed tasks; engaging in preliminary analysis of their current skills and understandings and predicting what new skills may be required for the tasks; and, perhaps, an analogic depiction of themselves morphing from a lonely inept juggler of tools, time, and commitments chained to a computer to a strutting conqueror lording it over a cowering computer.

Crucial to the concept of mental models is the notion of "runability" (Jih & Reeves, 1992). We run our mental model to test out possible outcomes in advance of some action, such as, strategies to employ if the hyperlink we coded in a Web page does not work when trialled. Running a mental model is a dynamic process of building, running, and perhaps then changing, the internal mental representation (of the real external situation). This means that the model can be used predictively, that is, in advance as well as in-situ, to carry out and troubleshoot some action (Jih & Reeves, 1992; Tallman & Henderson, 1999). Mental models are the internal workspace for our thinking, understanding, and troubleshooting.

Mental models are fluid; their boundaries change depending upon the situation and expertise of the learner (Park & Gittelman, 1995). If the learner's mental model is elaborate and accurate enough, it permits them to try out various alternative actions, predict situations before they arise, and react by utilising knowledge from past experiences in order to handle successfully the current situation. However, like clocks, small-scale mental models of reality need neither be wholly accurate nor correspond completely with what they model in order to be useful (Johnson-Laird, 1983). In fact, mental models can be typically incomplete, disorganised, or naïve (Howe, Tolmie, Anderson, & Mackenzie, 1992) based on deeply ingrained assumptions or generalisations that influence how the learner understands the world and how they take action (Senge, 1990). But holding an inappropriate mental model can lead to ineffective learning, or worse, no learning at all (Jih & Reeves, 1992).

In the light of the research above, this study sought (a) to identify the essential characteristics of the students' espoused mental models, that is, those at the commencement of the course and their reflective mental models, that is, those at the end of the course; and (b) to ascertain if and how the students' mental models about teaching with the WWW and learning with the WWW changed.

Methodology

Context

The course *Teaching and Learning with the WWW*, provides a theoretical and productive pedagogy approach to (a) World Wide Web design; (b) information literacy, and (c) incorporation of the WWW as a teaching and learning tool in schools, higher education, industry or other workplaces. The course is designed to provide relevant, individualised, and collaborative situated learning activities that take into account the participants' current and intended work contexts, their prior experiences with the Web (ranging from novice to skilled user) and, importantly, a desire to develop their own specific Web project. The course materials consist of mailed out collated books of readings and Web based materials including a WebBoard Discussion Forum. Students are required to work their way through the materials at their own pace in a sequence they find workable while dwelling on those materials most appropriate to their project needs. At all times they are encouraged to critique the various elements of the course and its delivery modes (print modules; Web site; and the WebBoard forums and interactions) as they are being utilised. Three assessment items are required to complete the course: a project, an essay, and a mix of WWW discussion postings. Commonly, students construct an instructional Web site for their project and then discuss the strengths and weaknesses of teaching and learning with the WWW as it relates to their project as an essay topic.

Participants

The 10 people who enrolled in the course came from varied backgrounds, such as primary and secondary school teachers, a teacher librarian, lecturers in Institutes of Technical and Further Education (TAFE), and a university librarian. While all had considerable background in their particular field of teaching, none had much experience with the content and issues covered by this course. This paper examines data from two of the participants - a primary school teacher (male) and a lecturer (female) in TAFE - who were allocated pseudonyms in the research. They were chosen because they represented a contrast between two levels of teaching, namely that which dealt with children and that which dealt with adult learners. Both were self-identified novice users of the Web.

Data Collection

A researcher-designed interview questionnaire drawn from the literature (e.g. Tallman & Henderson, 1999) was the main data collection instrument. The following are key interview questions relevant to this paper: What is your mental model of learning with the WWW? and What is your mental model of teaching with the WWW?

