Chapter 6: Practice Interpreted

6.1 Introduction

This chapter is an account of the analysis, interpretations and assertions emerging as a consequence of retrospective analysis of both qualitative and quantitative forms of data obtained during the design and enactment phases of the second cycle of this study. As suggested in design based research literature, one of the primary aims of conducting retrospective analysis is to locate the design experiment in a “broader theoretical context” and create situated accounts of learning that relates learning to the means by which it can be supported and organised (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). In providing the analysis and interpretations an attempt is made to connect findings with conjectures made earlier in design and enactment stages while responding to research questions set forth at the commencement of this study. Sections of this chapter follow a similar pattern in which the relevant research question is restated followed by a list of conjectures drawn in relation to the issues being investigated and presentation of findings and discussions.

In section 6.2 issues related to student participation in blended online learning are presented and discussed. Factors affecting student participation are discussed in the context of personal, online design and course design issues. Section 6.3 covers the topic of access and use of online environment by students and attempts to highlight findings related to Internet access, online communication and the role of computer skills in learning mathematics in an online environment. Section 6.4 focuses on the role of teacher in blended online learning. The teacher’s role is discussed in terms of pedagogical, social, managerial and technical dimensions and how they were affected in a blended learning environment. Sections 6.5 and 6.6 present findings related to students’ attitude and achievement from pre-test and post-test measurements and Section 6.7 discusses assessment issues in blended online learning of mathematics.
6.2 Student Participation

One of the research questions in the second cycle of this study aimed at exploring issues related to student participation in online learning within a blended learning format. Student participation was considered as their attendance in face-to-face sessions, access count on the WebCT home page for the course, engagement with online activities, completion of assessment task requirements and postings on the discussion board.

The conjectures drawn regarding student participation in the second cycle of this study proposed that:

- Blended learning would lead to improved learning and retention of students because those students who are unable to attend particular face-to-face sessions would be able to continue with the module and participate in learning activities.
- Use of authentic data from the Internet would affect student attitude towards mathematics positively and their engagement with class activities and mathematics would be enhanced.
- Navigational scaffolding in the online design will keep a student focused on a particular learning path and avoid distractions resulting from browsing external websites.

In terms of class attendance student participation followed a similar pattern in both treatment and control groups as described in Chapter 5.3.2.1. Student numbers dropped during the first six weeks of the course from both the treatment and control groups and it appears that there may have been a range of factors at play that affect attrition rate at TAFE level courses generally. A literature search conducted by Gabb, Milne and Cao (2006) shows that likely factors that influence attrition at TAFE and higher education courses include prior academic achievement, course preferences, course fit, quality of
teaching, language background, parental education and blending work and study. However, in this study our goal was more specific and our analysis focused on identifying those factors that influenced students’ participation in blended online learning activities. Studies in online learning in the higher education sector have shown that learner readiness and course design factors directly affect learner participation in online learning (Gunawardena & Duphorne, 2001; Harasim, Hiltz, Teles, & Turoff, 1995; Swan, Shea, Fredericksen, Pickett, & Pelz, 2003). Similarly, effective presentation and organization of content in the online learning environment is also known to be an important factor in encouraging student participation in online learning. It includes interface design factors such as screen design, navigation, interactivity and feedback (Mihalca, 2005). During the second cycle of this study factors affecting student participation in blended online learning of mathematics in a vocational education context were investigated from the perspective of learner readiness factors, interface design factors and course design factors.

6.2.1 Learner Readiness Factors

Learner readiness factors have been identified as personal factors such as students’ learning preference, prior learning experience, computer skills, interest in the course content, learner attitude and motivation (Gunawardena & Duphorne, 2001). A number of these factors affecting students’ participation in blended online learning came to our attention during class observation. One of the most important factors was student’s computer skills and prior experience of the Internet. Warschauer (2003) notes that learners display varying abilities to make maximum use of online technologies. He points out that students’ ability to make effective use of online technologies is not necessarily an issue of access to technology and hardware and asserts that students’ computer literacy and familiarity with the online medium is more important for their effective participation.

In the second cycle of this study we noted that students’ previous knowledge of the Internet, browsers, online navigation and experience of discussion forums and online chat were important factors in their online participation. But, for many students it was their first experience of engaging with computers to do mathematics and those who had low
competence levels in working with computers had to find help and spend relatively more time attempting online activities. These students with low confidence level with computers needed a lot of encouragement and support from teachers and their peers to participate in online activities. On the other hand students with prior experience and skills in using computers appeared to demonstrate greater readiness to participate in online activities. In some cases, however, students’ attitude and motivation played a greater role in their participation in online activities and despite their readiness and computer skills they remained less active participants online. As an example one student in an interview session reported that:

You can’t always use the Internet for maths because you need a person up there explaining on the board, putting in the quotations and everything, it’s better. The internet hasn’t just got much things, it’s just got information that’s it, you need some examples, you need a person. ...I’ve been longer, I’ve been using the computer, internet for longer but I’ve been using chat. I do a lot of infoteching around, it’s easier for us. [Interview transcript: student - Zoe]

This comment highlights the issue of preconceived notions about learning mathematics and confirms that the use of computers in a mathematics class is not always seen as a positive thing by participating students although most students, both active and inactive in terms of online use, agreed that online activities in the business mathematics module was a positive change.

Another personal factor playing an important role in students’ participation in the blended online learning was students’ attitude towards mathematics. Many students started with a very negative attitude towards mathematics as shown by measurements collected using Aiken’s Mathematics Attitude Scale. A detailed comparative analysis of the affect of blended online learning on students’ attitude towards mathematics is presented in Section 6.5 however this section focuses on the affect of students’ attitude towards their participation in blended online learning.
Nearly half the class who took the attitude pre-test obtained a negative score on a scale of –20 to +20 showing that many students in the treatment group did not have a liking for mathematics as a subject. One mature age student showed clear signs of “mathematics anxiety” and reported in interview that:

*I go weak at knees at the thought of having to do that (maths). I never thought I’m that bad as I’m going in the subject, like I never needed to have to do that, I can’t remember ever doing this what I’m doing in this maths subject so it’s a new world for me.* [Interview transcript: student.- Peter]

This student had a score of –20 on the mathematics attitude scale but despite this apparently negative feeling about mathematics his participation in online activities as measured by access to WebCT count was quite high at 115. He struggled to do class work throughout the semester but stayed on to achieve a minimum pass (See Table 6.2). Similarly, another female student from this group who was active in online participation with the highest WebCT access count of 144 visits also scored low on her mathematics attitude. In her interview she also reported that she “gets really scared” with mathematics. These students show that despite their poor attitude towards mathematics in actual practice they were quite keen to take part in online learning activities.

*Figure 6.1. Scatter graph and trendline of WebCT access count of students compared with their pre-test attitude scores on Mathematics Attitude Scale.*
Correlation between students’ pre-test attitude scores with their online participation in terms of WebCT access count produces a relatively weak (Pearson’s $r = -0.26$) association between these two variables showing that online activities were not affected either positively or negatively by students’ attitude towards mathematics. As shown in the scatter graph (Figure 6.1), students with relatively high attitude scores were not the only ones active with online learning. In fact, some students who had shown negative attitudes towards mathematics appeared to show greater participation in accessing and using online activities. This correlation between pre-test attitude score and WebCT access count was calculated using scores of all students who were present at the start of the course and had taken the pre-test attitude test.

Table 6.1

<table>
<thead>
<tr>
<th></th>
<th>WebCT Access Count</th>
<th>Pre-test Attitude</th>
<th>Post-test Attitude</th>
<th>Attendance</th>
<th>Final Achievement Test Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>More Active</td>
<td>103</td>
<td>-1.6</td>
<td>1.2</td>
<td>87</td>
<td>70.8</td>
</tr>
<tr>
<td>Less Active</td>
<td>55</td>
<td>-3.2</td>
<td>7</td>
<td>90</td>
<td>53.4</td>
</tr>
</tbody>
</table>

Based on their WebCT access count students were grouped into more active and less active online students. Students who reached a WebCT access count of greater than the median score of 57 were listed as more active online students and those who scored 57 or less were listed as less active online students (See Table 6.2 and 6.3). A comparison of mean scores reveals that more active students achieved better results in the final achievement test compared to less active students. However, in terms of attitude there was a greater improvement in attitude of less active students as shown by their mean score improvement from –3.2 to 7, even though the mean achievement score was a mere pass (Table 6.1).
When seen in the context of overall participation and final achievement scores, students with a positive attitude score seem to have accessed and participated in online activities and achieved better than average results in their final test whereas some more active online students with a negative attitude score towards mathematics despite their greater participation in online activities barely passed the module as shown in the Table of Performance for More Active Online Students (Table 6.2).

Table 6.2
*Individual Performance of More Active Online Students*

<table>
<thead>
<tr>
<th>Attendance %</th>
<th>Online Participation</th>
<th>Attitude</th>
<th>Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WebCT access count</td>
<td>Articles read</td>
<td>Total posts</td>
</tr>
<tr>
<td>Donna</td>
<td>100</td>
<td>144</td>
<td>66</td>
</tr>
<tr>
<td>Peter</td>
<td>83</td>
<td>115</td>
<td>46</td>
</tr>
<tr>
<td>Ngyen</td>
<td>100</td>
<td>98</td>
<td>59</td>
</tr>
<tr>
<td>Jacob</td>
<td>83</td>
<td>95</td>
<td>26</td>
</tr>
<tr>
<td>Tina</td>
<td>58</td>
<td>91</td>
<td>56</td>
</tr>
</tbody>
</table>

In comparison, most of the less active online students had obtained a negative score on the attitude towards mathematics scale. As shown in Table 6.3 there was very little variation in their WebCT access counts suggesting that they had accessed the course website only from the class as part of online activities during class sessions.

