Paper 167 – Full Paper

Enhancing Information Systems Literacy Education via the Four Resources Model

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Abstract

In this paper we describe why and how the Four Resources Model - a normative, diverse-method literacy education model for literacy education - has been trialed as an additional scaffolding strategy within a core first year introductory Information Systems (IS) subject of a university business school. The motivation for this trial was the need to pedagogically manage the broad distribution in IS prior knowledge levels that students brought into the subject. Engineering and computing science students enter the subject with considerable IS literacy, whilst many business students enter the subject with little IS literacy and a significant wariness of any technology-oriented subject. Predictably these greatly varying initial prior knowledge levels created difficulties for teaching staff and students in many areas of teaching and learning. The Four Resources Model was chosen for this trial because the Model's elements (code breakers, semantic competence, pragmatic competence, and critical competence) directly aim to provide structured scaffolding in literacy pedagogy across a broad range of disciplines. The trial was conducted over a one semester timeline (13 teaching weeks). Students self-selected into the trial because of their voluntarily announced lack of IS confidence and prior knowledge. These students received a weekly scaffolding session with the subject's principal lecturer – with each session structured as per the Four Resources Model to enable the students to develop flexible strategies for deciphering IS terminology, to relate chapters of the set text to each student's experience/knowledge, to understand the applied uses of IS theory, and also to appreciate the broad discourses that influence IS theory description and applications. Analysis of the feedback data from these scaffolding sessions has caused the trial strategy to be scaled up and made available (via MP4 video and audio download) to any enrolled student for the 2011 year.

1. Introduction

In this paper we describe why and how the Four Resources Model (Freebody & Luke, 1990; Luke, 1995) has been trialed as an additional scaffolding strategy within a core first year introductory Information Systems (IS) subject of a university business school. As such, this paper connects with the theme of learning, teaching, and assessment. The Four Resources Model is described in a reflective essay (Freebody & Luke, 1999) as a normative, diverse-method (i.e. inclusive of many practices) literacy education model designed to apply across

many disciplines (not just English courses). The view in (Freebody & Luke, 1999) is that literacy capabilities comprise three dimensions or 'lens':

a) The *breadth* of literate practices contained within the curriculum – i.e. what kinds or genres?
b) The *depth* and *degree* of control exercised – i.e. how much?
c) With what *transformative* direction and power?

Freebody & Luke (1999) state that *breadth* and *depth* of literacy practices can be reliably and validly measured within an education setting – whilst *transformative* direction and power possibly trace to creativity and remain an unresolved measurement issue. Rush (2004) states that the Four Resources Model is a pedagogical framework for developing *depth* of literacy control along four necessary (but not individually sufficient) repertoires/practices/resources:

- *Code breaking* – the capability of students to understand terminology and concepts within the discipline
- *Semantic competence/text participant* – a student's comprehension of a significant portion of a discipline text
- *Pragmatic competence* – the learning of uses for various texts within a discipline
- *Critical competence* – involving the student awareness of how discipline texts "*construct and position human subjects and social reality*" (Luke, 1995, p. 107)

The scaffolding strategy produced within this research uses each of the above four repertoires as a reference framework to assist a student to develop "*…a basic level of computer and information literacy*".

Undergraduate first year students comprise approximately 98% of the IS subject's enrolment. The core first year introductory IS subject is titled "*Computer-based Information Systems*" and the subject's major learning outcome is stated as follows: "*By completing this course students will attain a basic level of computer and information literacy, a strong knowledge of theoretical computing fundamentals, as well as an awareness of the possibilities and limitations of existing technological solution*". Computer literacy within the IS subject is defined in terms of a person's capacity for purposeful and effective use of information and communication technologies (ICTs) in relevant settings (Oliver & Towers, 2000), together with the need to know how to use ICTs for present and future learning and problem solving (Krause, Bochner, Duchesne & McMaugh, 2010). Information literacy within the IS subject is defined as the ability to locate, evaluate, manipulate, manage and communicate information to become an independent lifelong learner (Meredyth, Russell, Blackwood, Thomas, & Wise, 1999) – and also to develop values and attitudes about knowledge and how it is used and shared (Langford, 2000). This literacy is acquired and assessed over the following set of four principal IS topic headings: (1) Business Process Modelling, (2) Database Theory and Application, (3) Information Security, and (4) Business IS Architecture, Networking and Function. The subject is mandatory for all business students regardless of speciality major (e.g. accounting, marketing, management, information systems). The subject is offered in both semesters of a two semester academic year. Typical enrolment numbers are approximately 550 per semester. The majority of this enrolment comes from business school students for whom the subject is core within the business school degree program. However significant enrolment numbers also derive from a broad mix of students within other disciplines. These students complete the subject as an elective and their student feedback consistently pinpoints the pervasiveness and importance of business computing as the major motivation for the enrolment. The male/female enrolment demographic is evenly split within the subject, and approximately 40% of enrolled students do not have English as a first language. The subject's class contact and student consolidation study timetables, together with the assessment protocol, are described in Figure 1.

