First year Bachelor of Education students' mental models of themselves as learners.

-------------------Ж--------------------

Trang Thi Thuy NGUYEN
School of Education
James Cook University Australia
Trang.Nguyen@jcu.edu.au

A/Prof. Lyn HENDERSON
School of Education
James Cook University, Australia
Lynette.Henderson@jcu.edu.au

Dr. Colin BASKIN
School of Education
James Cook University, Australia
Colin.Baskin@jcu.edu.au

Abstract*: There is political and academic concern about the high retention rate occurring among first year education students in universities worldwide. It is believed that students' knowledge and thinking skills may prevent them from completing their teacher education program. Mental models are seen as a crucial factor since research shows that they can profoundly influence students' knowledge, critical thinking skills, and problem solving in learning environments. Accessing students' mental models will provide information about their conceptual scaffolds. By exploring students' mental models, lecturers may be able to identify students' difficulties and develop better instructional designs.*

This paper presents findings from a research project that examined First year Bachelor of Education students' mental models while undertaking a pre-service teaching subject in Information and Communication Technologies and Education. The quantitative method study is used to capture the breadth, depth, and correlation factors of students' mental models. Analysis was carried using exploratory factor analysis. Results suggest that there are four factor presenting mental models of the students: Academic Engagement with Effective Learning Strategy Mental Model, Disengagement Mental Model, Collaboration Mental Model, and Ineffective Learning Strategy Mental Model.

Keywords: Pre-service teacher education, mental model, academic engagement, effective learning strategy, disengagement, collaboration, ineffective learning strategy.

Introduction:

In universities worldwide, the greatest number of dropouts occur among first year education students (Chambers & Roper, 2000). In Australia, Krause, Hartley, James and McInnis (2005) reported that the number of withdrawals for all university students in their first year of study is higher among low achieving students than among the high achievers. There is a great concern among educators about students' thinking skills which prevent them from completing their teacher education program (Mc Douglas, 2004). Learning at university demands much from students, especially for those in first year who have to manage the transition from school or from work to university. In order to learn efficiently, students need to possess mental models, critical thinking, metacognitive, and strategy skills to reflect on and regulate their learning (Paris & Winograd, 1990; Zimmerman & Martinez-Pons, 1992). According to de la Harpe (1998), effective learning is "a product of students matching the course requirements and their personal available learning skills" (p. 4). Effective learning depends on individuals' mental models and their metacognitive, strategy skills. Instructional methods and curricula also play an important role in students' effective learning (Biggs & Moore, 1993).

This study, therefore, focuses on students' mental models in the learning environment. There is significant worldwide research interest in mental models (e.g.,Bacon, Handley, & Newstead, 2003; Henderson, Putt, & Coombs, 2002; Radvansky & Copeland, 2004; Tallman & Henderson, 1999), and in social learning and/or distributed cognitive context (e.g., Anderson & Henderson, 2004; Baskin, Barker, & Woods, 2004; Chen, 2003; Chesnevar, Maguitman, Gonzalez, & Cobo, 2004; Steketee, 2002). However, a wide survey of the literature has found that none of the above investigated first year Bachelor of Education students' mental models and their shared mental models with tutors and peers in tutorials, computer workshops, and online discussion forums. This study aimed to fill this gap in the literature by exploring students' espoused mental models which could provide insight into first year students' retention.

Mental models:

This section introduces the body of literature underpinning the aspects of mental models for this study: functions of mental models, mental models resist to change, novices and experts, and distributed mental models.

Function of mental models:

Mental models are valuable constructs in the consideration of how we acquire knowledge and achieve understanding. Mental models are individuals' understandings of given concepts based on earlier and current experiences, beliefs and socio-cultural environments (Halford, 1993; Henderson & Tallman, 2006; Johnson Laird, 1987; Johnson Laird & Byrne, 2000). Mental models both modify, and are modified continuously by, incoming inputs (Lambert & Walker, 1995). The formation of mental models is heavily dependent on prior conceptualisation of attitudes and beliefs with respect to the world around us, ourselves as learners, our capabilities and prior experiences, the issues and problems we face, and lastly our strategies (Norman, 1983; Senge, Roberts, Ross, Smith, & Kleiner, 1994). Their importance lies in the part they play in learning. Individuals utilise mental models in their working memories when performing tasks or learning new concepts, combining these with their prior knowledge mental models stored in long term memory and any information extracted from the task (Cañas, Antolí, & Quesada, 2001).

