UNIVERSITY STUDENTS' COGNITIVE SKILLS AND STRATEGIES WHILE LEARNING IN SECOND LIFE

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Abstract

Universities and other educational institutions continue to invest heavily in acquiring virtual worlds. However, rigorous research on the value of these environments in terms of cognition is scant. In response, this qualitative empirical research gathered evidence of student cognitive skills and strategies utilised during a 90 minute Second Life lesson. In order to develop proficiency in a first year university core Chinese language and culture subject, students were required to identify and order food in Mandarin in the Second Life Chinese inn/teahouse. To ascertain the cognitive skills utilised during this SL lesson, stimulated recall methodology, centred within Information Processing Theory and a Mediating Process Paradigm, was employed. An innovative screen and video capture technology provided the stimulus for the stimulated recall interviews. A total of 735 thinking skills and strategies, including 73 metacognitive skills, were reported by 11 students as having occurred during the lesson. Nevertheless, there was a marked disparity between interviewees with the lowest reported thoughts (23) and the highest (178). Although all students completed the tasks, this variability in students' cognitive skills highlights the value of using a Mediating Process Paradigm to understand more insightfully the complexities of teaching and learning in virtual worlds.

Introduction

The rapidly growing number of educational virtual worlds is influenced by the promotion of Second Life (SL) as a highly effective teaching and learning tool (for example, Australian Flexible Learning Framework, 2006; Bradshaw, 2006; Campbell, 2009; Mayrath, et al., 2009; Roussou, Oliver, & Slater, 2006) that caters for "digital natives" preferences for social, interactive wired technologies (e.g., Prensky, 2005; Kamel Boulos, Hetherington, & Wheeler, 2007). Coupled with the increasing focus on university retention, particularly that of first year students, Universities have invested heavily in buying virtual worlds. Over 300 universities had a SL presence in 2008 (Michels, 2008) of which X University has 300 000 square metres across six SL islands to facilitate teaching and learning in various disciplines, including Chinese language and culture.

Put succinctly, a virtual world is a computer based environment in which users inhabit and interact with avatars that are digital representations of the user. Second Life is one such virtual world and is well suited for teaching and learning second languages. SL provides learners with "personally meaningful authentic material in the target language" (Schwienhorst, 2002, p.202) and in an authentically replicated environment (e.g., a Chinese inn/teahouse). Neither the SL environment nor its objects (e.g., Chinese food) or interactive tasks (e.g., selecting and costing specific menu items) disappear at the end of the language and culture lesson. Some authors (e.g., Mayrath, Traphagan, Heikes, & Trivedi, 2009) argue that "SL is simply ... a platform for users or avatars to create and/or explore places and spaces" (p.2). The agency afforded to SL users in the Chinese Language and Culture subject, for instance, engenders diverse, changeable and rich learning environments which are far from simple.

Literature Review

In another paper accepted for this conference, the authors describe the research literature in language learning relating to the affordances offered by virtual worlds, and SL in particular. However, of particular interest for this research project is Schwienhorst's (2002) conclusion that the affordance of learner autonomy in synchronous virtual worlds are particularly valuable in supporting experimental, learner centred environments which can not only raise language and linguistic awareness and performability but also support complex thinking and critical reflection.[1] This is particularly interesting because of the lack of subsequent research on ascertaining the cognitive processes of students engaged in virtual worlds.

There is, however, an increasing research literature focusing on aspects of utilising SL as a teaching and learning tool in education, as evidenced by the *Journal of Virtual Worlds Research* dedicating its fifth volume to "Pedagogy, Education and Innovation in Virtual Worlds" (2009). Nevertheless, much has been an exploration of proposed educational implications based on the nature of SL (Coffman and Klinger, 2008), how to create and implement SL interventions (e.g., Mayrath, et al, 2009) and, as Herold (2009) pointed out, the worth of SL interventions in terms of student and lecturer feedback via Likert Scale and short answer questionnaires and interviews.