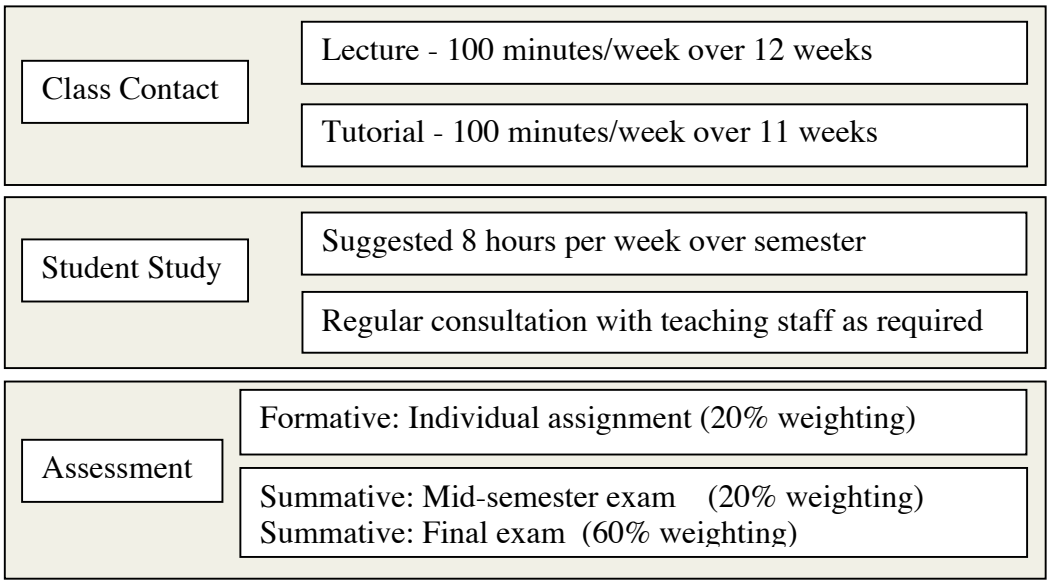

Figure 1: Class contact, study timetables, assessment protocol

The motivation for trialling a scaffolding strategy based on the Four Resources Model within this IS subject was to pedagogically manage both the broad distributions in IS prior knowledge levels and enthusiasm for technology studies that students brought into the subject. The possible existence of these broad distributions had been indicated via informal discussions between teaching staff and students during the semesters prior to 2010. It appeared that many non-business students entered the subject with considerable IS literacy, whilst many business students entered the subject with little technology literacy and a significant wariness of any technology subject. Predictably these greatly varying initial prior knowledge levels created difficulties for teaching staff and students in many areas of teaching and learning – and these difficulties required mitigation and management.

This paper will unfold with the following structure. Section 2 will describe the overall research context relating to the pedagogical trial. Section 2 will also include a description of the Four Resources Model and why it was selected to theoretically underpin the pedagogical trial. Section 2 will also outline how the Four Resources Model was mapped to the production of a specific IS the scaffolding strategy. Section 3 will present the findings obtained in all stages of the research (i.e. preliminary data collection, trial implementation, and finally trial evaluation. Section 3 will also briefly describe the future focus for this research – that is, how the trial has since been scaled up to accommodate all interested new students enrolling within the IS subject from 2011. Section 4 will conclude the paper.