Mental models are seen as allowing learners to plan and accomplish tasks; to evaluate results; to interpret unexpected results in the context of the learning environment (even if the learner's perception of the environment is incomplete or incorrect), and, finally, to restructure concepts about their environment (Greca & Moreira, 2000; Norman, 1983; Van Der Veer, Puerta Melguizo, Van Der Vet, & Van Oostendorp, 2000). Gentner and Stevens (1983) and Wild (1996) phrased this as mental models providing learners with the means to conceptualise, remember, interpret, and communicate information, as well as to control their performances and make predictions.

Norman (1983) and Henderson and Tallman (2006) asserted that we use mental models to manage the degree of our knowledge, enhance our understanding, and troubleshoot problems. However, mental models are not always accurate (Gentner, 2002; Norman, 1983). Other researchers (Farooq & Dominick, 1988; Howe, Tolmie, Anderson, & Mackenzie, 1992; Norman, 1983) confirmed that mental models still work even when inaccurate, disorganized or naïve, because, as Norman (1983, p.7) stated, while "they may not to be technically accurate (and usually are not), they still have to be functional. Inaccurate models can be of great help in the examination of students' knowledge in order to reveal types of learning processes". Gentner (2002, p. 9683) asserted that "if typical incorrect models are understood, then instructors and designers can create materials that minimize the chances of triggering error". Jonassen (1994) suggested that understanding learners' effective and ineffective mental models will help in the design of learning environments which support the generation of efficient mental models.

Mental models resist change

Mental models are often difficult to change. Individuals will readily accept and integrate new information if it fits in with their existing mental models, or discard it if they deem it irrelevant or unimportant. Because learning is influenced by students' epistemologies, some students develop mental models which hinder them from succeeding in certain academic disciplines (Halpern, online document, date unknown). They do not recognize the inadequacy of their mental models, and still use them in discussion with others or in applying them to external events (Duffy, 2003). Henry Petroski (1992) claimed that people "... tend to hold onto their theories until incontrovertible evidence, usually in the form of failures, convinces them to accept new paradigms" (pp. 180-181). Senge (nd) suggested a number of strategies for learning new mental models, such as dialogue and social learning. People should engage in metacognition through dialogue that helps them to be aware of their mental models and how these mental models affect their work. Within social learning environments, individuals share their knowledge, insights, and perspectives. This in turn requires them to consider others' perspectives. Collaborative learning will help members of groups communicate with each other to explore others' mental models, create shared mental models, and learn new mental models. Examples for developing new mental models among students in *ICTs and Education* subject include discussion boards and formal discussions in tutorial groups. The change in mental models is a successful strategy that allows students to learn more efficiently.

Novices and experts

Sloboda (1996) defined an expert as "someone who can make an appropriate response to a situation that contains a degree of unpredictability" (p. 108). Experts will also have the ability to solve unpredicted problems in new situations ulitilising their prior experiences to simulate different strategies in various mental models before carrying out the most appropriate to that situation. As Norman (1983) had previously pointed out, experts run their mental models to envisage the states and behaviours of the environment. Experts generally have the resources to elaborate complex mental models to steer and help them perfect their performances (Payne, 1988). Experts, having automaticised processes while performing tasks, are left with a larger amount of cognitive capacity for integrating information, planning, troubleshooting, and for further strengthening their mental models in their specific knowledge domain (Glaser, Lesgold, & Lajoie, 1985). Experts enjoy the manipulative advantage of having superior cognitive strategies in comparison with novices who, according to Staggers and Norcio (1993), base their mental models on concrete forms of knowledge, reflecting the limitation of their cognitive development and its uncertain links to other declarative, procedural, and conceptual knowledge (Anderson, 1995). This limits novices' skill levels in learning or reinstating previous knowledge (Qureshi, 2004).

Others (Borgman, 1986; Gentner & Stevens, 1983; Norman, 1983; Payne, 1988) also suggested that an expert's mental model is fundamentally different from a novice's, and is not simply more elaborate or accurate. Newton (1996) believed that novices often start with a narrow scenario, looking for surface details first. They may have trouble processing new information because of having difficulties integrating this with their prior knowledge. "This can place an increased burden on processing capacity [in their short term memory] and novices may not make an economical or efficient use of the capacity they have" (Newton, 1996, p. 206). Further, Newton (1996) asserted that, in contrast, the expert's mental model "tends to be hierarchically organized with broad strategies at the top and narrower tactics below. [It also links] useful actions and declarative knowledge to form clusters that tend to be deployed simultaneously" (p. 206). Also, because novices are preoccupied with establishing mental models and attempting to picture and simulate processes in real time, this causes them difficulty in envisaging abstract relations and properties (Glaser, Lesgold, & Lajoie, 1985).