Table 6.3
*Individual Performance of Less Active Online Students*

<table>
<thead>
<tr>
<th>Attendance %</th>
<th>Online Participation</th>
<th>Attitude</th>
<th>Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WebCT access count</td>
<td>Articles read</td>
<td>Total posts</td>
</tr>
<tr>
<td>Abdul</td>
<td>75</td>
<td>57</td>
<td>32</td>
</tr>
<tr>
<td>Zoe</td>
<td>75</td>
<td>57</td>
<td>28</td>
</tr>
<tr>
<td>Sagar</td>
<td>100</td>
<td>57</td>
<td>29</td>
</tr>
<tr>
<td>Jim</td>
<td>100</td>
<td>54</td>
<td>29</td>
</tr>
</tbody>
</table>
However, one less active online student (Juang) with a positive score on attitude scale was able to gain 75% marks in the final test and though his access count to WebCT was lowest his participation rate in other aspects of online participation such as articles read, original posts and follow up posts was similar to one of the more active online students (Jacob) who also scored the best result in the final test. I think that student attitude towards mathematics played a less significant role in their participation in online activities but students with a positive attitude towards mathematics seem to have used the online access more selectively. However, it is clearly seen that negative attitude towards mathematics did not pose as a barrier to participation in online activities.

Table 6.4
*Correlation Coefficient values for students participating in blended online learning (paired sample only)*

<table>
<thead>
<tr>
<th></th>
<th>Attendance</th>
<th>Pre-test attitude</th>
<th>Post-test attitude</th>
<th>WebCT access count</th>
<th>Final test score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td></td>
<td>0.237</td>
<td>0.196</td>
<td>0.210*</td>
<td>0.179</td>
</tr>
<tr>
<td>Pre-test attitude</td>
<td>0.237</td>
<td></td>
<td>0.788</td>
<td>-0.100</td>
<td>0.775</td>
</tr>
<tr>
<td>Post-test attitude</td>
<td>0.196</td>
<td>0.788</td>
<td></td>
<td>-0.159</td>
<td>0.329</td>
</tr>
<tr>
<td>WebCT access count</td>
<td>0.210*</td>
<td>-0.100</td>
<td>-0.159</td>
<td></td>
<td>0.076</td>
</tr>
<tr>
<td>Final test score</td>
<td>0.179</td>
<td>0.775</td>
<td>0.329</td>
<td>0.076</td>
<td></td>
</tr>
</tbody>
</table>

*Correlation Coefficient was 0.783 when comparison between WebCT access count and attendance scores of all 24 students in the treatment group were used.

It appears that there was no association between students’ attitude towards mathematics and their participation in online activities as evidenced by their WebCT access count. A correlation analysis of between WebCT access count and pre and post test attitude scores showed weak correlation values of −0.10 and −0.159 respectively (Table 6.4). It seems that not all students in the blended learning environment participated with the same enthusiasm and some students despite showing a 100% class attendance registered less than 50% WebCT access count compared with the more active online students (Table 6.2 and 6.3) resulting in a reading of weak association between WebCT access count and class attendance when comparison used paired sample scores only (Table 6.4). However, when all students were considered for a correlation between WebCT access count and
attendance (Figure 6.2) it was found that the association between their attendance and WebCT count was fairly strong ($r = 0.783$). It suggests that, generally, most students participated in the online learning environment fairly consistently but the rate of participation was not uniform and among regular students the distribution between active and less active online users was nearly equal (Tables 6.2 and 6.3). It also indicates that the blended learning environment in the class encouraged students’ ongoing and consistent participation in online and WebCT activities.

![WebCT access vs attendance Trendline](image)

*Figure 6.2. Access to WebCT home page compared with attendance in face-to-face class.*

Findings related to learner readiness factors point to the fact that although students’ readiness to participate in online learning activities in mathematics requires them to have pre-requisite skills and confidence in computer use, these factors are not sufficient motivators for students’ actual use of the technology in a learning environment. Students appear to choose to use the online learning resources selectively. From this analysis it also appears that students’ attitude towards mathematics plays a more significant role in their performance in achievement tests than on their participation in online learning.
environment. For many students, their active involvement in online learning did not produce improved results either in their attitude towards mathematics or in their final achievement scores suggesting that either we were unable to harness their skills and interest in computers towards enhancing their mathematics or our testing methods did not lend well towards learning happening via computers.

### 6.2.2 Interface Design Factors

This study involved the design and development of an online learning environment for mathematics and its use for supporting classroom teaching in the vocational sector. In this context the design experiment process allowed us to continuously tweak with the design of our online learning environment. Research literature on interface design (Mihalca, 2005) and our observations and analysis led us to identify a number of design factors linked to participation of students with the online learning environment. These factors included navigational scaffolding, interactivity, authentic learning experiences and the blended learning model. During the design and enactment stages of this study a number of these design issues prompted us to draw tentative conjectures about how modifications in design might lead to improvement in practise and outcome. In the following section some of these conjectures will be contested and refined with support from evidence collected during the study.

Our design of MCA online website and WebCT module home page drew on principles of anchored instruction where learning resources required for solving a problem are embedded in the learning environment and students have to explore and use these resources to solve given problems (Cognition and Technology Group at Vanderbilt, 1992). In this context navigational scaffolding refers to elements within the design of a learning environment which help learners find and access information and tools without being sidetracked or adding to their cognitive load (refer to section 4.2.2.). Through this approach of navigational scaffolding we hoped to keep students focused on a particular learning path and avoid distractions resulting from browsing external websites. Students’ frustrations with unstructured use of the Internet as a resource is clearly indicated by the
following extract from a student interview:

We use internet all the time in other classes but they’re more like ‘do research, go and find this information’ and you’ve got to go and use search engines…I find that pretty boring and number one cos it takes a long time. But I think they’d be limited as to what they really is online stuff. You need some kind of structure. If they’d planned it and set it up as a weekly thing and followed the course outline and said ‘this week we’re doing this topic, look on the homepage and there’s a few site to click on and read this article’ and then ‘put in a report on it’ or something, or ‘email me and tell me what you thought about it’ that would stimulate me to go out and do the research. But I find a lot of lecturers ‘just go and do a search’ and you think ‘I hate searching’ because you go through so much information and you’re unmotivated whereas I know if I go to the site here there’s online tasks, the resources are on the page, everything I need is there usually or I’m shown how to do it even if I don’t know, a little bit more motivation there I think. [Interview transcript: student - Jacob]

Since we also relied on external Internet websites for our dynamic mathematics content it was prudent for us to plan our design in a way so that students could get direct access to these dynamic content. Usually, the actual dynamic mathematics content on a website is buried in deeper layers of the website and users have to navigate their way to the desired content by first making selections from the opening screen of a website. Observation of students working independently on websites had shown to us that finding relevant parts of a website that give you the necessary resource or tool was quite confusing and time consuming for students and many were distracted and lost on these external websites. Both MCA online and WebCT module design incorporated direct access to tools and resources from external websites and this navigational scaffolding proved very helpful for students. While doing trials for MCA Online enactment (refer to Section 4.3) and also while doing online activities with the treatment group (refer to Section 5.3) classroom observations of students’ engagement on computers revealed that they were able to locate and use relevant tools and resources without being lost or distracted. In many cases the
transition from their local website to a resource on an external website was so seamless that they were unable to differentiate if they had moved to another website on the Internet. The usefulness of navigational scaffolding provided by our module website was summed up by the same student as:

It's handy because realistically you get so much work and so many assignments that to get another piece of paper that we've got to take home and do in our books is a little bit lethargic and boring. But...jump on the net for few minutes, read through a couple of questions, utilise the resource page and stuff, it's a good change. And it's quite simple too to follow through...I think later rather than earlier I have understood how much it is able to help. Initially there wasn't enough emphasis on it, we knew it was there and we had a bit of a review through it but it wasn't until after we around I got in there and started playing around a little bit and looking at this stuff I thought 'all these resources, if only I knew they were here earlier it would've made my life a little bit easier'. [Interview transcript: student - Jacob]

While students were able to access many dynamic websites and interactive content from external websites through a tightly controlled navigation and design, it demanded continuous monitoring of these links by Cathy and me and as designers for the course website we had to keep a constant track of changes in external websites and update required links. My experience and expertise of managing website content proved to be a crucial factor in keeping these links working for students.

Interactivity afforded by online activities ranks as another important factor affecting students’ participation in blended online learning. Our conjecture regarding interactivity was that the interactive activities on our website will help in building students understanding and use of mathematical concepts. Research findings indicate that interactivity is one of the key aspects of electronic technologies that enable a deep change in the experience of doing and learning mathematics (Kaput & Thompson, 1994, p. 678). Similarly, studies have also shown that interactive tasks with immediate feedback enabled the medium to engage students’ attention for longer than usual (Laurillard, 1997;
Mavrikis & Macciocia, 2005). Our online environment included interactivity in two forms. In one form students engaged with software generated simulations and problems where they were able to input data themselves and in the other form they engaged in online communication involving discussion board postings and email. In our design of the online environment we ensured that we had included both interactive skills practice exercises as well exploratory problem solving exercises (refer to Section 4.2.4 and Section 5.3 for detail of these exercises).