2. Research Context

In overview, this research was conducted as an exploratory, interpretive study using qualitative and quantitative data collection and analysis. This research is defined by the bounded system (Merriam, 1998) of student participants' involvement over two consecutive semesters (during the calendar year 2010) of the IS subject. In general form, the interpretive methodology aims to provide insights as to how a particular phenomenon has been rationalized by a person or group of persons. In general form, the interpretive methodology requires initial data collection followed by the construction of insights via the researcher's analysis of the collected data. Travers (2001) states that interpretive research is considered most appropriate when it is necessary to consider the "*often complicated relationship between people, ideas and institutions*". Marshall & Rossman (1989) suggest the interpretative approach is appropriate where the research has a descriptive, exploratory focus. It is

acknowledged that the exploratory nature of this interpretive case study restricts the broad applicability of the research results obtained to date. Whilst this suggests a lack of external validity within this research, it is stressed that the exploratory findings have since been used to generate a suitably scaled pedagogical strategy for the total enrolled student cohort – this strategy will be operationally delivered and quantitatively assessed during 2011. The time-line and research process milestones of this case study are described in Figure 2.

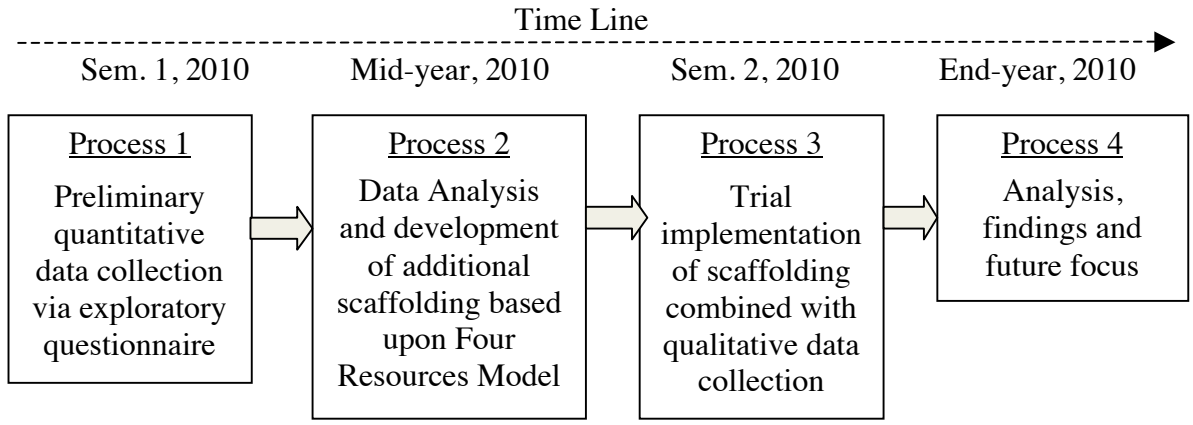

Figure 2 Case study timeline and research process milestones

This section will now describe the research methodologies and overall design of research processes 1, 2, 3 and 4.

Process 1 – preliminary quantitative data collection commenced in semester 1, 2010 with an exploratory questionnaire (appendix A) that was completed by enrolled students. The questionnaire's aim was to explore possible correlations between student gender, student enrolled degree program, student existing technology knowledge levels (aligned to the IS subject topics) and student enthusiasm for a technology subject. The students' existing technology knowledge levels were assessed by four groupings of questions – with each question aligned to one of the four main four principal IS topic headings: (1) Business Process Modelling, (2) Database Theory and Application, (3) Information Security, and (4) Business IS Architecture, Networking and Function. Each of the four question groupings posed two sub-questions: the first asking the student to self-rate existing knowledge in the relevant area, and the second asking an open ended question about the relevant area. This second question was designed as a control moderator to the student's self-rating.

Process 2 – quantitative data analysis and the subsequent development of additional scaffolding was completed in the four week mid-year break (July 2010). The data analysis strongly indicated a broad distribution in IS prior knowledge levels and enthusiasm for technology studies that students brought into the subject. The teaching staff within the subject unanimously agreed that this indicated two generalized proximal development zones (Vygotsky, 1981) as conceptually represented within Figure 3 (full data analysis results will be presented in Section 3).