Chi, Fetovich, and Glaser (1981) asserted that novices and experts also differ according to their levels of conceptual understanding, reflected in their mental models. While experts conceptualize their own thinking, novices use formulae or sequences of steps to solve problems (Henderson & Tallman, 2006) novices who have had some experience in problem solving normally use mechanic and procedural strategies until the problem is defined, in contrast to the efficient strategies employed by experts (Henderson & Tallman, 2006).

Experts are better able to use metacognitive skills to monitor and reflect on their performance, thus continuing to make it even more accurate and efficient. Chi, Glaser, and Farr (2002) suggested that experts have the ability to continue strengthening their expertise through prior knowledge stored in their long term memory, guiding perceptions and problem-solving, and that this enables them to perform better than novices. This was confirmed by Salomon's study (Doolittle & Camp, 2003) that tracked learners' improvement from inefficient, slow, and frustrating to fast, quick, and efficient. Thus mental models can continuously improve with performances as students learn so that processes can be handled more efficiently by their working memory (Salomon, 2002).

Distributed mental models

Shared mental models, considered as a distributed cognitive process, have been explored by various researchers (e.g., Banks & Millward, 2000; Mathieu, Heffner, Goodwin, Cannon-Bowers, & Salas, 2004).

Mental models are socially constructed through interaction with more capable or knowledgeable people (Henderson and Tallman, 2006). Mental models are shaped and developed in social context as different learners have different mental models when

observing the same event or doing the same task (Ellis & Maidan-Gilad, 1997). Learners enhance their studies deeply by exchanging their assumptions, generalisations, critique, elaboration, and understanding of concepts. Information gathering among groups augments the "extensiveness" of the group's mental models through interpretation and dissemination of information, and, at the same time, increases the "congruence" of individuals' mental models (Ellis & Maidan-Gilad, 1997, p. 5).
Moreover, mental models distribute in a group involving social discussion. Individuals compare their own mental models containing their own ideas with others', manipulating incoming information to solve problems (Henderson and Tallman, 2006). Learners are able to embed mental models of other's concepts within their own mental models in a relevant domain while working among groups (Anderson et al., 1996). It is crucial to identify first-year students' mental models to "uncover" of learning strategies.

Methodology:

Participants:
Participants in this study were 102 first year Bachelor of Education students taking a compulsory first semester first year subject. The ages of participants were between 17 to 54 years old. Female participants made up 76.5% (N=78) of the total surveyed, 24.5% (N=24) were male students.

Instrument:
Students completed the survey which consisted of 55 statements. The survey was based on the questions in "The first year The first year Experience in Australian Universities: Finding from a decade of national studies" (Krause, Hartley, James, & McInnis, 2005), Metacognitive Awareness Inventory (MAI) (Schraw & Dennison, 1994) and other literatures (e.g.,de la Harpe, 1998). Participants responded on this 5-option Likert-type scale on student's mental models of themselves as learners. Students were asked to indicate their agreement to each statement. Choices were: 5--strongly agree, 4-- agree, 3-- neutral, 2 -- disagree, and 1-- strongly disagree.

Procedures:
The survey was administered during the mass lecture in second week of the first semester. Before answering the questionnaire, students were explained the purpose of the study and were also assured of the confidentiality of their identity. The average time to complete the survey was 10 -15 minutes.

Data Analysis:
A principal components factor analysis with varimax rotation was conducted for students' mental models. The adequacy of the relationship between items was tested using the Kaiser-Meyer-Olkin (KMO). The KMO of 50 items was .500.

Kaiser (1974) has suggested that if the KMO in the study is less than 0.6, the indicator variables with the lowest individual statistical value should be dropped until the KMO overall rises about 0.6. The method involved repeated analyses and inspections. Therefore those variables with the lowest individual KMO statistic value were eliminated until KMO rose to 0.6 for the consistency, reliability, and validity of the survey. Problematic items with loadings on more then one component were deleted one at a time and principal component factor analysis was repeated until a final interpretable solution with a simple structure was identified. Thus, the 32 out of 50 statements were used to delineate the components in this study. The Kaiser-Meyer-Olkin Measure was 0.638, and Bartlett's Test of Sphericity was significant (p<0.1). Based on the Cattell Scree plot (Cattell, 1966) and the interpretability of the factors, a four components orthogonal solution was accepted after the extraction of principal components and a Varimax rotation (see Figure 1).