Observations from classroom practice indicate that the interactive tasks where the software provided them immediate feedback had a positive effect on students’ participation and their motivation to take part in online activities increased. It appears that immediate feedback from the software allowed students to take more risks in attempting the questions and using the guess and check method. Their increased motivation was evident from their active participation, increased social interaction with peers (sometimes to show them that they had done better or discovered something new). As an example during the first online activity on algebra transposition, once students had become familiar with the screen layout and navigation, they seemed to enjoy the practice where feedback was instant and they could monitor their progress. Delors, In'am, & Roberto (1998) point out that using the new technologies is also a way of combating under achievement because people who experience difficulties under the traditional system are sometimes better motivated when they come to use them and are thus better able to show where their talents lie. I noticed that students’ motivation increased during the interactive online activity; perhaps it was because many students were able to experience success in solving equations using the technology. An entry from my class observation of this session reads:

*This task proved a success in online learning as most students seemed to enjoy their participation and success in learning the task. Many students used pen and paper to help them solve the questions and self-scoring as a positive experience for most. A female student later reported that she liked this site and task very much and at home she helped her sister to practice algebra equations using this*
It appears that self-assessment part of online maths learning is welcomed by most students. [Observation notes: Thursday 16 August 01]

The affect of interactive activities on students’ participation was generally positive and most students appeared excited to interact with computers where they could see the consequences of their action in the form of some feedback.

The availability and access to web resources enabled our design to include authentic learning activities using live and real data. We were able to design tasks that required students to seek information from real life sources and use them in solving problems. Use of banking websites (refer to section 5.3.3), use of live currency exchange rates during online activities on the topic of interest rates (refer to section 6.3.4) and use of depreciation calculators to work out salvage value and depreciation calculations (refer to section 5.3.5) provide examples of learning activities where face-to-face classroom work was extended with the help of online access to authentic data and information from real life resources. Although students in the class were working with problems presented to them in the traditional form of worded questions, the context within which these problems were located was real. In this way when students accessed and utilised online tools and resources to solve these problems, they were able to see the direct relevance of the mathematics learned to real life problem solving.

For most students in the treatment group it was their first experience of doing mathematics activities in an online environment and they expressed mixed feelings about the usefulness of this approach. On the one hand we had students who were excited about using computers and the Internet to do mathematics activities and on the other hand some students showed reservations about using computers. I think that some students had a preconceived notion of learning mathematics and for them formal mathematics is doing serious work with pen and paper and solving questions using different techniques and algorithms. However, after a number of weeks of online activities these students also appeared to show an acceptance of the relevance of the computers in learning mathematics but only after they had participated in online activities which provided dynamic content and interactivity (refer to section 5.3.5).
In terms of interface design factors it appears from this study that the navigational scaffolding and interactive activities that provide immediate feedback to learners play an important role in students’ successful experience in blended online learning. It confirms the view expressed in earlier research of using the web in classrooms that students gloss over information as they explore a website and are likely to miss important information (Clark, Hosticka, Kent, & Browne, 1998) and that students require scaffolding to focus their surfing tendencies (Gerber & Shuell, 1998). The success of navigational scaffolding provided in the design of MCA Online website also supports the view that information on the website should be chunked to prevent overload during processing in working memory (Ally, 2004) and that students are more focussed in using the web in mathematics learning when the teacher is able to do the initial screening for relevant content (Gueudet, 2006). Our study shows that careful planning and navigational scaffolding can make the use of the web free from distractions and more focussed on learning mathematics.

6.2.3 Course Design Factors

Students’ participation in online learning was also affected by how the course was designed and delivered. During phase one of the study I had noticed that students’ participation with the online environment remained marginal when online components were not directly linked to classroom learning and assessment. As a conjecture we anticipated that if we presented discipline specific content in an online design that was closely linked to their classroom work, students enrolled in a mathematics module would be able to use it more effectively and benefit from it. However during the enactment stage of phase one of the study it became clear that students use the online activities only when they are an integral part of their learning program. We found that students were too occupied with their regular course work and had very little time left for self-directed learning using the online environment.

Recent research from the Australian vocational education sector points to the success of online learning when it is blended with face to face classroom learning (Brennan, 2003; R. Brown, 2003; Fisher, 2003). From a survey of more that 400 vocational education
students Cashion and Palmieri (2002) note that hybrid or blended delivery was seen very positively by both teachers and students because it offered “flexibility together with the benefits of both face-to-face teacher supported instruction and online learning” (p.9). In the second cycle of this research when we used a blended learning environment it appears that students participation in online activities was positively affected as discussed earlier in Section 6.2.1.

But, the nature and volume of course content to be covered during this 30-hour module appears to have had some bearing on participation in online blended learning. The range and scope of learning outcomes prescribed for this module (refer to section 5.1.1) demanded a pace of teaching to which most students seem to have had difficulty adjusting. Although students valued what was covered and agreed that it was relevant for their field of work, in terms of fostering conceptual understanding they thought that the whole module was quite fast paced. Students who were returning to study after a gap of few years complained that they needed more time to cover each topic. One student commented that:

*I don’t probably need more support, I need more time. With me, it’s just an individual thing. I need more time than others that went through the VCE which isn’t there. Like this course had brought in mature age but with this maths class they don’t supply what we need for it like the time factor….For me that’s not there, maybe for other mature age…they could get it if they’re mathematically minded, but I’m not, so just probably for me it’s not good, not right for me the way it was, like every module gives us only two weeks and it’s not enough time for me….It is very much. Look I want to try, that’s why I’m attending every class but it’s just...* [Interview transcript: student - Peter]

When asked about the content of the course and what they felt about its relevance to their future goals students were mostly positive. While some could give specific examples of how topics covered in this course were relevant for their work others were vague in their
response but generally felt that things learned would be needed in future. For example one student recalled the topic of interest calculations and said that:

"Yeah it’s good, it’s relevant and I find it useful b/c we’re doing some work about interest and about, I think it was, putting money in the bank and then working out the interest and in a couple of years and so on how much money you will earn, or how much interest you earn. And I was really interested in that, and I wouldn’t mind doing that myself, and the procedures in which we went about doing that was helpful." [Interview transcript: student – Paul]

Another student responding to the same question noted that:

"We talk about is amongst ourselves, we don’t see right now what the role of some of them are but maybe when we’re in the job we’ll realise why we done it at the time. Like some subjects, within the modules, you know ‘why are we doing this’ maybe we don’t realize it now but maybe later in the future it is going to be helpful to us to know...Yes it’s structured really good, there is a lot of hard work when you put it in you’ll see the results, but if you don’t you’ll get snowballed but if you put it in it’s really well-structured the course and you’re given enough time to do it all." [Interview transcript: student- Peter]

A mature age student who had experience of working in the field noted that:

"Oh definitely the maths. I was a bit surprised, for a couple of reasons, how much I’d forgotten since high school, I remembered the words but all the little (inaud) and formulas I’d forgotten, but it makes a lot more sense. I remember in the workplace trying to figure out (inaud) and you can see how simple it is and the utilisation of formulas I thought ‘this is really applicable to any kind of business’. And I’m still a bit surprised that’s it’s at such a basic level, it’s still a little bit difficult and challenging for me but I figure if you’re going to go into business you’ve got to understand...[comparing it with high school] Definitely. It was a bit more you have to do it and you didn’t enjoy it but now, being in the workforce"
before...it makes a lot more sense. Very relevant. [Interview transcript: student-Jacob]

In terms of relevance it seems that students were able to make a connection between topics covered in the module and their relevance for workplace and industry. It is possible that Cathy’s selection of authentic and industry relevant worded problems for practise exercise sheets helped students make this connection between mathematics processes and workplace relevance. The selection of online activities made this link stronger because students could draw information and use tools available directly from industry sources. In this way presentation of authentic and industry relevant mathematics content seems to have assisted student participation in blended online learning. One student commenting on the relevance of content and the use of computers and the Internet noted that:

Most of the stuff I’ve learnt in this course helps me, in my workplace, I’m learning like computers and Internet... you learn more and when you go outside you pay more attention to them. [Interview transcript: student – Tina]

Conversely, the pace of teaching and lack of time for consolidation of learning seems to have put students under pressure and left them with little time to engage with exploratory activities available from online environment. For a full time student, the overall load of coursework during a semester seems to be such that it left little time for additional learning activities or participation in discussion board exchanges. During mid semester many students appeared to be stressed with the pressure of tests and assignments from their course. One student responding to a question on factors affecting their study noted that the load of class work and tests was affecting her. She said:

Yes, other classwork. Too much. This day I have three tests already...crazy, explode. Too much. Tests is just like you may remember but you don’t learn nothing, you forget, assignment then you study, you know. [Interview transcript: student - Kate]
In addition, Cathy reported in week eight that two teachers from her department had been given teaching assignments in China and because they will leave in two weeks time they had given students assessment tasks early to finalise results before leaving for China. This extra load on students seems to have had a flow on effect and their participation in mathematics module in terms of attendance and participation in learning activities. The pace of teaching and load of subjects being studies during a semester seems to have negatively impacted on participation of students in blended online learning as they could not afford additional time required for engagement with online activities beyond classroom contact hours.