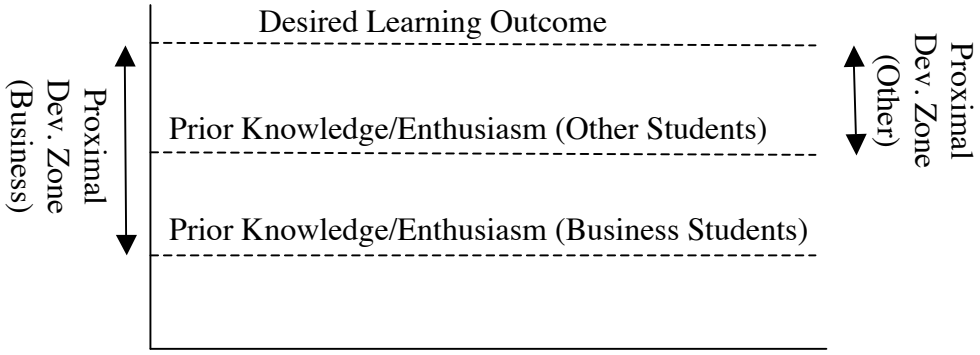

Figure 3 Generalized proximal development zones

Students within the first zone were clearly well placed to attain the theory and practice competence (i.e. the learning outcomes) of the IS subject – whilst students within the second zone were poorly placed. This conclusion in turn suggested the addition of a scaffolding strategy – that is, additional teaching support for students (Wood, Bruner, and Ross, 1976). Existing teaching practices or curriculum were not altered in any way. The teaching staff reflected upon the subject's major learning outcome – the goal was to produce computer literacy – not computer scientists. Literacy definitions were then considered. The literacy description in (Winch et al. 2004, p. xxxi): '*we can think of literacy not merely as a single set of skills, but as a way of operating with a variety of texts within particular sets of social situations…Literacy practices are embedded in the practices of our every day lives*'. The literacy description in (Santoro, 2004, pp. 51-52): '*There are school Literacies, computer Literacies, out-of-school Literacies, social Literacies and so on that are characterised by a wide range of written, spoken, aural, visual, digital, and multimodal texts*.' Many innovative literacy pedagogical models to underpin our desired scaffolding strategy were then considered - the final choice was the Four Resources Model (Freebody & Luke, 1990; Luke, 1995).

Process 3 – the final output from research process 3 were weekly scaffolding sessions designed via the Four Resources Model (a generic framework is contained at Appendix B). Each session was approximately 20 minutes in duration and was designed to prepare a student for richer comprehension of the formal teaching for that particular week of the course (i.e. to reduce the distance between the student's current level of topic knowledge and the level he/she can achieve via the established lecture/tutorial instruction and consolidation sessions). Consequently it was important for a student to complete each scaffolding session *before* attending the lecture and tutorial for that week of the course. Each session would be completed by the subject lecturer within his office. Some sessions involved single interaction between student and lecturer, whilst other sessions involved group interaction (limited to 3 students per group). This characteristic was totally dictated by student and lecturer timetables. Each session would be based upon a concise (1 to 3 pages) printed handout (as per Appendix B) designed to utilise each characteristic of the Four Resources Model. This handout would be made available to each student at the beginning of the session. Each session would unfold as per the framework of the handout with appropriate hand-drawn visualisations by the lecturer on a white board. Each student was encouraged to make appropriate notes or voice recordings. Each attending student must have attempted to read the week's readings (e.g. a set text chapter) before the session. All discussion must be conducted in courteous and simple business language (complicated technical terminology must be translated into '*plain English*').

The implementation of the scaffolding strategy was coupled with qualitative data collection. Student feedback was requested via the single research question:

Describe how the session has helped you and how the session could be improved?

Student feedback was generously and enthusiastically provided – the details and analysis findings will be discussed in the Section 3. Lecturer reflections were also recorded immediately at the conclusion of each scaffolding session.