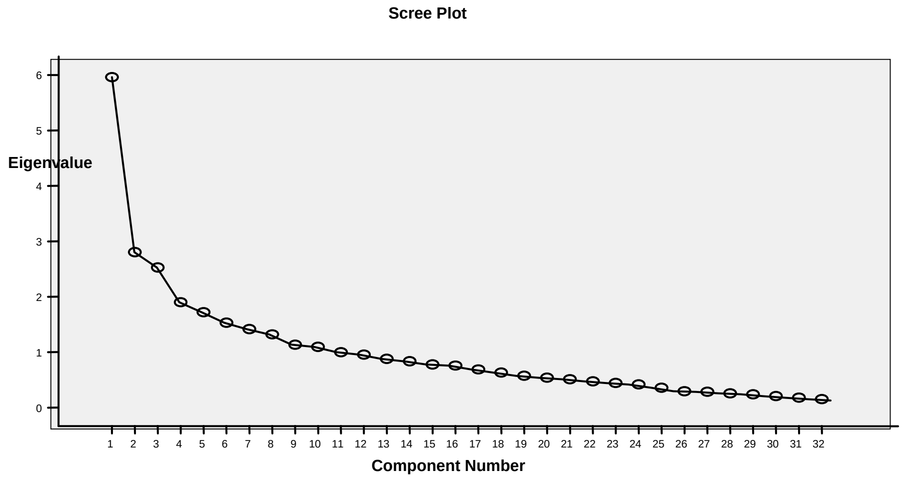

Figure 1: Scree plot for four-factor solution

The four factor solution accounted for the 39.9% of variance. The rotation converged in six iterations. Cronbach's alpha coefficient of internal consistency was used to ensure that the items comprising the resulting components produced a reliable scale. A minimum acceptable level of 0.60 has been proposed (Hari et al, 1998).

Four factors were named Academic Engagement with Effective Learning Strategy Mental Model, Disengagement Mental Model, Collaboration Mental Model, and Ineffective Learning Strategy Mental Model. The eigenvalues of four factors were 6.34, 3.05, 2.55, and 2.05 accounting for 17.6%, 26.0%, 33.1%, and 38.9% of the variance respectively.

Results and Discussion:

Factor 1: Academic Engagement with Effective Learning Strategy Mental Model

This factor consists of the fourteen strongest belief items about students' engagement with the learning environment, the loadings ranged from .686 to .420. A Cronbach's alpha (α=.83) was found (see Table 1).

Table 1: Factor loadings of Academic Engagement with Effective Learning Strategy Mental Model

Q No.	Factor 1: Academic Engagement with Effective Learning Strategy Mental Model (α=.83)	**Loadings**
B5	I know what I am trying to accomplish with my learning	.686
B6	I enjoy the intellectual challenges of this subject	.656
B11	I keep trying until I succeed	.623
B13	I have a strong desire to do well in this subject	.595
B18	I really enjoy a task that involves coming up with new solutions to problems	.577
B7	I get a lot of satisfaction from studying	.549

B2	I really like being a university student	.546
B15	I keep thinking about information or an issue until understand	.497
B39	I try to remember solutions to similar problems in order to solve a computer problem	.495
B1	I know what is required of a first year university student	.478
B12	I give my opinions during tutorial discussions	.470
B4	I have a clear idea of what is expected of me in this subject	.453
B37	I ask myself questions in order to make sure I understand the content I have been studying	.453
B3	I really want to be a teacher	.420

This factor shows the substantial loadings of items that pertained to students' engagement with their learning. They reported mental models of engagement on the following: their understanding of the requirements of the subject they are studying, whether they utilised different strategies to perform learning tasks, and how they motivated themselves to achieve the standards set for themselves as first year university students.

Sudents' mental models of themselves as university learners - "I really like being a university student"- appeared to influence their academic engagement and performance. They activated mental models to visualise an image of themselves as learners in different learning situations. Their espoused mental models showed that they were able to assess the demands of each learning situation, and, in turn, select cognitive strategies that are the most appropriate for each situation. Cognitive strategies include problem solving skills, reasoning, rehearsing applying understanding to a new situation, and development of critical thinking to carry out the proposed tasks, for instances, "I keep thinking about information or an issue until I understand", or "I try to remember solutions to similar problems in order to solve a computer problem", or "I really enjoy a task that involves coming up with new solutions to problems".