The second author who was not involved with teaching the course administered these interviews. The interviewer clarified that the student knew what a mental model was by using, as an example, making a cup of coffee in the microwave. The participants were allocated pseudonyms until the data analysis stage, which occurred after final marks were awarded. The pre mental model interview was administered at the beginning of the course after the students had advised the lecturers by email that they had received the course materials and confirmed their willingness to participate in the research with the interviewer. The

interview was again administered at the completion of the course together with a course evaluation questionnaire. Data from the transcripts were analysed by the three researchers in collaboration and any differences in understanding and/or interpretation were resolved by consensus.

The constant comparative method (Strauss & Corbin, 1998) was utilised to contribute to the coding and analysis of the interviews. Data from the students' project, essay, and WebBoard interactions with their peers provided confirming evidence.

Results and Discussion

Mental Models of Learning with the WWW

The espoused and reflective mental models of learning with the WWW are shown in Table 1.

Student 1: Jelene		Student 2: Boris	
Espoused MM	Reflective MM	Espoused MM	Reflective MM
♦ Self focus on own studies as a learner ♦ Distance Education is structured ♦ WWW has no finish point; go off on tangents	♦ Self focus in terms of work: • WWW as a resource • Students as rural learners	♦ Focused on generalised learner ♦ Museum metaphor for learning: • Static displays • Many doors to choose, but… • Restricted freedom	♦ Focused on own students as learners ♦ Museum metaphor for learning: • Creative endeavour • Interactive endeavour • Freedom to explore

Table 1: Comparison of Espoused and Reflective Mental Models of Learning with the WWW

Jelene's mental model of learning with the WWW before undertaking this course was influenced by her previous experience of distance education through the print medium. She compared the structured delivery of distance education with the open-endedness of learning with the WWW as a potential difficulty:

> What I find more difficult already when learning on the Web [opposed to print-based distance education] is that you don't have a finish. You go off on tangents and, somehow, you have to track the tangents and come back to a given point.

Her response to the same question at the end of the course focussed on the Web as a resource for her, making links between her learning and search skills, "Because my search skills have improved, I find I'm getting the information faster … It's improved my learning skills." This suggests that the anxiety she predicted had abated.

Boris had an interesting analogy for learning with the Web. He said, "It's like going through many doorways of learning. … it's like a museum, you can go through each door and basically the information is there, like static displays." One characteristic of his mental model that was reinforced in his comments to this question at the end of the course was that of 'freedom' for the learner. In his comments prior to doing the course he used the idea of freedom within the museum as a kind of 'restricted freedom', "… you basically have a choice which door to go through to choose what topic you're interested in to learn from." His notion of 'freedom' is expanded in his post-course reflective mental model where he talks about "freedom to explore [and] freedom [for the students] to explore for themselves … in their own learning styles." Whereas initially Boris saw the museum, that is, the WWW, as a place where learning is passively tied to *static* information, his mental model had changed over the duration of the course to viewing learning with the WWW as "… a creative, an *interactive* endeavour." This represents a change in his mental model that is illuminated in the discussion of his mental model of teaching with the WWW (see below).

Mental Models of Teaching with the WWW

There are interesting changes in both students espoused to reflective mental models to the question: "What is your mental model of teaching with the WWW?" (Table 2).

Student 1: Jelene		Student 2: Boris	
Espoused MM	Reflective MM	Espoused MM	Reflective MM
♦ Focus on her students: • Understanding the learner • Instructional design of course materials influenced by MEd course	♦ Focus on own course project: • Instructional design ♦ Mastery teaching model: • Teacher models • Students imitate • Only then, freedom to explore	♦ Focus on students ♦ Focus on product ♦ Museum metaphor for teaching: • Tour guide • Teacher directs students as to which door to open • Student freedom within the museum tour	♦ Focus: Learning partnership with students ♦ Focus on process ♦ Museum metaphor for teaching: • Tour guide • Facilitator • Constructivist • "See you back here in an hour" • Student freedom to take risks & decisions with support & scaffolding