Process 4 –all qualitative feedback and reflections of process 3 were coded and analysed using the Glaser-Strauss' *constant comparison* method (Glaser & Strauss, 1967) to allow interpretive themes to emerge. In this coding and analysis process conceptual categories are initially generated by a comparison between/across data observations. The formulation of a category is an attempt to find a concept of a slightly higher level of abstraction than the data itself. The category labels a set of observations that describe the same phenomenon – the category is a separate element of a theory, that is, a concept (Glaser & Strauss, 1967, p. 36). Categories must be meaningful, that is, they should generate interest in, and assist understanding of what issue is being studied (Glaser & Strauss, 1967, p. 36). Whether or not a category is appropriate cannot be judged solely from the correctness of the underlying data – the usefulness of a category must be decided from its ability to contribute to the emerging theory. New data are constantly compared with evolving categories – with the ongoing generation of new categories. Comparisons between categories generate hypotheses, which are defined as categories related to one another (Glaser & Strauss, 1967, pp. 39-40). The collection of data will continue until no further properties can be found or added to categories – a stage called theoretical saturation (Glaser & Strauss, 1967, p. 61). It is stressed that the Glaser-Strauss' *constant comparison* method has only been used in Process 3 of the overall research methodology – consequently it is not appropriate to categorize this overall research as grounded theory. The findings of this analysis will be presented in Section 3.

3. Findings and Future Focus

Quantitative data analysis was completed within process 2 of this study, followed by qualitative data analysis at process 4. This section will now discuss the findings of these analyses, together with a concise description of the future focus of this research.

Process 2 Findings – quantitative data analysis was performed upon the initial data collected within this research via the questionnaire of Appendix A. This questionnaire was designed to research the possibility that business students (upon entering the IS subject) possessed lower levels of IS existing knowledge and technology subject enthusiasm than enrolled students from other degree programs. A total of 61 questionnaires were collected from a student enrolment of 568. The questionnaire structure facilitated analysis of the collected data along three major dimensions: (*male business – female business*), (*male other – female other*), and (*business – other*). The complete data analysis along all three dimensions in relation to each of the five questions of the questionnaire is presented at Appendix C. The data analysis of process 2 centred upon testing with a Welch correction to the two-sample, two-sided *t-test*. The Welch correction handles the situation of possibly unequal variances by adjusting the degrees of freedom. In the case of equal variance, the usual formula for the degrees of freedom is regained. Appendix C shows there is no statistical difference (at 95% confidence) between the male-female groups for all questions. Therefore the question became: is there any difference between the *business* and *other* group (ignoring gender)? Appendix C shows the statistically significant difference (at 95% confidence) between these groups for all five questions. This result confirmed the broad distribution in IS prior knowledge levels and

enthusiasm for technology studies that students brought into the subject, and consequently the two generalized proximal development zones as conceptually represented within Figure 3.

Process 4 Findings – qualitative data was obtained from all scaffolding sessions conducted. A total of 45 students attended 14 sessions across the semester (i.e. 13 weeks). Most of these sessions were conducted by the lecturer with either 2 or 3 students in attendance – some sessions were conducted between the lecturer and a single student. A total of 17 students attended more than one scaffolding session and this serves to introduce a longitudinal dimension to the study.

The analysis initially identified 25 categories across the collected data set. Further analysis to reduce overlap and redundancy amongst these categories reduced the identified set to 10. Final analysis to derive the most important categories reduced this to a set of 4. This final set of categories is shown in Table 1 (with categories listed in alphabetical order).

Research Question	Categories Identified
Describe how the session has helped you and how the session could be improved?	Motivation and Engagement
	Multiple Learning Levels
	New Literacies
	Personalized Learning Environment

Table 1 Final set of categories from qualitative analysis

Each of the identified categories was supported by responses from multiple student participants. Elaboration of each category – together with meaningful participant quotes – is described as follows.

Category 1: Motivation and Engagement

All student participants presented to the early scaffolding sessions with expressed feelings of anxiety and a low sense of self-efficacy in relation to the IS subject. Many students expressed concerns about their perceived inability to pass the IS subject assessment tasks (especially the final Summative examination). This fits within the view of (Bandura, 1986, 1997) which asserts that an individual's motivation and engagement reduces when anxiety is experienced via a perceived lack of control over a potentially aversive outcome. Examples of student comments within the early scaffolding sessions are as follows:

> *I am really worried about failing this subject….Computers scare me and I do not understand much about them….this subject scares me……I cannot ask questions because I don't know where to start…I still have to do the subject….I just can't get started…*