The students' mental model of belief and confidence in their studying was reflected in their ability to understand or to do well in their learning for accomplishing the task -"I know what I am trying to accomplish with my learning". They also reported a mental model of confronting the intellectual challenges they face, for example "I enjoy the intellectual challenges of this subject".

The persistence mental model, to keep trying to understand a problem or to perform to the best of their ability in working out answers, even when the problems were challenging or difficult, was reflected in the responded item "I keep trying until I succeed". The high loadings on the following item "I really enjoy a task that involves coming up with new solutions to problem" showed that students had a mental model of potential to generalize thinking and problem solving skills, in order to meet the need to generate successful solutions. Students engaged in applying their existing mental models of the knowledge, based on information processing and thinking, to understand and develop strategies to solve problems conceptually when they encountered any level of difficulty to any given problems.

Factor 2: Disengagement Mental Model

This factor was labeled Disengagement Mental models because of the emphasis of items on being disengaged with the learning environment. Five items loaded on component 1, the loadings ranged from .699 to .363 (see Table 2). A Cronbach's alpha (α=.65) was found.

Table 2: Factor loadings of Disengagement mental model

Q No.	**Factor 2: Disengagement** (α=.65)	**Loadings**
B21	I prefer to agree with other people's ideas then formulate my own opinions	.699
B16	I would rather do something that requires little thought....	.651
B23	I sit back when working with other students in activities during class	.625
B10	I find it is difficult to get myself motivated to study	.598
B33	I find out answers to questions by relying on the subject materials	.363

The high loadings in the items "I prefer to agree with other people's ideas than formulate my own opinions' and "I would rather do something that requires little thought…" revealed students' report that they did not run mental models which actively involved them in the learning process and high order thinking skills to reflect their thinking, analyzing, and evaluating to the problems. If students had constructed their robust mental models in class activities and discussion, they could use these mental models for reasoning new information from other students. They then could assimilate new information, and reorganize the newly interpreted information back to their own mental models, and use aggrandized mental models for formulating their own opinions (Norman, 1983).

Beside that, motivation is a major factor in students' interest in their learning at university and can be conceptualized as students' energy and drive (Martin, 2003). Lacking of self motivation is one of the 10 students' perceptions of factors influencing their academic success and failure (Killen, 1994). Furthermore, motivation affects the use of cognition and metacognitive skills (Schraw, Crippen, & Hartley, 2006). Many researchers (Ames, 1992; Graham & Golan, 1991; Urdan & Giancarlo, 2000) suggested that motivated students are more likely to attempt to engage deep cognitive strategies to fulfill challenging tasks. Students' mental model of motivation through the reported item "it is difficult to get myself motivated to study" would lead students to disengage from studying, and be uninterested in expanding their skills, knowledge and proclivities needed for engaging in critical thinking.

Urdan and Giancarlo (2001) argued that motivation and critical thinking are linked together. According to Killen (2003), motivation is a fundamental element in problem solving. Students who reported that they were not motivated and did not possess appropriate mental models, could be failing to identify the resource of information, to participate in activities, and to utilise sophisticated reasoning at university level, for example, "I sit back when working with other students in activities during class", or "I find out answer to questions by relying on the subject materials".

Factor 3: Collaboration Mental Model

This factor was labeled Collaboration Mental Models because of the emphasis of items on collaborating when studying. Six items loaded on this factor, the loadings ranged from .468 to .740 (see Table 3). A Cronbach's alpha (α=.72) was found.

Table 3: Factor loadings of Collaboration mental model

Q No.	**Collaboration Mental Model** (α=.72)	**Loadings**
B24	I work with classmates outside of class on assignments	.740
B27	I ask other students for help when I encounter difficulties in solving problems	.699
B22	I study with other students	.691
B26	I learn through discussion with other students	.635
B19	I value opinions that differ from mine	.518
B20	I am willing to change my ideas when evidence shows that my ideas are weak	.468

The statements in this factor referred to the mental model of experiences in collaborative learning. Collaboration can help in providing a rich experience that contributes to individual learning through divergent perspectives. Students brought their divergent mental models into a collaborative learning environment. They enhanced their studies deeply by exchanging their assumptions, generalisations, critique, elaboration, and understanding of concepts (e.g. "I learn through discussion with other students."). They then created new understandings based on discussions that they had.