Our observations regarding the course design factors confirm previous research that in the vocational education field conventional courses and delivery strategies limit their suitability for online learning environments and an improvement in learning materials and assessment strategies is needed to see better use of online technologies in developing more effective learning environments (Oliver, 2004). The nature and volume of content load on students seemed to affect their ability to participate in flexible learning opportunities offered by an online learning environment. However, blending face-to-face learning with online activities in the classroom affected students’ participation positively although some students used the online environment to a limited extent only.

### 6.3 Access and Use of Online Environment

In this section of the chapter analysis and interpretation of qualitative and quantitative data related to how students access and use the online environment for their learning needs is presented. This part of research aimed to identify patterns of access and use in relation to home and school access to Internet, preferred online activities, access and use of online communication tools in learning mathematics and the role of computer and mathematical skills in the use of mathematics related online content.
Two design conjectures were linked to the research question on how students’ access and use the blended online environment for learning mathematics: one related to the flexibility provided by online environment and noted that blended learning would lead to improved retention of students in the course because those students who are unable to attend particular face-to-face sessions would be able to continue with the module and participate in learning activities by accessing the course website from home. The second conjecture related to enhanced communication opportunities provided by the online medium and noted that continual and extended use of discussion board communication would lead to the development of a community of practice that is able to solve problems using this new medium of communication to share knowledge and information. In the following section I will draw on classroom observations, WebCT data, student journals and interview transcripts to identify and report patterns of students access and use of online learning environment.

6.3.1 Access to Internet

Because mathematics lessons during the second cycle of this study were conducted in a multipurpose classroom where computer access was readily available, access to the online environment from classroom was not a problem. Students were also able to access the Internet from networked computers in the library and open access computer labs and in this way access to the Internet from campus was freely available.

In a survey questionnaire administered to the treatment group students (Appendix 6.2) only four out of 24 students reported that they did not access the Internet from home. Journal entries by students during three sessions indicated that most students accessed the Internet from both home and school. Popular locations for accessing the Internet as calculated by counting the number of occurrences for words (home, school, work and library) in students’ journal entries reveals that school and home account for more than 90% of access locations for the Internet, and home rates more often (48%) than school (43%) for accessing the Internet by students (Figure 6.3). However, it appears that home and school are equally preferred locations for accessing the Internet but as indicated by access to mathematics online learning environment and postings of the WebCT
discussion board where 77% postings were made during school hours (Figure 6.8), the classroom appears to account for most of the access to online learning in the mathematics module.

Figure 6.3. Distribution of locations for accessing the Internet as indicated by students’ journal entries.

Figure 6.4. Weekly count of access to Internet as reported by students.
It became clear from the data obtained from student survey questionnaire and three weekly journals completed by students that access to Internet was readily available to most of them and school and home were the main locations from where they accessed the Internet. However, as WebCT data and access to the course home page suggests, this ready accessibility of Internet did not lead students to access and use the online environment from outside the campus locations as expected in our conjecture at the start of this phase of study.

![Time spent on Internet](image)

*Figure 6.5. Number of hours spent on Internet as reported by students.*

In response to the question in the journal template about how many times a student went on the Internet during last seven days only five students completed the journal entry for all three weeks and two amongst them (Juang and Jacob) reported accessing the Internet between 4 and 12 times in a week. Other students reported accessing the Internet between one and eight times per week (See Figure 6.4). Juang and Jacob also appear to have been more confident users of the Internet and in response to the question that how much time they spent on the Internet during the week these two students and another student, Peter,
reported using the Internet in the range of five to 30 hours during the week (Figure 6.5). Another five students filling in journal entries reported using the Internet between less than an hour to five hours per week. Some entries in the journal listed Internet use only for a few minutes and it appears that some students misread the question and reported only daily use rather than hours used for the week. At least one student confirmed this in a follow up session and her record was corrected. It is also worth noting that because of irregular attendance pattern many students missed the opportunity to complete weekly journals.

![Main activities on Internet](image)

*Figure 6.6. Students’ main activities on the Internet*

In journal entries students reported that the main activities on the Internet were mostly related to the course including research for assignments. For an open-ended question asking students to list and describe their main activities on the Internet a wide range of responses were received. These responses were grouped into five main categories: *school work; games; chat; email* and *personal research*. The *school work* category included
terms like assignments, exams, school subjects, homework and research. The category listed as *personal research* included activities such as banking, exchange rate, news, weather, music and job search. Figure 6.6 shows the frequency of responses under each category where activities described as email, chat, games and personal research are ranked closely in terms of their use by students. Schoolwork is reported as the most frequent reason for students’ access to Internet.

![Pie chart showing the distribution of WebCT postings according to time they were posted.](image)

*Figure 6.7. Distribution of WebCT postings according to time they were posted.*

The journal entries helped in identifying students who were more active online users and it was expected that these students would have no difficulty in accessing and using the mathematics online learning environment designed for this module. When WebCT logs were analysed for students’ access and postings it was found that the majority of postings and follow up comments on the discussion board were posted during school hours with more than 75% of postings occurring between 11 am and 5 pm. In fact 71% postings happened between the hours of 11 am and 2 pm showing that classroom contact hours
(11am to 1pm) were responsible for most of the activity in the online environment. There were a very small number of active online students who posted messages and accessed the WebCT home page after school hours. As shown by the distribution of postings on WebCT in Figure 6.7, nineteen per cent postings were recorded during evening and late night hours.

The blended learning format allowed students time to use the online environment during class hours and it is not surprising that most of the access occurred during school hours. Research has consistently shown that blended learning is preferred by VET trainers, teachers and learners, and most persistent and successful use of new technologies takes place in blended learning where face-to-face teaching is mixed with online learning (Brennan, 2003; Cashion & Palmieri, 2002; Misko, Choi, Hong, & Lee, 2004; Stehlik, Simons, Kerkham, Pearce, & Gronold, 2003). The findings from this study is thus consistent with previous research.

6.3.2 Use of Online Communication

After limited success of online chat facility from MCA online website during phase one, the design for the WebCT module included only email and discussion board communication facilities. Smith and Ferguson (2005) note particular difficulties of communicating mathematics in an online chat and discussion forum but the potential of student – student and student – teacher interaction in an online discussion format led Cathy and I to design learning activities where students were expected to take part in the online discussion board by posting messages and responding to other messages. Bransford, Brown, & Cocking (1999) point out the communication afforded by new technologies can assist in mathematics learning by making it easier for teachers to give students feedback and connect classroom to community at both local and global levels (p.195). This view is also supported by Kaput & Thompson (1994) who predicted that the “connectivity” aspect of new technologies which allows it to link teachers to teachers, students to students and student to teacher are a source of power to change the “experience of doing, learning and even teaching mathematics” (p. 679). The message
board and email facilities built into WebCT home page and links to Ask Dr. Math archive (Drexel University, 2000) from the resource page were aiming to introduce students to this new experience of doing and learning mathematics.

In terms of students using WebCT discussion board to post messages and exchange ideas in an asynchronous mode, analysis of WebCT logs shows limited use made by students. WebCT logs show that the access and use of the discussion board by students varied on an individual level with an average of 2.3 for original postings and an average of 1.7 for follow up postings. Students who had reported access and regular use of Internet in weekly journal entries showed above average use of discussion board but there was no clear pattern as many students who dropped out of the course after a few weeks also registered above average discussion board usage.

\[\text{\textbf{Figure 6.9.} Frequency of postings by students on the WebCT discussion board.}\]
It appears that most students used the discussion board only when it was part of an online activity where the teacher had provided clear instructions for posting students responses on the discussion board (for example the algebra online activity for posting worded problems based on linear equations, refer to Chapter 5, Section 5.4.2). There was little evidence of postings where students had initiated a posting to seek assistance from other students or the teacher.

![Figure 6.8](image)

**Figure 6.8.** Messages posted on the discussion board during different topics.

Figure 6.8 clearly illustrates that students’ postings were significantly higher for the topics where online activity required students to post responses to discussion board. Both Algebra and Depreciation topics required students to post messages on the WebCT discussion board and Table 6.5 shows that these two topics had the highest numbers of postings recorded. The depreciation online activity included an online assessment task where students were asked to submit their work via online posting but the algebra online activity was a genuine collaborative activity where students had to create a word problem and post it on the discussion board for other students to solve. Although it was a non-
assessment task students took a keen interest in it and a flurry of postings appeared during the session. However, when other topics such as Percentages, Interest and Linear Equations left the posting of responses on the discussion board as an optional activity WebCT logs showed significantly less activity.

Although data from students’ weekly journals and WebCT logs show that students reported frequent use of the Internet in their journal entries and taking part in WebCT postings regularly, there is little evidence to suggest that students used the discussion board to generate social communication. The only messages appearing to show some informal social interaction were the messages posted during introductions in the first session. It appears that the tone of mathematics lessons set in class created an expectation of problem solving and calculations based nature of mathematics and, use of discussion board for generating social contact was not necessary when the class was able to interact in a face-to-face classroom.