Consequently, the research addressed two SL research areas that Coffman and Klinger (2008; also see Feldon & Kafai, 2008) argued were critical. Thus, it utilised a theoretical and methodological paradigm that provided robust empirical data targeting the aim of the research – the identification and evaluation of the cognitive skills and strategies utilised by students during a first year, university SL Chinese language and culture lesson. The particular research questions addressed in this paper were: What thinking skills and strategies did the students utilise during the SL lesson? What is the comparison between higher level thinking skills and lower level thinking skills and strategies? This framework afforded insights into what was going on in the students' heads during an educational SL experience.

Theoretical and Methodological Framework

This was a qualitative empirical study contextualised within the information processing theory, mediating process paradigm, and introspection process tracing methodology (see Figure 1).
The *information processing theory* explains how learning and remembering occur. After receiving incoming stimuli into sensory memory, the stimulus is either discarded or sent to short-term working memory. Then it is either discarded or processed and sent to long term memory for categorised storage from which, when needed, it is recalled back to short term memory and then delivered as responses or learning outcomes (Galbraith, 1994; Huitt, 2000). Such an outcome, in this study, was correctly ordering a meal suitable for four friends with differing diet requirements.

The *mediating process paradigm* (Fig, 1) focuses on the thought processes that are involved in information processing and thus "mediate, or come between, stimuli and outcomes. Mediating processes can be viewed as the fine-grained elements of cognition through which, and by which, everyday cognitive outcomes are realised" (Henderson, Putt, Ainge & Coombs, 1997, p. 163).

Introspection process tracing methodology is employed to access those thinking processes through utilisation of stimulated recall interviews. Adherence to its strict protocols demonstrates that participants can access and report what they had actually been thinking during, for instance, the SL lesson, and verbalise those thoughts (Henderson & Tallman, 2005; Gass & Mackey, 2000; Erickson & Simon, 1980). Recall accuracy is enhanced if conducted within 24 hours as there is a 95% accuracy of

[1] Schwienhorst (2002) used the term Virtual Reality (VR); however, his definition is closely aligned with that of the term Virtual Worlds which began to become popular after 2002. Schweinhorst's description of the functionality and affordances of VR are consistent with that of Second Life.

recall which drops incrementally to 65% if it is 14 days later (Bloom, 1954; Gardiner & Parkin, 1990). Strict Interview Protocols require non-directive questions: *Can you tell me what you were thinking when you ordered that dish?* This is because vocalising thoughts as well as explaining them interfere with memory recall (Ericsson & Simon, 1993).