When engaging in a collaborative learning environment, students were able to explore other mental models and to be aware of their own mental models. Moreover, learners could be able to benefit from other individual's thinking by comparing their own mental models with others, embedding mental models of other's concepts within their own mental models in a relevant domain (Henderson & Tallman, 2006; Anderson et al, 1996).

Evaluation is described as the mental process in which a judgment is made about the significance of some aspects of the topic. Students' critical evaluation of their own mental models and other's ideas, for instance, "I value opinions that differ from me" resulted in a desire to change any mental models they thought inadequate. The example for developing new mental models among students was "I am willing to change my ideas when evidences show that my ideas are week". This change in mental models of students would have been a successful strategy that allows students to learn effectively. This agreed with Henderson and Tallman (2006) suggestion that "mental models can be managed by their user to effect necessary changes". It is tended to provide the fundamental for success in learning if students effectively ran their own mental models, and made comparison with other mental models and changed them as needed during collaborative learning.

Factor 4: Ineffective Learning Strategy Mental Model

This factor was labeled Ineffective Learning Strategy Mental Model because of the emphasis of items on weak learning strategies. Seven items loaded on this factor, the loadings ranged from .392 to .686 (see Table 4 a). A Cronbach's alpha (α=.667) was found.

Table 4: Factor loadings of Ineffective Learning strategy Mental Model

Q No.	Ineffective Leaning Strategy Mental Model (α=.667)	Loadings
B29	I do not need to use a variety of strategies to be an effective learner	.686
B17	Learning new ways to learn doesn't excite me	.565
B49	When I spend a lot of hours on my assignment, I will get a very good mark	.550
B46	I only read what I have to do in the Web Lecture Topic in order to answer the question	.540
B48	I usually do an assignment just before it is due	.456
B38	When writing, I am more likely to paraphrase an author's words rather than use my own words	.456
B31	I prefer finding answers by myself rather than getting help	.392

Examining high loadings on non-strategy learning, non-critical thinking skills were reported in this factor, one could immediately tell that students ran novice mental model. It is important to note that students did not report their mental models of using different study strategies on a regular basis in this core subject, for instance, "I do not need to use a variety of strategies to be an effective learner". This shows that they did not use deep level of cognitive engagement. However they indicated that they occasionally used shallow levels of cognitive engagement by the attempt to get their work done just in time, for example "I usually do an assignment just before it is due". What is more, their espoused mental models of learning this subject revealed that they rarely sought understanding of all materials and only read the minimum amount necessary - "I only read what I have to do in the Web Lecture Topic in order to answer the question". They revealed that they would not self construct their mental model of writing an assignment by themselves, as novices have little knowledge of deep structural relations, for example, "When writing, I am more likely to paraphrase an author's words rather than use my own words".

Implications and conclusions:

The findings of this study suggested four factors presenting mental models of first year university undergraduates: Academic Engagement with Effective Learning Strategy Mental Model, Disengagement Mental Model, Collaboration Mental Model, and Ineffective Learning Strategy Mental Model.

The Academic Engagement with Effective Learning Strategy Mental Model and the Collaboration Mental Model were identified as having a powerful influence on students' learning environment, engagement, achievement, motivation, and collaboration in university study. Students who held mental models that connected with university and teaching career were more motivated to engage academically with the learning environment. More particularly, students holding more appropriate mental models chose wider learning strategies. Students' mental models of collaborative learning seemed to impact significantly on university achievement.

The Disengagement Mental Model and Ineffective Learning Strategy Mental Model were considered as being of low relevance in motivating students to engage in leaning. The Disengagement Mental Model appeared to be important to this study. The statements in this factor showed that motivation and thinking skills are related, which is one important implication for in-depth future research. The Ineffective Learning Strategy Mental Models factor seemed to play a key role in predicting whether or not first year university students complete their first year course. In conclusion, there is a need for additional investigation to reinforce the findings. Further post surveys will be analysed to determine whether these mental models factors are significant predictors of course completion or course withdrawal.

References:

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*, 261-271.

Anderson, N., & Henderson, M. (2004). e-PD: Blended models of sustaining teacher professional development in digital literacies. *E-Learning, 1*(3), 383-394.

Bacon, A. M., Handley, S. J., & Newstead, S. E. (2003). Individual differences in strategies for syllogistic reasoning. *Thinking and Reasoning, 9*, 133-168.

Banks, A. P., & Millward, L. J. (2000). Running shared mental models as a distributed cognitive process. *British Journal of Psychology, 91*(4), 513-531.