Table 2: Comparison of Espoused and Reflective Mental Models of Teaching with the WWW

Jelene's reported mental model in the pre interview focused on two aspects. One was the importance of understanding the learner. Her mental model held that it was important for her as a teacher to "get in the student's head, trying to work out how they are going to receive my instructions." The second focus revealed how her MEd course was influencing her perceptions of what it may mean to teach with the WWW. By the time of the interview, Jelene (and Boris) had received the print materials, database disk, HTML tutorials, and WWW address which included the WebBoard forum discussion. Because her mental model of teaching was student oriented, she approved this aspect in *Teaching and Learning with the WWW*:

> … the work starts with notices, letters, personal letters [including ones from the lecturers about themselves], email letters, and then you have to go off and onto the Web and back [to the print and other materials]. So I imagine that it's going to be very similar to how I will teach.

Thus, her espoused mental model included the element of prediction.

It is interesting that her project, creating elements of a Web literacy course for rural workers she previously taught in print mode with some face-to-face instruction, included some elements of personalisation. She included a photo, self-comments, an 'email me' hotlink, and audio segments that involved her voice-over reading the text on the Web page. This reinforced the teacher's concern in her mental model of learning with the WWW for understanding the needs of her students, some of whom had very low reading literacy levels. In addition, a past student's photo, voice-over profile, and comments to personalise and promote the contextualised applicability of the activities to her current students were included. The personalised elements in her Web course reflect those in the MEd course that Jelene voiced as being part of her espoused mental model of teaching with the WWW.

Her explanation of her mental model did not mention these aspects in the post interview. Rather, it focused on the instructional design of her project and emphasised a mastery model of teaching and learning (see Table 2):

> A learning model was developed as a multiliteracy model which I've actually applied to online delivery and, in that process, I have had to consider how the students go through these processes. … I talk about why they're going to do what they're going to do, then I show them how to do what they've got to do, and give them a chance to practice and apply in a different situation [using the built-in online interactions]. It's linear; it's structured but with a menu for [navigational] choice **…** Basically, mine [the WWW section of my TAFE course] is a tool … to get them interested and using the Internet; it is not for using the Web as a resource to move across to other sites.

Jelene's espoused mental model of how students could best be taught with the WWW echoed her concern that teaching should involve understanding the characteristics and contexts of one's learners. Translating this into practice, that is, her Web course, Jelene's exiting (reflective) mental model of best WWW teaching practices for her group of students reflected linear instructivist methods that provide security within a closed environment.

The mental models delineated by Boris appear more diverse than those of Jelene. His espoused mental model of teaching with the WWW also included students. It was based on an instructivist pedagogy, "… being that instructor, in terms of finding information of Web sites that they might visit in order to facilitate their own learning or their interest area." He continued running his mental model, repeating the museum analogy and identifying his role as a tour guide, "Much like in a museum. Many rooms, many doors, and you're the guide to direct them towards those. Obviously, there is then a lot of freedom for them to explore for themselves." There was a major change from a pre mental model that espoused an instructivist pedagogy to a reflective mental model that embraced a constructivist pedagogy:

> I see myself as a facilitator. I don't see myself as an expert … My role as a teacher is not always giving them the information [rather it is one] that provides scaffolding … giving children that freedom to explore for themselves is important.

We interpreted this dramatic shift in his mental model as follows. Initially, Boris depicted himself as a tour guide who led students to certain rooms, that is, preselected Web sites, with a standardised information spiel and some freedom to choose which item to look at, that, in the classroom context, meant that the children would choose from amongst the various Web sites he provided. In contrast, in his exiting mental model he saw himself as a tour facilitator, one who said, 'See you back here in an hour or when you need me', thus allowing students the freedom to take risks and decisions with support and scaffolding.