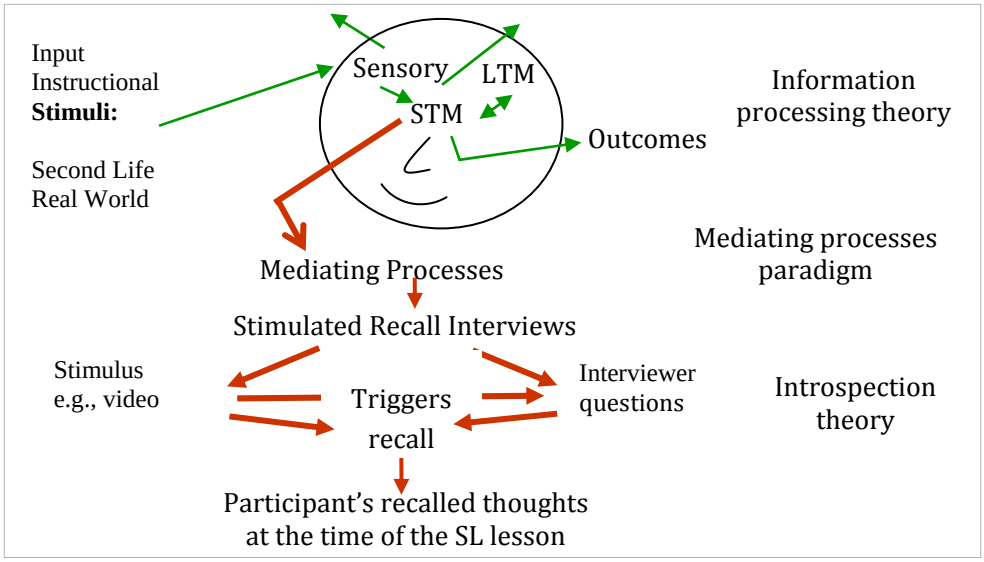

Figure 1. Theoretical and Methodological Framework

Stimulated recall methodology has been effectively utilised in a wide variety of educational contexts: with: ESL learners (Gass & Mackey, 2000), non-English speaking Thai medical students (Pausawasdi, 2001), with teacher-librarians and students from Grade 4 though 12 in the USA and Australia (Henderson & Tallman, 2006), 13 year old video-game players (Henderson, 2005); and Australian Indigenous B.Ed students learning with IMM courseware (Henderson, Putt, Ainge, & Coombs, 1997).

Participants, Context and Data Collection

The first semester subject, *Chinese 1*, admits students who have not formally studied Mandarin Chinese. In 2009 the subject had 153 students, with 67% having English as a first language. Apart from the use of SL in a series of 90 minute lessons, the subject consisted of the traditional weekly lectures and tutorial, independent study based on textbooks and their associated language DVD. With respect to familiarity with virtual environments, 46% of the students had never spent time in a SL virtual world or played a 3D game with an avatar before, 37% a few times, and 17% many times or frequently.

Of these, 11 students, nine females and two males, volunteered to be interviewed. Only two had previously formally studied another language other than their mother tongue: one of these students had learnt one different language and the other student already had two non-English languages and was currently studying a further European language. Two interviewees had been in a recreational SL virtual world and another four had played a 3D game with an avatar.

This research targeted the second 90 minute lesson in a series of on-campus lessons located in a computer laboratory but conducted in SL. The first lesson targeted learning and practicing SL related skills. The lesson under scrutiny in this study was specifically focussed on language and culture content previously covered in the classroom and textbook. In this lesson the students had a number of learning objectives aligned with those of the subject and based on a collaborative learning activity to identify and order appropriate food in Mandarin in a Chinese restaurant setting (see Figure 2). For instance, the lesson aimed to strengthen student use of Chinese pinyin Romanisation to input Chinese characters on a computer as well as to be able to read Chinese characters (consequently, this lesson did

not allow voice communication). In a dynamic semi-spontaneous scenario, communication was centred around, but not limited to, practicing key vocabulary and phrases related to ordering food learned from the textbook and to extend on the textbook through new phrases introduced by the tutor or robots (automated avatars). Successful completion of the SL lesson could only be achieved through reading, writing and negotiating choices in Chinese text.

Figure 2. Chinese Inn/Teahouse in Second Life

The study adhered to the well established stimulated recall method of video recording participants during the lesson and then replaying it during each individual's retrospective interviews. The video was paused by a student when recalling a specific thought and when the researcher thought it might elicit mediating processes. This minimises researcher bias of determining when the student reported. A major strength of the stimulated recall interview is using the video to explore the visual cues, such as frowning or taking notes, which have been found as major indicators of mediating processes (e.g., Gass & Mackey, 2000; Henderson & Tallman, 2006).

A significant innovation in this study was the use of screen capture software (Screen Flow) to record both the avatar's on-screen activity in Second Life as well as the face of the participant (via the inbuilt web camera). Unlike previous use of videotape technology, this allowed full resolution capture of the screen, instant visual scrubbing (fast forward and rewind) along the video, synchronisation of face and screen video capture, and full-facial expression capture. In addition, the use of a software solution to this task allowed for a particularly non-intrusive data collection process (as opposed to video cameras with tripods and camera operators).

Data Analysis and Findings

One transcribed interview was coded and categorised by all four authors simultaneously; then swapped and checked by the others. Discussion ensued when there were differences until all agreed. Each then completed 2 or 3 which were then double checked. The lead author then re-checked all for consistency of coding. Transcript data that were considered invalid – thoughts that occurred during the interview and not during the actual lesson or as a result of a leading question by the interviewer – were discarded.