Baskin, C., Barker, M., & Woods, P. (2004). Scoping social presence and social context cues to support knowledge construction in an ICT rich environment. Retrieved 01 July, 2005, from www.aare.edu.au/04pap/bas04434.pdf

Biggs, J. B., & Moore, P. J. (1993). *The process of learning* (3 ed.). Sydney: Prentice Hall.

Borgman, C. L. (1986). The user's mental models of an information retrieval system: An experiment on a prototype online search. *International Journal of Man-Machine Studies, 24*, 47-64.

Cañas, J. J., Antolí, A., & Quesada, J. F. (2001). The role of working memory on measuring mental models of physical systems. *Psicologica, 22*(1), 25-42.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1*(2), 245-276.

Chambers, G., & Roper, T. (2000). Why students withdraw from initial teacher training. *Journal of Education for Teaching, 26*(1), 25:39.

Chen, C. (2003). A constructivist approach to teaching: implications in teaching computer networking. *Information Technology, Learning, and Performance Journal, 21*(2), 17-28.

Chesnevar, I. C., Maguitman, G. A., Gonzalez, P. A., & Cobo, L. A. (2004). Teaching fundamentals of computing theory: A constructivist approach. *Journal of Computer Science and Technology, 4*(2), 91-97.

Chi, M., Feltovich, P., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5*, 121-152.

de la Harpe, B. I. (1998). *Design, implementation and evaluation of an in-context learning support program for first year education students and its impact on educational outcomes.* PhD thesis, Curtin University of Technology, Perth.

Doolittle, E. P., & Camp, G. W. (2003). Constructivism: The career and technical education perspective. Retrieved May 23, 2005, from http://vcampus.uom.ac.mu/upload/private/200332695533/200332695533.pdf

Duffy, F. M. (2003). I think, therefore I am resistant to change. *Journal of Staff Development, 24*(1).

Ellis, S., & Maidan-Gilad, N. (1997). Organizational performance and shared mental models during planned change. Retrieved June 24, 2005, from http://recanati.tau.ac.il/faculty/pdf/ellis_shmuel/NAAMA.pdf

Farooq, M. U., & Dominick, W. D. (1988). A survey of formal tools and models for developing user interfaces. *International Journal of Man-Machine Studies, 29*, 479-496.
Gentner, D., & Stevens, R. E. (1983). *Mental models*. Hillsdale: NJ: Lawrence Erbaum Associate.
Glaser, R., Lesgold, A., & Lajoie, S. (1985). Toward a cognitive theory for the measurement of achievement. In R. Ronning, J. Glover, J. C. Coloney & J. C. Witt (Eds.), *The influence of cognitive psychology on testing and measurement* (pp. 41-85). Hillsade: NJ: Erlbaum.
Graham, S., & Golan, S. (1991). Motivational influences on cognition: Task involvement, ego involvement, and depth of processing. *Journal of Educational Psychology*(83), 187-194.
Greca, M. I., & Moreira, A. M. (2000). Mental models, conceptual models, and modelling. *International Journal of Science Education, 22*(1), 1-11.
Halford, G. S. (1993). *Children's understanding: The development of mental models*. Hillsdale: NJ: Laurence Erlbaum.
Halpern, D. F. (online document, date unknown). Applying the science of learning: Using the principles of cognitive psychology to enhance teaching and learning. Retrieved 18 September, 2005, from http://www.house.gov/science/research/may10/halpern.htm
Henderson, L., Putt, I., & Coombs, G. (2002). Mental models of teaching and learning with the WWW. Retrieved 01 December, 2004, from http://www.ascilite.org.au/conferences/auckland02/proceedings/papers/063.pdf
Henderson, L., & Tallman, J. (2006). *Mental models, stimulated recall and teaching computer information literacy*. Lanham WD: Scarecrow Press.
Howe, C., Tolmie, A., Anderson, A., & Mackenzie, M. (1992). Conceptual knowledge in physics: The role of group interaction in computer-supported teaching. *Learning and Instruction, 2*, 161-183.
Johnson Laird, P. (1987). Mental models. In A. Aitkenhead & J. Slack (Eds.), *Issues in cognitive modeling* (pp. 81-100). Hillsdale, NJ: Lawrence Erlbaum.
Johnson Laird, P., & Byrne, R. (2000). Mental models and pragmatics. *Behavioural and Brain Sciences, 23*, 284-286.
Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*(39), 31-36.
Killen, R. (1994). Differences between students and lecturers' perceptions of factors Influencing students' academic success at university. *Higher Education Research and Development, 13*(2), 199-211.
Killen, R. (2003). *Effective teaching strategies: Lessons from research and practice* (3 ed.). Tuggerah, Australia: Social Science Press.
Krause, K., Hartley, R., James, R., & McInnis, C. (2005). *The first year experience in Australian universities: findings from a decade of national studies*. Melbourne: Department of Education, Science, and Training.
Martin, A. J. (2003). The student motivation scale: Further testing of an instrument that measures school students' motivation. *Australian Journal of Teacher Education, 47*(1), 88-106.
Mathieu, J. E., Heffner, T. S., Goodwin, J. F., Cannon-Bowers, S. J., & Salas, E. (2004). Scaling the quality of teammates' mental models: Equifinality and normative comparisons. *Journal of Organisational Behaviour, 26*(1), 37-56.
Mc Douglas, M. (2004). *First steps in becoming a teacher: Initial teacher education students' perception of why they want to teach.* PhD Thesis, Central Queensland university.
Newton, D. (1996). Some observation on mental models. In R. Saljo (Ed.), *Learning and Instruction* (Vol. 6, pp. 201-217). Great Britain: Elsevier Science Ltd.