<table>
<thead>
<tr>
<th>Posting Type</th>
<th>Number of Students who posted messages</th>
<th>Number of Messages Posted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction message</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Algebra online activity</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>Reply to student posts</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Interest online activity</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Depreciation online activity</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>Depreciation assessment task</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Posting Type</th>
<th>Number of Postings</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Tasks</td>
<td>6</td>
<td>Group</td>
</tr>
<tr>
<td>Prompts for response</td>
<td>2</td>
<td>Group</td>
</tr>
<tr>
<td>Reminders</td>
<td>4</td>
<td>Group</td>
</tr>
<tr>
<td>Posting Results</td>
<td>3</td>
<td>Individual</td>
</tr>
</tbody>
</table>
The teacher’s contribution in promoting and encouraging the use of the discussion board by students also appears to be very limited and it is clear from Table 6.6 that most of the teacher’s postings were related to posting online tasks and there were only two prompts for responses. It appears that the nature of online activities and topics being covered did not create a need for students to engage in collaborative online communication via discussion board except for the topic of algebra online activity. This analysis shows that the online medium requires teachers to be more creative in their design of activities and teaching of conventional mathematics with the help of online collaborative communication is a challenging task.

6.3.3 Computer Skills and Use of Online environment for Mathematics

Observations of the treatment group class revealed that although confident users of computers were able to access and navigate the online learning environment with relative ease, their confidence in using computers did not necessarily turn them into effective and productive users of mathematics in the online environment. The ASCII symbols used in mathematical online tools and content knowledge assumptions implicit in external mathematics and financial websites posed problems for students and they had to learn and work out how to use the tools and resources from these sites. Direct links to relevant tools and resources saved students from being distracted or lost in navigation but Cathy and I had to provide direct assistance in explaining symbols and jargon commonly used on external websites.

Some students were more active users of the online medium and used to log onto computers and access their email and chat programs while the class was doing face-to-face teaching. They appeared to be quite at ease with skills required in accessing email, chatting and browsing popular media websites and when it came to using WebCT, online tools for mathematical tasks and navigating a website like Ask Dr Math, they quickly became familiar with the new learning medium. Although working with mathematics in
an online medium required new learning such as understanding ASCII symbols for mathematical operations they needed less assistance and once they had learned these new skills they were willing to help other students in class who were slow to pick up new skills and had less confidence in working with computers.

It appears that the students’ meta-cognition skills played an important role in determining the extent and quality of their use of the online learning environment. These meta-cognition skills involved their ability to plan and decide their goals and what strategies are best to get there, their ability to monitor and evaluate their progress and their ability to decide when to terminate a particular course of activity (Biggs & Moore, 1993). In order to illustrate students’ selective use of the online learning environment I have presented a brief account of two cases where students approached the online activities differently based on their computer and meta-cognition skills.

6.3.3.1 Case 1: Juang

Juang was a 19-year-old male student whose parents came from Philippines. He had completed his year 12 the previous year and had studied mathematics methods and further mathematics as part of his VCE subjects. Juang was a cheerful young person who enjoyed being at school. He attended all sessions for the mathematics module and liked participating in class activities. He appeared confident in mathematics and showed a positive attitude towards it with a pre-test score of +6 on the attitude scale. He was doing this course because he liked to work in the import-export industry and liked to travel overseas. He saw mathematics as an area of study with close relevance to life. In the interview session he remarked that, “from my view maths in needed everywhere… (I) got no problem with maths at all”. Juang worked well in this module and participated in both print based and online activities. His attitude towards mathematics improved considerably during this course and his post-test attitude score increased to +18.

Juang appeared to be a confident user of computer and had a computer at home. He also had access to the Internet from home and used it for research, chatting, email, news and
other interests. In his three weekly journal entries he reported using the Internet on an
average of two to three hours per day from home. In comparison to other members of his
class Juang reported the most prolific use of Internet from home but this familiarity, ease
of access and competence in working on Internet did not result into greater access and
use of online learning environment in mathematics. Juang’s access count on WebCT
showed a modest access count of 51 and articles read count of 26. However, it appears
that Juang made good use of his chatting and online communication skills by posting 5
original and 3 follow-up messages. Class observation and WebCT logs of Juang’s
participation in online activities shows that although he did not access the online learning
environment as frequently as some other members of his class, his use was highly
selective and aimed at meeting the requirements set by the teacher.

During online activities on the topic of algebra when students were asked to write a
worded problem that can be solved by using a simple algebra equation he posted the
following problem:

Tony worked at Malvern Post office. He works 25 hours on weekdays on a normal
average rate of $14.57 per hour and works 5 hours on Saturdays which is a rate
of one and a half of normal rate. Tony also took some stamps home valued at $9
which will be deducted from his pay.

How much wages in Tony going to get this week?

All the best of luck to everyone solving the problem.

Another Juang production!

The difficulties in communicating mathematics in the online discussion were clearly
visible from students’ attempts at writing mathematical expressions in their postings. The
following example of Juang’s attempt at posting a solution of an equation on discussion
board is a clear example:

\[ x(x+1) = 8556; x^{Squared} + x = 8556; x^{Squared} + 1x - 8556 = 0 \]
\[ (x + 93)(x - 92) = 0 \]
His confidence with computer use and access to the Internet from home appears to have made a meaningful contribution towards his learning as he acknowledged that:

...I live far away from here, it’s good when you come home and you don’t know what’s happening, you can have a look you open it up, see what homework you have, you do it on the web, it’s as easy as that. Seeing all the handouts, it’s all too, it’s difficult, you’ve got a lot of work to see which one’s this, but I think through the Internet’s much better. Good anytime.

Juang attended all sessions for the module and successfully passed five out of six weekly tests. His final test score was 75% showing that Juang was able to perform well in this module. The case of Juang shows that he was a confident student with good computer and meta-cognition skills. He had learned mathematics at school and this preparation seems to have helped him to cope with the demands of this module well. He liked the Internet based learning and used it selectively to suit his learning goals.

6.3.3.2 Case 2: Peter

Peter was a 33-year-old mature age student from a Yugoslavian background who joined this course after working for 15 years in a national freight company. He wanted to broaden his skills and knowledge to be able to work in an international trade context. After finishing year 10 he had left school and joined the workforce. He appeared sincere and motivated in his learning but there were clear signs of mathematics anxiety. His attendance during the semester was 83% and he completed all assessment tasks and took part in the final test for the module. He had another mature age friend doing this course with him and both worked well together.

Peter showed a pronounced negative attitude towards mathematics with a pre-test score of \(-20\) on mathematics attitude scale. In his interview he expressed his fear of mathematics in very clear terms. He pointed out that he could not remember that he had
done these things in maths ever before and he was shocked to see that he was so poor in his mathematics skills. A reason for his mathematics anxiety seemed to emerge from his understanding that he had very little mathematics background. He pointed out that:

*I only completed year 10 when I left school 15 years ago, cos I’m a mature age now, I’m 33, I’ve been working the last ten years in trades. I’ve never needed mathematics in my old job where I was before, mathematics wasn’t something I needed to do in the last 10 years so it doesn’t come easy for me to do.*

Peter had experience of using computers and had his own computer at home. He also had a connection to the Internet from home. As indicated by entries in his weekly journals Peter was a frequent user of the Internet from home with 10 to 20 hours of Internet use in a week. He used to go on the Internet for entertainment but since joining this course had started spending most of his time on course related research and assignments. It appears that he liked the online learning environment for mathematics as he had the second highest access count for WebCT home page and had fourth highest count for articles read. He posted six messages on the discussion board with five messages related directly to work requirements for online tasks and one was posted as a response to another student’s answer to a mathematics problem.

Peter’s main issue with the course was the fast pace at which it moved and did not give him opportunities to learn at his own pace. For him the requirements of the course were too full and too rushed. When asked about what were the bad points about this course from his point of view he pointed out:

*I don’t probably need more support, I need more time. With me, it’s just an individual thing, I need more time than others that went through the VCE which isn’t there (which I don’t have). Like this course had brought in (taken in) mature age but with this maths class they don’t supply what we need for it like the time factor... For me that’s not there, maybe for other mature age... they could get it if they’re mathematically minded, but I’m not, so just probably for me it’s not good,*
not right for me the way it was, like every module (topic) gives us only two weeks and it’s not enough time for me... It is very much. Look I want to try, that’s why I’m attending every class but it’s just...

But he liked the idea of assignments and assessment being accessible in an online environment that included flexibility so he could do things at his pace and beyond the time frame of the classroom. When asked about whether he thought computers and the online environment made learning easier, he gave an example of how it helped his learning. He remarked:

Definitely...When we done that assignment at home, depreciation or something, that gave me a lot of time to at first understand it, I went on my own pace, I wasn’t limited in two hours class to do it, and if I was stuck on something I would go away from it and come back and solve the problem that way, but if I was stuck in class...yeah I’m under time pressure, so it was good to do that assignment at home and I was confident that I would complete it. Whereas here if I was in class for two hours can I complete this, if not...

Peter failed his three weekly assessment tasks on the topics of algebra, interest and linear graphing but passed his final test with a 50% score. His performance in class activities was poor during first half of the course and his mathematics anxiety remained till the end. His post-test attitude score on mathematics attitude remained –20.

This case shows the difficulties Peter faced in learning and meeting the requirements of the mathematics module as a mature age students who enrolled in this diploma course after a gap of 15 years from school. It also shows that the online learning environment offered help and assistance to support his learning but the nature of assessment tasks and pace of teaching were too much of a burden for his learning needs. It appears that being a confident user of the Internet helped him participate in the online environment with confidence but due to poor time management skills and a lack of confidence in
mathematics he was unable to be selective in his use of the online learning environment. He managed to successfully complete his diploma course in the following year.