Twenty different cognitive skills were identified (Table 1). Four aspects are obvious:

(1) the range is from the lowest level thinking skill/strategy of *recalling* stored information to the highest level thinking skills/strategy, *metacognition*, that included examples of its awareness and, more significantly, its control function;
(2) there are 15 reported under-utilised thinking skills/strategies (fewer than the 5 percentile);

(3) *affect*, defined as thoughts that identify emotions and feelings, scored the highest number (145);
(4) there was considerable variability in the number of recalled thoughts by the 11 students, with Interviewee 7 reporting 178 thoughts, and Interviewee 6, a mere 23, that had occurred while they were actually working through the SL lesson;
(5) eight higher order thinking skills (bolded in Table 1) were utilised with six being reported by all students.

Discussion

What is pleasing is the high number of reported higher level thinking skills and strategies. These are in bolded type in Table 1 and five are singled out for comment. There were 121 instances of *strategy planning* thereby demonstrating that these students were devising tactics to accomplish the lesson objectives within the SL environment and future study tasks (e.g., revisiting the SL site for exam revision). Interviewees 3, 6 and 11, who reported the lowest number, also utilised this skill (9, 2 and 5 instances, respectively). *Evaluating*, making judgements about the value and worthwhileness of their progress and language abilities as well as learning with SL, was the third highest (107). *Metacognition* (73) – realising that they know or do not know as well as reflecting on, evaluating, and directing (i.e., controlling) their own thinking – was used by all students, but significantly by Interviewees 4, 8 and 9. All but one interviewee provided instances of *justification*, that is, trying to prove that a proposed action/idea is reasonable or correct through self-argument. However, a comparatively disproportionate number (one third) were reported by Interviewee 8. Ten students reported thoughts that demonstrated they *generated* their own questions and extrapolated by going beyond the SL lesson and the subject.

Table 1: Collated Types and Number of Thinking Skills and Strategies by Interviewee.

Type*	Interviewees											Total	%
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**		
Affect	3	15	3	19	15	2	5	46	12	20	5	**145**	19.7
Strategy Planning	9	15	9	18	10	2	6	31	6	10	5	**121**	16.5
Evaluating	3	14	3	15	12	3	2	27	7	15	6	**107**	14.6
Metacognising	5	5	3	17	7	1	2	14	13	5	1	**73**	9.9
Justifying	2	4	0	12	5	2	3	22	5	4	4	**63**	8.6
Comparing	5	2	2	5	0	2	2	9	4	2	1	**34**	4.6
Generating	2	1	2	5	3	1	1	8	2	7	0	**32**	4.4
Anticipating	2	3	2	1	1	1	1	8	8	3	1	**31**	4.5
Confirming	1	0	3	5	4	0	1	4	1	3	2	**24**	3.3
Diagnosing	1	5	2	4	2	5	1	1	1	2	0	**24**	3.3
Categorising	1	3	3	4	0	1	1	3	1	1	0	**18**	2.5
Linking	0	3	3	2	2	0	0	0	0	5	0	**15**	2.0
Analysing	3	0	3	2	0	1	1	0	3	1	0	**14**	1.9
Recalling	1	1	2	1	1	1	2	0	3	1	1	**14**	1.9
Translating	0	0	0	0	0	0	2	2	2	0	1	**7**	1.0
*Deliberating***	0	0	0	0	0	1	0	2	1	2	0	**6**	0.8
Reflecting	0	1	0	0	0	0	0	1	0	0	0	**2**	0.3
Imaging	0	0	0	0	1	0	0	0	0	0	0	**1**	0.1
Selecting	0	0	1	0	0	0	0	0	0	0	0	**1**	0.1
Applying	0	0	0	0	0	0	1	0	0	0	0	**1**	0.1
TOTALS	**38**	**72**	**41**	**110**	**63**	**23**	**31**	**178**	**69**	**81**	**27**	**735**	**100**

* Higher order thinking skills and strategies are bolded; the lowest are italicised; the remainder are middle range.
** *Deliberating* occurred when the type of thinking was not disclosed (e.g., "I was just thinking about the dishes.")