The MEd course influenced this change. Indeed, in his post interview evaluation of the course, Boris emphasised that the instructional design and role the lecturers adopted "provided a lot of support … [and] some scaffolding in terms of structure; at the same time, it provided the freedom to use that support" and reflect on your understandings and progress. Boris's mental model had evolved as he interacted with the MEd course materials, peers, lecturers, and his project (cf. Norman,1982; Tallman & Henderson, 1999):

> Even though I've done this course, I don't see myself as an expert. Of course, it's opened up my eyes … and given me more confidence … and I see that same thing applying to the kids. If I can give that same thing to the children, some confidence through support, scaffolding, then let them go the next many steps, then I think that's what my role as a teacher is (Reflective Mental Model Interview).

With mental model formation, we continuously seek new information and test the results against our current models. For Boris, it appeared that the new information was so compelling that he rethought and revised his model.

Another focus in Boris's espoused mental model was obtaining a product, that is, finding information within a teacher-directed closed environment. It had changed to focus on process, that is, developing both a procedural and conceptual understanding of information literacy with respect to email and the WWW.

This meant that teaching and learning with the WWW now had “the potential to be a creative endeavour, an interactive endeavour” in the classroom (Post Mental Model Interview).

Bringing It Together

Boris' classroom pedagogy was essentially constructivist (Personal communication with Boris’ school principal). Yet, when confronted with *Teaching and Learning with the WWW*, his reported espoused mental models demonstrated an instructionist perspective of learning and teaching and a picture of the Web as merely an information resource. However, his reflective mental model of the Web saw it as an interactive environment that allowed creative contributions by teachers and students. Two features of his mental models of teaching and learning with the WWW were an emphasis on student freedom to construct their own mental models and his role as a scaffolder of their learning rather than the expert information giver. There was now congruence between his mental models and constructivist classroom pedagogy. This is further evidenced in the curriculum project developed as part of the course assessment. His students' mission was “to journey into Cyberspace” in order to solve a science challenge of their choice thereby making “learning more purposeful, a link to real life outside the classroom.”

Unlike Boris, Jelene's mental models of teaching and learning were influenced by the competency based pedagogy of her Institute of TAFE work environment. In spite of the constraints imposed by this pedagogy, Jelene's project for the MEd course successfully married this with the complexity and interactivity of the WWW and her continued emphasis on personalising teaching materials.

In both cases, Boris and Jelene were aware of the context of their learners and they were able to accommodate this in their reflective mental models. Notwithstanding the pragmatic constraints of their students' contexts, both were able to translate their mental models into effective curriculum materials through their projects.

Implications

What outcomes does our exploration of students' espoused and reflective mental models offer in seeking to shape teaching and learning at a distance with the WWW?

First, it offers an understanding of the concept of mental model within a particular context. In this study, changes in the participants’ mental models were influenced by the course and, in turn, informed the students’ assessment.

Second, we found our analysis illuminating in terms of understanding how the instructional design of the course impacted the students learning journey and therefore suggest that an examination of the students' mental models could yield a similar result for other distance educators. One area that we will be pursuing is what we have learned about teaching a multiple media course that relies on computer technologies, particularly the WWW, and how we seek to reinforce those aspects that have appeared to have enriched the students’ mental models. There may be adventurous ways for not only the lecturer but also the students, themselves, to use their self-disclosed mental models as a tool for discussion. For example, students would post their evolving mental models to the Web discussion forum and what this may mean to them as learners. Such exploration could also uncover the relevance of this as a worthwhile tool for their own teaching with the WWW.

Third, perhaps Boris’ journey has implications for those working in distance and flexible education utilizing the Internet. Boris, a peer-identified constructivist teacher, when immersed in this new environment initially appeared to adopt a more secure instructivist philosophy and pedagogy. As he changed from a novice to a competent and confident learner at a distance and with the WWW, he was able to realign with his constructivist pedagogy. The extent to which this may be reflective of others moving into this new way of learning (and teaching) warrants further research.

Fourth, our trial study reveals that ascertaining students' mental models could be a useful tool for academic and research purposes. It appears to warrant further research beyond our continuing analysis of the mental models of the other student participants in the course.

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