6.3.3.3 Using Meta-cognition

The two cases presented above point to the important role of students’ confidence and meta-cognition skills in their ability to make effective use of the online learning environment. While Juang appeared to be well prepared for the course and used his meta-cognition skills and confidence to selectively use learning resources from the face-to-face and online environments to meet the requirements of learning activities and assessment tasks, Peter came to this course after a gap of many years and did not seem to be prepared to cope with the pace of learning expected in this course. Peter appeared to use the online learning environment more but lacked the meta-cognition skills of a confident student to apply it to course demands.

In addition, the difference in prior knowledge of mathematics students brought to this course also seems to have affected their confidence and use of the online learning environment. While Juang having done mathematics subjects in his VCE studies was more confident and used the online environment to his advantage, Peter, on the other hand, came with limited prior knowledge of mathematics having completed only a year 10 mathematics course several years ago. He lacked confidence and it appears that his above average access and use of the online environment is an indication of his desire to overcome his anxiety in mathematics. Research with adult learners has shown that anxiety and low confidence affects learners’ performance in mathematics (Coben, 2003; FitzSimons, 2002) Although Peter appears to have made reasonable efforts both in the face-to-face sessions and in online activities, the pace of learning in the course did not allow him to catch up on mathematical concepts he needed to learn and master.

In relation to students’ computer skills and their use of the online learning environment to learn mathematics this study supports previous research by Cretchley and Galbraith (2003) that students’ computer confidence and motivation levels do not show a strong association with their mathematics confidence and motivation. This study confirms that
in a vocational education mathematics course also students who show high confidence and motivation with computers do not necessarily show a similar attitude in their mathematics learning. In this study it also appears that students with a positive attitude and motivation towards mathematics were able to use the online learning environment more effectively using their meta-cognitive skills of planning, monitoring and evaluating their progress, and using strategies that were best suited to achieving their goal of passing the assessment tasks. For example, they posted messages on the discussion board only when it was required and did not spend their time on online activities when they were not an essential part of assessment tasks. These findings have implications for teachers and course designers in vocational education where many students may come to a mathematics course with good computer skills but a negative attitude and low confidence in mathematics. In order to harness students’ interest and skills in computers towards mathematics learning we may need to modify our thinking about course design factors such as the nature and amount of content expected to be covered in a module, pace of teaching and explicit attention to teaching meta-cognitive skills for learning with computers.

6.4 Teacher’s Role in Blended Learning

This section of the chapter on analysis and interpretation of practice aims at responding to the research question: How does integrating an online environment in classroom-based learning of mathematics affect a teacher’s role?

The significant role played by the teacher in online learning has been documented by research in the vocational education and training sector (Brennan, 2003; Cashion & Palmieri, 2002; Stehlik, Simons, Kerkham, Pearce, & Gronold, 2003). Studies have also shown that an entirely online mode of learning is less common in this sector and most students and teachers prefer to learn in a blended online format where online learning is mixed with some form of face to face teaching (Cashion & Palmieri, 2003; Simons & Stehlik, 2004). Cashion & Palmieri (2002) in their research report titled, ‘The secret is the teacher’ note that, “Quality online learning relies on the work of good teachers.
Responsive, helpful, knowledgeable teachers facilitate an effective online learning experience” (p.9). In a mathematics classroom where a teacher is attempting to integrate online technologies with traditional face-to-face learning the issues of the teacher’s technical skills, access to resources, organizational and structural support and her own instructional beliefs play an important role in effective design and implementation of technology supported learning (Ertmer, Addison, Lane, Ross, & Woods, 1999; Forgasz, 2006; Handal, 2004). In order to analyze blended online learning from a classroom teachers’ perspective and how it affects the role of the teacher I will use the framework first proposed by Berge (1995) and applied by Bonk, Kirkley, Hara and Dennon (2001) in describing and analyzing the teacher’s role in post secondary online learning. This framework expresses the teacher’s role in terms of pedagogical, social, managerial and technological actions and identifies practices that are likely to assist in the success of online learning including blended online learning. In addition, while discussion teacher’s technical role in a technology rich learning environment I would draw on the framework adapted by Goos (2006) to analyze the interactions that occur between the teacher and the learning environment.

The pedagogical role of teacher covers everything concerned with teaching and facilitating education processes for students’ to develop understanding of key concepts, ideas, and skills. The managerial role involves dealing with organizational, administrative and procedural tasks and issues concerned with teaching in an online supported environment (Berge, 1995). The social role aims at promoting a friendly environment and a sense of community amongst learners. It includes actions like attending to learner’s individual concerns, providing feedback and reward and encouraging participation. The technical role involves dealing with technical issues related to course design and implementation, referring students to appropriate support resources, diagnosing and clarifying problems encountered by students and assisting students in learning new online tools and applications (Bonk, Kirkley, Hara, & Dennen, 2001; Teles, Ashton, Roberts, & Tzoneva, 2001). Although Berge’s framework categories teachers role in four distinct functions these roles need not be perceived as compartmentalized and in many instance the roles specified as technical can easily be perceived as pedagogical roles of the
Cathy played a lead role in the planning and teaching of this mathematics module in a blended learning format. Her interest and involvement in the current study has been documented in detail in chapter 5.1.3. As a teacher/researcher involved in this study, I worked closely with Cathy and in this section I will draw on the above framework to describe how she managed the pedagogical, managerial, social and technical roles in the context of a blended learning environment in teaching a mathematics module.

### 6.4.1 Pedagogical Role

A teachers’ own understandings about mathematical knowledge, mathematics teaching and mathematics directly influences their decisions about what to teach and how to teach it (Ball, 2000; Bransford, Brown, & Cocking, 1999). Cathy was an experienced teacher who had worked in secondary schools before moving to the vocational education sector. She also had extensive experience of teaching mathematics in the business and marketing area of the VET sector. She also had interest in online technologies and was a steering group member of the MCA online project during the first cycle of this study. Working within the constraints imposed by the modularised and competency based assessment (FitzSimons, 2002), Cathy had developed her own teaching materials (class notes and exercises) for students. She also knew from previous years’ experiences that most students would not buy the recommended mathematics textbook for the module and would rely predominantly on the teacher provided exercises and notes. Her teaching followed a teacher led instruction method that appeared to be closely aligned to the pedagogy of cognitive apprenticeship (J. S. Brown, Collins, & Duguid, 1989). She introduced, explained and modelled mathematical concepts and procedures with examples drawn from everyday applications of mathematical concepts in business and marketing. In the traditional teaching method applied with the control group class she would follow up her modelling and direct instruction session with problem exercise sheets where students would work individually and sometimes in pairs to practice the application of the concept and skills learned. She was well at ease with this method and
noted that, “… having been teaching maths for quite a number of years I can just walk into class and I can just put up, have a lot examples and all that in traditional mode.”

The use of online learning environment in a blended learning format affected Cathy’s pedagogical role and offered opportunities for additional authentic and interactive learning activities in the class. These interactive learning activities were web-based and offered instant feedback, multiple representations and networking opportunities (Goos, Stillman, & Vale, 2007). Her openness to try new ideas, her involvement in the research project and her willingness to integrate online technologies in the classroom practice suggested openness to new ideas in her teaching approach. Her remarks during an interview session that, “the curriculum is set and I have to follow it whether I agree or not”, hint towards her frustration of limitations imposed by the curriculum.

Although Cathy appeared to accept the prevailing VET model of teaching she appeared also keen to embark upon new approaches. The issue of teaching directed to learning outcomes and competency assessment continued to create a tension regarding choice of learning activities to be used in the class (Ainley, Pratt, & Hansen, 2006). She noted that:

...they [students] have got to be competent in every learning outcome and it doesn’t seem to be a holistic approach to things, and I hope that the training package that’s coming out will give us the opportunity to develop training packages [modules] without the limitations of the curriculum because that determines what I put and don’t put in the activities.

The design and teaching strategies used with the treatment group class show that Cathy’s instructional beliefs were more flexible than expected from a traditional positivist teacher following transmission mode teaching. The online learning medium offered opportunities for interactive, authentic and collaborative learning experiences that Cathy readily incorporated in her teaching sessions. The interactive learning experiences included web based activities that allowed learners to engage with web-based applications where they were able to input their own data and receive immediate feedback. The authentic learning
experiences involved using real data from commercial and public websites in solving problems. In this way the online activities allowed her to extend her traditional face-to-face teaching methods to include elements of constructivist learning (Jonassen, Peck, & Wilson, 1999). For example in a collaborative online activity on the topic of algebra she asked students to create and share a simple word problem from everyday experience (see Chapter 5, Section 5.4.2). In this example she was eliciting students’ responses to assess their current understanding of the algebraic concept of equation. Cathy encouraged students to take risks and suggested that they can work in small groups and teams to attempt this problem. In another interactive online activity she asked students to search and evaluate depreciation calculators (see Chapter 5, Section 5.4.5). In this activity she encouraged students to use both manual and calculator based methods to check and verify their own methods and calculator’s functionality. As an example of an authentic learning experience Cathy used an online home loan calculator from a Bank’s website in an activity where students were exploring the concept of compound interest and how different variable affect the period of loan and the amount of interest paid (see Chapter 5, Section 5.4.3). The approach adopted in these activities is an illustration of how Cathy was able to include elements of constructivist pedagogy in her predominantly teacher directed instruction.