Norman, D. A. (1983). Some observations on mental models. In D. Gentner & A. Stevens (Eds.), *Mental models* (pp. 6-14). Hillsdale, N.J.: Lawrence Erlbaum Associates.
Paris, S. C., & Winograd, P. (1990). How metacognition can promote academic learning and instruction. In B. F. Jones & L. Idol (Eds.), *Dimensions of thinking and cognitive instruction* (pp. 15-51). Hillsdale, New Jersey: Lawrence Erlbaum Associates.
Payne, S. J. (1988). Methods and mental models in theories of cognitive skill. In J.Self (Ed.), *Artificial intelligence and human learning* (pp. 69-87). London: Chapman & Hall.
Qureshi, L. (2004). Models of the learner. Retrieved May 01, 2005, from http://venus.uwindsor.ca/courses/edfac/morton/models_of_learners.htm#Novice
Radvansky, G. A., & Copeland, D. E. (2004). Working memory and situation model processing: Language comprehension and memory. *American Journal of Psychology, 117*, 191-213.
Schraw, G., Crippen, K. J., & Hartley, K. D. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education, 36*(1-2), 111-139.
Schraw , G., & Dennison. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*, 460-475.
Sloboda, J. (1996). The acquisition of musical performance expertise: Deconstructing the "talent" account of individual differences in musical expressivity. In K. Ericsson (Ed.), *The road to excellence: The acquisition of expert performance in the arts and sciences, sports and games* (pp. 107-126). Mahwah, NJ: Lawrence Erlbaum Associates.
Soloman, H. (2002). Cognitive load theory (J. Sweller). Retrieved 21 March, 2005, from http://tip.psychology.org/sweller.html
Staggers, N., & Norcio, A. (1993). Mental models: concepts for human computer interaction research. *International Journal of Man-Machine Studies, 38*, 587-605.
Steketee, N. C. (2002). *Exploring conditions for the effective implementation and use of computerised cognitive tools.* PhD Thesis, Edith Cowan University, Perth.
Tallman, J., & Henderson, L. (1999). Constructing mental models paradigms for teaching electronic resources. *School Library Media Research, 2*.
Urdan, T., & Giancarlo, C. (2000). *A fresh look at the relationship between classroom goal structures and student motivation.* Paper presented at the American Educational Research Association, New Orleans.
Urdan, T., & Giancarlo, C. (Eds.). (2001). *A comparison of motivational and critical thinking orientations across ethnic groups* (Vol. 1). Greenwich, CT: Information Age Publishing.
Van Der Veer, G., Puerta Melguizo, M., Van Der Vet, P., & Van Oostendorp, H. (2000). Mental models of incidental human-machine interaction. Retrieved 16 March, 2005, from http://www.cs.vu.nl/~gerrit/mmi9910-report1.doc
Wild, M. (1996). Mental models and computer modeling. *Journal of Computer Assisted Learning,, I*(1), 10-21.
Zimmerman, B. J., & Martinez-Pons, M. (1992). Perceptions of efficacy and strategy use in the self-regulation of learning. In D. H. Schunk & J. L. Meece (Eds.), *Student perceptions in the classroom* (pp. 185-207). Hillsdale, New Jersey: Lawrence Erbaum Associates.