In comparison with the instances of higher level thinking skills and strategies, there were only five ranked at the lowest level and are italicised in Table 1. Two of these, *confirming* (24) and *recalling*

(14), were in the mid-range percentile group but less than 4 percent. *Confirming* involved thoughts like: "Yes, I've got the correct dish for a diabetic." The other three – *deliberating* (6), *imaging* (1), and *selecting* (1) – were very low. *Reflecting* was the only higher level one in this very low range. The SL lesson stimulated recall of a larger number higher and medium level thinking skills and strategies than at the low level.

The others were designated "middle range" thinking skills/strategies. *Anticipating* entails such thoughts as: "That's when I thought that this not going to be easy [sic]." C*ategorising* thoughts were triggered by the lesson tasks, especially choosing the correct dishes.

There was only one instance of *imaging* which is visually depicting oneself in a particular environment: "This is when I was thinking about being in a Chinese inn/teahouse in this small town in China ordering this dish." Contrast this with another student's thought: "I'll order a dish in Mandarin when I'm eating at my local Chinese restaurant". The latter did not report seeing himself in that restaurant, thus it was not an instance of imaging. The rich emersiveness of the SL virtual world would have been a factor limiting this thinking skill/strategy.

Typical reported thoughts in the *affective* domain were: "I'm happy that I now have three dishes" and "I was getting angry. That's what I was thinking: 'I'm angry'." That this area received the highest number of reported thoughts and that the majority were negative is not surprising, given their previous SL and 3D experiences or non-experiences. The Chinese language and culture SL virtual world did not provide a game learning environment. More significantly, none had been in a teaching and learning SL virtual world (other than their first lesson when they learnt how to use the SL's functions).

Table 1 findings are not dissimilar to those in other pedagogical contexts: first year B.Ed. Indigenous students when learning with IMM courseware (Henderson, 1996); comparison of under- and post-graduate students' thinking processes when studying with the WWW, IMM, and text-based materials (Henderson, Putt, Ainge, & Coombs (1997); thinking skills of distance education university students when learning with text (Marland, Patching & Putt, 1992), experienced teachers learning with IMM (Putt, Henderson & Patching, 1996); 13 year olds playing a recreational computer-video game (Henderson, 2005); medical students thinking skills and engagement (Pausawasdi, 2001); and clinical reasoning of medical students and physicians (Barrow, 2000). Such research identified, for example, that students categorised as less academically-able utilized valued higher level cognitive skills and strategies, than did those with higher grades. This has implications for university (and school) teaching.

Conclusion and Implications

Various methodological frameworks would benefit from utilising the research data gathering technologies in this study. They afford the distinct advantage of providing a way to unobtrusively capture rich data about what students are doing in-world as well as the real-world activities, such as utilising the text book. Interviewers need little training with this paradigm. However, given the dearth of recalled thoughts by some students, more stimulated recall practice with "pretend students" who do not respond is advisable.

This research demonstrated that Second Life can be utilised as a cognitive tool to enhance thinking, problem solving, and learning. Aligning the mediating processes – the thinking skills and strategies – with their triggers, that is, with the aspects of the SL lesson, both in-world and the real world of the classroom, will provide the instructional conditions that can be targeted to promote higher level thinking skills and strategies.

The researchers' further step will utilise the same theoretical and methodological paradigm to ascertain the students' thinking skills and strategies with a game-based teaching and learning SL lesson. Comparing the results with those in this article will provide data as to whether the game SL

lesson produced greater or fewer higher-level cognitive processes for students, particularly those categorised as "digital natives".

Overall, the authentic Chinese inn/teahouse teaching and learning SL site maintained student focus on the lesson's objectives and promoted utilisation of a range of academically valued thinking skills and strategies.

References

Australian Flexible Learning Framework (2006). Virtual Worlds - Real Learning! Retrieved 23 August, 2009, from http://virtualworlds.flexiblelearning.net.au/

Barrows, H. (2000) Stimulated recall: Personalized assessment of clinical reasoning. Springfield, IL: School of Medicine, Southern Illinois University.