Clarke (2005) asserts that a common interpretation of the constructivist manifesto has led to de-legitimising of the act of “telling” in a mathematics class (p. 12). He points out that “telling” often labelled as a transmissive teaching approach could play a valid role in teaching if the function played by telling is to introduce new ideas or allow the student to generate knowledge. One clear influence of online blended format on Cathy’s pedagogical role appears to be that her “telling” sessions on particular topics were extended to allow students to explore these concepts further and generate new understanding. For example Cathy used a “telling” approach to teach the transposition method for solving algebraic equations involving interest rate formula \( P = IRT \) as this teacher directed approach was considered necessary for teaching them the skill for solving algebraic equations and introducing the concept of simple and compound interest in subsequent lessons. In the following online session students were able to explore the
relationship between interest paid on a home loan, interest rate, period of loan and affect of extra repayments through an online calculator which provided simulation for various scenarios. In this way Cathy used the “telling” approach to teach the skills for algebraic transposition but followed it up with online activities that allowed further exploration of the idea to extend students’ understanding of the concept on interest amount calculations on a home loan.

Hagan (2005) in her autoethnography of teaching mathematics in Melbourne’s secondary schools notes that the school culture and expectations and the role of assessment plays a key role in dictating a certain style and approach to teaching. This idea is amply demonstrated in the vocational education sector where competency based training is believed to have led to a largely transmission model for teaching of mathematics (FitzSimons, 2002). However, it appears that access to online learning environment and Cathy’s pragmatic approach to teaching allowed her to extend a seemingly transmission model of teaching to include more interactive, authentic and collaborative problem solving learning activities in her mathematics teaching. At this point it is also important to recognise that Cathy was well supported in her attempt to integrate online learning with face-to-face teaching by the researcher who took part in the design of the online learning activities as a co-designer for the online learning environment.

### 6.4.2 Social Role

The social function played by the teacher in an online teaching and learning context relates to the aspects of learning that aims at making the learning environment friendly and supportive and leads to a sense of community among participating learners (Bonk, Kirkley, Hara, & Dennen, 2001). In the traditional classroom teaching of mathematics Cathy’s social role remained confined to classroom interactions with students, attending to their learning and assessment needs in a face-to-face situation. She had a pleasing personality and students were able to develop a good rapport with her during the course. She gave her email to all students from both control and treatment group students and offered them course related assistance. Cathy’s offer was taken up by students as one student from the control group class reported in interview:
...sometimes I do email the teacher and find out information from her. I ask the classmates if I miss out class. I emailed Cathy before cos I missed a class which I got a test that week, so I emailed her to make a time for me. She replied straight away.Yeah, cos that time I was in a computer class and she emailed me so fast, it’s easier. [Interview transcript: student- Kate]

Cathy was always willing to assist students and also helped them during outside class hours. But, as she reported in interview other factors such as timetabling and whether students have another class just after their mathematics class makes a big difference. She reported, “One of the groups that [was] not an online group actually approached me more but that’s possibly because of their time-table”. In fact this class had a free period after their mathematics class. Although Cathy had offered her email to all students doing mathematics, she reported that the treatment group class contacted her by email the most. In response to the question that whether she noticed any difference between control and treatment groups in terms of email contact, she reported:

"Yes, actually this particular group [treatment group] have thought of using email more than the others so it has made a difference even though it wasn’t of maths homepage [WebCT], they tried to communicate electronically anyway."

Cathy’s social role with the treatment group class included an additional dimension in the online environment. Apart from face-to-face interaction with students she also had to play a role in the online environment. Research has shown that the online social role requires instructors to develop nurturing skills because learners need to be encouraged to participate in online environments by means of ample feedback and reward (Laurillard, 1997; Manor, 2003). In this study the discussion board component of the online environment required the teacher to play a significant social role. It was this communication medium that allowed the teacher to post weekly online activities for students and encouraged their participation in postings. For both Cathy and the students of the treatment group class the use of online discussion board was a new experience.
Having a look at the number of messages posted by students on different topics and the number of messages posted by the teacher for various tasks as shown in Table 6.5 it appears that limited use was made of the discussion board. Cathy posted a total of 15 messages on the discussion board and six of these were online activity tasks for topics covered during the semester (Table 6.6).

Research has found that discussion board activities are less readily accepted in mathematics learning. Schuck (2003) in a study with first year teacher education students reported that almost 60% of students did not visit the online forum used as part of their mathematics education subject. Smith and Ferguson (2005) in their study of attrition rates in undergraduate mathematics courses offered in online distance education mode in the U.S. A. note that threaded discussions work well where students read and discuss papers but threaded discussions are not very useful for mathematics courses where problem solving is more important than discussion. In our module, Cathy used the discussion board largely as a communication medium to keep students informed about their class work. Out of the six online tasks posted by her only one was an open-ended task on the topic of algebra where students had an opportunity to use the discussion board in a creative way (see Chapter 5, Section 5.4.2). The remaining online tasks were mainly concerned with practice and application of concepts and elicited mainly a single posting response from students. The tasks did not appear to be conducive to generating online discussion. While the possibility of prompting by the teacher and ready access to tools of communication appeared likely to work in favour of increased interaction on the discussion board, in reality the problems of communicating mathematics in online forums and the nature of learning tasks being influenced by curriculum and assessment requirements limited the scope of interaction on the discussion board. Islam and Vale (2005) in a study of teacher’s role in promoting online peer group learning found that when discussion tasks are open ended and controversial and when their content is relevant for students, there is greater likelihood of evoking postings on the discussion board. In our case the discussion board use in the module did not involve open-ended discussion on controversial topics.
As a facilitator of online discussion board activities Cathy’s social role expanded to include increased email communication with students and discussion board postings. She appeared to play only a minor role in encouraging students’ participation in online postings. The nature of online tasks set by her were not expected to lead to threaded discussions but she played her role as a teacher in using the discussion board as a communication medium with students to provide them feedback and keep them informed about the progress of the course and assessment related issues. It could be argued that different tasks could have encouraged greater use of discussion board communication but course requirements limited our options for discussion board tasks. Other researchers have also found that in comparison to arts and humanities based subjects mathematics teachers find it particularly difficult to make effective use of online communication channels such as discussion boards and chats (Smith & Ferguson, 2005).

6.4.3 Managerial/ Administrative Role

The managerial role of teacher refers to activities that are designed to make the course run smoothly at an administrative level (Teles, Ashton, Roberts, & Tzoneva, 2001). In typical online courses this means managing course content on the online platform, dealing with enrolment issues, coordinating posting and marking of assignments and assessments and setting clear objectives and agendas for online discussion and conferences (Mason, 1998). In this study Cathy had to play a significant role at the administrative, organisational and course management levels.

With respect to the managerial role Cathy was playing a lead role in initiating this innovation in teaching within her department, she had to convince her head of department about potential benefits of teaching this mathematics module in a blended online format and obtain approval for trying this design experiment with her mathematics class. She was able to convince her program manager easily because this innovation was closely linked to the flexible learning policy advocated by funding bodies in the vocational education sector. She was offered encouragement by her department by being nominated for professional development training in online learning and received a laptop computer
to assist in her work. She was given material and moral encouragement but no time allowance was given for her efforts in planning and implementing an innovative delivery in a blended learning format. Cathy pointed out that, “I didn’t get any time off teaching to do it. It was on top of everything else that I do”. In her role as a teacher she took additional responsibilities for gaining management support and approval for necessary resources to teach mathematics in a blended learning format.

In her managerial role Cathy also had to make efforts to ensure timetabling arrangements and class allocations allowed for smooth functioning of her blended learning class. She needed to secure a computer laboratory allocation for her mathematics class. She reported that for her mathematics modules she insisted on having at least one part of weekly lessons in a computer lab but it was not always possible due to room allocation problems. For this blended module she had her manager’s support in obtaining a computer laboratory allocation. This situation shows that for mathematics teachers working in the VET sector, it is not always easy to get a computer laboratory for their mathematics classes.

Cathy also had to take responsibility for organising the course resources for blended online learning. She organised for the allocation of a WebCT space for her mathematics module and registered her treatment group students for online learning via WebCT. As a teacher Cathy’s managerial role also included monitoring and uploading of course related materials on WebCT on a weekly basis. On one occasion, she confided that she posted answers to problem exercises for students from a cyber café while on a weekend trip in the outback. She also had to monitor postings on the discussion board and reply to email queries. In this way, as a mathematics teacher her managerial role expanded to include many more responsibilities that were not part of her previous experience of classroom teaching.
6.4.4 Technical Role

The technical role of teacher is closely intertwined with pedagogical issues and involves choosing appropriate software for online learning, designing online content and supporting students in becoming competent in the use of selected technology (Teles, Ashton, Roberts, & Tzoneva, 2001). Research in online learning shows that when a teacher is able to facilitate a smooth use of online technologies students are able to concentrate on the academic task of learning (Bonk, Kirkley, Hara, & Dennen, 2001). However, the issue of how much technical skill a teacher needs to have to successfully deliver online learning is debatable. In many situations the teacher does not need to perform many technical roles in person because other support options are available in organizations. Research in the VET sector has shown that the successful integration of flexible and online technologies in learning requires more than technical skills; it requires careful consideration of instructional design in online learning environment and new pedagogical approaches based on teaching and learning theories that are in keeping with emerging understanding of online learning (Brennan, 2003; McKavanagh, Kanes, Beven, Cunningham, & Choy, 2002; Stehlik, Simons, Kerkham, Pearce, & Gronold, 2003). In both first and second cycles of this study the teachers’ technical role involved not only to deal with the access, hardware and software issues but also involved issues related to instructional design and selection of online tools and resources for classroom use in learning activities.