By mid-semester, it appeared participant motivation and engagement with the IS subject were improving. Student feedback was consistently more positive as per the following examples:

> *I am more confident about technology…no need to worry as much…Starting to feel better about passing the subject…I started to feel good about the problem solving exercises in the book…I can get into the tutorial exercises and not just switch-off…feel like I can join in lectures and tutorials a bit more…*

Category 2: Multiple Learning Levels

Information literacy (a major learning goal of the subject) extends beyond skills and knowledge to include values and attitudes about knowledge and the use of computers (Langford, 2000). To be information literate, an individual needs to apply higher-order cognitive skills of discrimination, interpretation and critical analysis (Krause et al., 2010).

The students' incremental development of these multiple learning levels was reflected in many feedback comments – examples of which included:

> *I started just trying to remember as many points as I could…now I see how the concepts work together…We are always told to construct knowledge but I never really got it…this helps me actually do this…Helps me build together the skills basics with how the concepts all fit together and deliver business value…The purpose of the teaching in the specific week becomes more clear…I don't have to learn the book so much, I can work out the answers…gives me a practical slant on how computers are so valuable in business.*

Category 3: New Literacies

Many of the concepts of information literacy are also contained in definitions of new literacies which are described in (Leu, Leu, & Coiro, 2004) as the essential skills, strategies and dispositions necessary for using and adapting to rapidly changing technology. This concept suggests that broad notions of literacy are being challenged and changed by new technologies which require multiple forms of literacy to exploit their full potential (Leu, Kinzer, Coiro & Cammack, 2004). This category emerged from the student feedback more clearly as the scaffolding sessions unfolded. Student comments were as follows:

> *…I used to get lost in following web links now I better get it…understanding the web uses the Internet makes better sense of all the new applications…Hypertext and hypermedia seem a lot more obvious to me now…looking for information is better by following the best URLs…the Internet setup makes for better reading…*

Category 4: Personalised Learning Environment

This category consistently emerged within every feedback session and was delivered as a criticism of the scaffolding exercise – and indeed all formalised teaching within the IS subject. Many students strongly favoured a learning environment that improved student time management, favoured student multi-tasking, and created a persistent/enduring content format which was readily accessible during the semester. Students did not want '*distant education*' – they wanted opportunities for personal contact with teaching staff combined with opportunities for a personalised learning environment. Comments included:

> *I find time-management a real challenge…not helped by teaching timetables…I like to multi-task and I can't during formal teaching sessions…Hard to concentrate for all the teaching session…It would be good to go over the session at my own pace…make it my experience…I could be a lot more productive with more control over how I access the teaching content*.

Future Focus – at the conclusion of 2010, the teaching staff of the IS subject had derived the four categories of Table 1. The next task was if – and how – these categories could be evolved into an improved teaching framework for the IS subject delivery in 2011. Categories, 1, 2, and 3 represented endorsement that the scaffolding strategy was clearly assisting a significant number of students to achieve a richer learning outcome in the IS subject. However category 4 encapsulated clear criticisms which centred upon more flexible delivery options of the scaffolding content (at least). Additionally, teaching staff were concerned that the scaffolding trial may not have been accessed by all students who potentially stood to benefit.

Consequently the decision was taken to retain the overall scaffolding framework (i.e. design shaped by the Four Resources Model) – whilst scaling up its availability to all students within the IS subject. The 2011 scaffolding strategy would comprise the audio/video recording of

each scaffolding session (reflecting the Four Resources Model) – with the resulting MP4 file available to all enrolled students as a Web download across the full 2011/semester one. It is planned to evaluate the effectiveness of this pedagogical content – and its flexible delivery - at the conclusion of the new semester.

4. Conclusion

This paper has described why and how the Four Resources Model (Freebody & Luke, 1990; Luke, 1995) has been trialed as an additional scaffolding strategy within a core first year introductory Information Systems (IS) subject of a university business school. The motivation for this scaffolding trial was to investigate a pedagogical strategy by which broad distributions in students' IS prior knowledge levels and enthusiasm for technology studies may be managed.

The researched has been progressed via both quantitative and qualitative data collection and analysis. The findings have indicated the success of the scaffolding strategy at a pedagogical level, whilst also pointing to the need to incorporate more flexible delivery options. This overall direction will be pursued and reported during 2011.