Bloom, B. (1954). *The thought process of students in discussion*. In S.J. French (Ed.), Accent on teaching: Experiments in general education *(pp. 23-46). New York: Harper and Row.*

Bradshaw, D. (2006). New practices in flexible learning: Virtual worlds - real learning! Pedagogical reflections Available from http://virtualworlds.flexiblelearning.net.au/reports/VWRL_pedagog_reflect.pdf

Campbell, C. (2009). Learning in a different life: Pre-service education students using an online virtual world. *Journal of Virtual Worlds Research, 2*(1), 3-17.

Coffman, T., & Klinger, M. B. (2008). Utilizing virtual worlds in education: The implications for practice. *International Journal of Social Sciences, 2*(1), 29-33. Retrieved October 2, 2007, from http://www.waset.org/ijss/v2/v2-1-5.pdf

Ericsson & Simon, (1980*)*. Verbal reports as data. *Psychological Review, 87*(3), *215-251.*

Feldon, D., & Kafai, Y. (2008). Mixed methods for mixed reality: Understanding users' avatar activities in virtual worlds. *Educational Technology, Research and Development, 56*, 575-593.

Gardiner, J.M. & Parkin, H. (1990). Attention and recollective experience in recognition memory. *Memory and Cognition, 18*, 617-623.

Gass, S. M., & Mackey, A. (2000). Stimulated recall methodology in second language research. Mahwah, New Jersey: Lawrence Erlbaum.

Henderson, L. (2005). Video games: A significant cognitive artifact of contemporary youth culture. In DIGRA 2005 Conference

Henderson, L. & Tallman, J. (2005). Stimulated recall and mental models: Tools for teaching and learning computer information literacy. Research methods in library and information studies, No.2. Lanham, Maryland: Scarecrow Press, Inc.

Henderson, L., Putt, I., Ainge, D., & Coombs, G. (1997). Comparison of Students' thinking processes when studying with WWW, IMM, and text-based materials. In F. Verdejo & Davies (Eds.), Virtual campus: Trends for higher education and training (pp. 162-124). London: Chapman and Hall.

Henderson, M. (1996). Multimedia interactivity: An investigation into learners' mediating processes during click-drag activities. Unpublished BEd (Hons.) thesis, James Cook University, Townsville.

Herold, D. Teaching media studies in second life. *Journal of Virtual Worlds Research: Pedagogy, Education and Innovation in 3-D Virtual Worlds, 2*(1). Accessed September 12, 2009, from https://www.jvwresearch.org

Huitt, W. (2000). The information processing approach. Retrieved September 21, 2009, from http://chiron.valdosta.edu/whuitt/col/cogsys/introproc.html

Kamel Boulos, M. N., Hetherington, L., & Wheeler, S. (2007). Second Life: An overview of the potential of 3-D virtual world in medical and health education. *Health Information and Libraries Journal, 24*, 233-245.

Marland, P., Patching, W., & Putt, I. (1992). Learning from text: Glimpses inside the minds of distance learners. Townsville: James Cook University of North Queensland.

Mayrath, M. C., Traphagan, T., Heikes, E. J., & Trivedi, A. (2009). Instructional design best practices for Second Life: A case study from a college-level English course. *Interactive Learning Environments, 17*(3), 1-18.

Michels, P. (2008). Universities Use Second Life to Teach Complex Concepts. *Government*

Technology. Retrieved from http://www.govtech.com/gt/252550

Pausawasdi, N. (2001). Students' engagement and disengagement when learning with IMM in mass lectures. PhD thesis, James Cook University.

Prensky, M. (2005). Listen to the natives. *Educational Leadership*, 63(4), 8–13.

Putt, I., Henderson, L., & Patching, W. (1996). Teachers' thinking elicited from interactive multimedia professional development courseware. *Educational Technology Research and Development*, 44(4), 7-22.

Roussou, M., Oliver, M., & Slater, M. (2006). The virtual playground: an educational virtual reality environment for evaluating interactivity and conceptual learning. *Virtual Reality, 10*, 227.

Schwienhorst, K. (2002). Why virtual, why environments? Implementing virtual reality concepts in computer-assisted language learning. *Simulation & Gaming, 33*(2), 196-209.