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Appendix A: Exploratory Questionnaire – Semester 1, 2010

Gender: Male / Female

Degree: Business/Other (please specify)

1(a) Rate your knowledge of business process modeling: Good Little

1(b) What is the purpose of business process modeling? (1 sentence):

……..

2(a) Rate your existing knowledge of database theory: Good Little Nil

2(b) Describe the relational database model? (1 sentence):

…….....

3(a) Rate your existing knowledge of IS security: Good Little Nil

3(b) What is IS authentication? (1 sentence):

…….....

4(a) Rate your existing knowledge of IS networking: Good Little Nil

4(b) How is the WWW related to the Internet? (1 sentence):

…….....

5(a) Rate your enthusiasm to technology-based subjects: High Medium Low

Appendix B: Scaffolding Session Design – Process 3

This appendix describes the generic template design (as per the Four Resources Model) for each scaffolding session.

Section 1: Student understanding of language/terminology within the text chapter (i.e. student's capacity to '*code break*' the text chapter). This session would focus upon:

- the discipline-specific nature of the language in the text chapter (i.e. terminology meanings)
- the spelling/pronunciation of terminology
- the use of symbolism/graphic representations within the chapter
- the expansion of abbreviations

Section 2: The semantic competence of the student in relation to the text chapter (i.e. the student's capacity to be a '*text participant*'). This session would focus upon:

- what are the student's previous experiences with the topic (i.e. the technology topic of the text chapter) – how do these experiences link with the text chapter?
- what are the major concepts of the text chapter – what are the relationships amongst these concepts (i.e. a concept map)?

Section 3: The pragmatic competence of the student in relation to the text chapter (i.e. the student's capacity to be a 'text user'). This session would focus upon:

- what is the targeted audience (professional practitioners, general users, others)?
- does the text chapter deliver adequate answers to student questions?
- does the text chapter suggest a biased/limited coverage – are there parameters/issues not covered?

Section 4: The critical competence of the student in relation to the text chapter (i.e. the student's capacity to be a 'text analyst'). This section would focus upon:

- whose interests, politics, culture, and overall system are served by the text chapter?
- is the discussion solely technical or are other groups included – e.g. ethical viewpoint, legal viewpoint, commercial viewpoint, environmental viewpoint. Does this matter – does this create a risk about the text?

Appendix C: Quantitative Analysis – Process 2

Question 1	**Male Business Female Business**	**Male Other Female Other**	**Business Other**
t value	-0.04283529	-0.407	-7.86716
p value	0.96611	0.6878	2.41E-09
Degrees Freedom	30.73499	21.916	36.14169
Hypothesis: *means* are equal @95%	Accept hypothesis	Accept hypothesis	Reject hypothesis
Question 2	**Male Business Female Business**	**Male Other Female Other**	**Business Other**
t value	-0.06263881	0.1164	-11.5305
p value	0.950459	0.9092	3.99E-15
Degrees Freedom	30.74741	12.616	45.70564
Hypothesis: *means* are equal @95%	Accept hypothesis	Accept hypothesis	Reject hypothesis
Question 3	**Male Business Female Business**	**Male Other Female Other**	**Business Other**
t value	-0.0795166	0.3554	-13.2675
p value	0.9371368	0.7285	2.21E-18
Degrees Freedom	30.76132	11.906	52.38054
Hypothesis: *means* are equal @95%	Accept hypothesis	Accept hypothesis	Reject hypothesis
Question 4	**Male Business Female Business**	**Male Other Female Other**	**Business Other**
t value	0.3266992	0.1173	-12.212
p value	0.7460918	0.9085	4.43E-17
Degrees Freedom	30.98922	12.321	53.36573
Hypothesis: *means* are equal @95%	Accept hypothesis	Accept hypothesis	Reject hypothesis
Question 5	**Male Business Female Business**	**Male Other Female Other**	**Business Other**
t value	0.2818505	0.3554	-11.8965
p value	0.7800587	0.7285	3.64E-17
Degrees Freedom	29.01618	11.906	57.72589
Hypothesis: *means* are equal @95%	Accept hypothesis	Accept hypothesis	Reject hypothesis