Although current mathematics education research literature from the school sector does not address the issue of online learning in mathematics in particular, teachers’ attitudes and instructional beliefs regarding pedagogy and the use of technology appear as important factors contributing to successful integration of technology in classroom learning (Handal, 2004; Norton, McRobbie, & Cooper, 2000). From a socio-cultural analysis of learning to teach mathematics with the help of technology Goos (2006) has applied Valsiner’s (1997) zone theory to develop an understanding of teachers’ work in using technology to teach mathematics in secondary schools. Relating this theory to the context of vocational education Vygotsky’s (1978) zone of proximal development (ZPD) can be thought of as the presumed space between teachers current knowledge and skills.
in making use of the technology to teach mathematics effectively and the potential knowledge and skills she can attain with assistance from professional development opportunities, mentoring support, training etc. Similarly, Valsiner’s zone of promoted action (ZPA) for a teacher of mathematics in vocational education may represent institutional policies such as promotion of flexible and online learning in the VET sector and the issues of students’ attitude to learning, motivation and assessment policies etc could be viewed elements relating to the zone of free movement (ZFM). Goos (2006) notes that for effective professional development a teacher’s ZPA needs to be located within her ZFM and be consistent with her ZPD.

In the context of this study the teaching of a mathematics module with a mix of face-to-face and online learning provided direct relevance for learning new technology skills. Cathy was an enthusiastic and keen participant in online flexible learning and followed professional development opportunities to improve her technical skills with computers and online learning. Cathy’s technical role in the teaching of this mathematics module involved design, integration and coordination of technology.

Firstly, at the technology design level Cathy had to take part in the design process for creating the WebCT home page for the mathematics module. She had become familiar with using WebCT during her profession development course in online learning. As an experienced user and designer of WebCT I played a mentoring role in helping Cathy learn and design the mathematics module website on WebCT. Cathy and I spent three sessions together during semester break and completed the first draft of the WebCT home page for our module. During these sessions Cathy gained designer level skills for WebCT and learned how to upload and format content pages, how to create discussion threads and manage discussion board postings. Although I assisted her in designing the WebCT home page for the module and provided professional development as a mentor in helping her become familiar with WebCT tools and resources, she took responsibility for content development and uploading. Resources and class exercises were uploaded on WebCT on a weekly basis and as the course progressed Cathy uploaded new learning resources. In this way, Cathy and I worked closely in ensuring that students were able to access course
related material in a timely fashion. Cathy was well aware of her ZPD in terms of WebCT skills and remarked that, “well I certainly need a lot more professional development for the WebCT”. She was aware of the implications of her own confidence with technology on students’ learning. She pointed out, “I certainly feel more confident to approach it myself and I think the more confident I am then I’ll be in a position to make a change to students I teach it to”. It seems that the designer level access and training to use WebCT as a designer led to the increase in Cathy’s confidence with online learning. As a mathematics teacher she had to invest considerable time in learning new technologies to be able to integrate online learning in her mathematics class. In this situation the ZPA factors appeared to be consistent with her ZPD in learning new technology skills to teach the module in a blended learning format.

Secondly, at the technology implementation level Cathy had to work with her curriculum content and find ways to complement print based learning with online learning. Working within the framework of organisational IT infrastructure Cathy had to use WebCT software platform for the online component of her module. WebCT offers a range of technological tools for content presentation, communication, testing and assessment but also imposes constraints in terms of layout and design for teachers (Oliver, 2004). Cathy’s technical role included learning about these tools and making decisions about their usability for her teaching approach and module content.

At another level, Cathy also had to test and evaluate various web based mathematics resources to assess their usefulness and suitability for her mathematics module. She was able to draw on her experience of MCA online resources and findings from the previous phase of this study to identify and select online mathematics resources.

The evaluation and integration of web based resources for the module took place on a continual basis during the semester and online learning tasks and activities for different topics included references to these web-based resources. In order to maximise their effectiveness only those web-based resources were selected that provided direct access to interactive learning objects and allowed users to interact with the object by providing
some user control and instant feedback. Cathy pointed out that the integration of web based learning has had a positive effect on students but appeared tentative about its effectiveness:

*It has certainly made a little bit of a difference in students that weren’t prepared to do the work, once they got a little bit engaged they were willing to try...in order to make it more effective in the future I think that we have to prepare the students for this type of learning before engaging in it and perhaps in our assessment we should do more, there should be some more online tasks.*

Technology integration was most problematic when it came to assessment tasks. Cathy was very receptive to the idea of having online activities on a topic complement and extend classroom-based learning and provide students more opportunities for learning. She was also very keen to bring authentic learning experiences via the use of web based links and resources and her online activities required students to work with real world and authentic data from the field of business and finance. However, integration of web based activities in assessment tasks for mathematics was a more challenging task. Firstly, curriculum integrity of a CBT module prescribed through learning outcomes demanded a more traditional form of assessment and designing online assessment tasks to meet performance standards required by learning outcomes was something Cathy could not resolve during this trial. Secondly, valid comparisons between control and treatment group performance demanded that assessment tasks for two groups be similar. As a result, only two assessment tasks had a component of online activity and the rest were totally print based assessment tasks requiring short answers. With respect to her technical role In her role Cathy appears to discover the complexity of assessment in online learning and notes that:

*... in order to make it [blended learning] more effective in the future I think that we have to prepare the students for this type of learning before engaging in it and perhaps in our assessment we should do more, there should be some more online tasks.*
In trying to integrate online learning with face-to-face instruction Cathy had to deal with competing agendas. One the one hand, the opportunities afforded by new technologies offered freedom to explore new learning activities and tasks but on the other hand assessment constraints limited integration of online activities in assessment.

Finally, with respect to her technical role Cathy had to deal with day-to-day technology issues related to the online component of learning. This required her to attend to students’ problems with software and computers and often meant that she had to seek help from the IT department. For example, at the start of the module a number of students were unable to log into WebCT due to incorrect user ID and password. Cathy contacted the WebCT administrator to solve this problem by correcting students’ login details. On occasions Cathy was unable to attend to student’s technical problems due to her focus on teaching and students had to help each other out. It is seen with online learning that the demand for technical assistance drops as teacher and learners become more familiar with technology being used (Anderson, Rourke, Archer, & Garrison, 2001). During this study also it was noted that most technical issues arose in the first three weeks of the course and once these were resolved students were able to work with the online interface without any technical problems. There was a clear difference between the technical assistance needs of mature age students and youths in the class. Choy and Delahaye (2002) in their study note that young adult learners show different orientation to adult learning principles (Knowles, 1980) and while they prefer the social aspect of adult learning they rarely think about their own roles and responsibilities as learners. Cathy also noted this difference in relation to technology use and support and noted:

*The mature age students were not so good in their technology, they were actually more [committed], they had a mature attitude to it and they were the ones who were trying to access work outside of the classroom, the younger ones were quite fast, they were more prepared to take it on but then it’s how they used it that differed. Adults are better with time management as well...the younger ones are*
prepared to take it on but ‘I’ll do it later when I get home’ but they never get around to it.

In the role of technical coordinator Cathy did not present herself as an expert to class and attempted to resolve technical issues through seeking help from more able students and other teachers. She was aware of her role as a mathematics teacher and knew that solving computer and technical problems required mastery of different skills. She took preventive actions to ensure that computers were working properly before classes started and took advice from IT support. She understood that providing technical assistance in class is an onerous task and encouraged students to help each other with such problems. Solving these technical problems in class created opportunities for student - student and student - teacher interactions where dynamics of classroom interaction changed and Cathy’s perceived role as an expert changed to a fellow collaborative learner.

Cathy demonstrated an ongoing interest in using technology to bring a change in mathematics teaching in her business mathematics modules. She was cognisant of new developments in the VET sector that could have exerted undue pressure on teaching of mathematics as a stand-alone module (Department of Education Science and Training, 2002; FitzSimons, 2003). For example, with the new national training packages literacy and numeracy skills were embedded in competence statements and training providers did not have to offer separate mathematics or literacy modules (Felsman, 2007). In personal conversations Cathy expressed her concern that mathematics modules may come under pressure with the implementation of new training packages and mathematics teachers may be required to teach subjects other than mathematics.

Stehlik et. al. (2003) in their report on professional development of contract and casual staff involved with flexible learning note that many staff take part in professional development to increase their employability and keep their jobs. Although Cathy was a permanent staff member and did not have any immediate threat to her job security it does not appear that her interest in exploring the use of technology in mathematics modules was motivated by employability concerns. Her involvement in the development of MCA
online environment and her involvement in the development and research of blended online learning with her mathematics class without any time release allowance from her department shows that she was committed to improving teaching and learning for her mathematics classes and was aware of the potential of new technologies in learning of mathematics for her students.

6.4.5 Summary

In summary Cathy’s role as a teacher was affected by integration of online learning in her module in a number of ways. At the pedagogical level she needed to revise her teaching content to incorporate online activities in mathematics, which allowed her to expand her teaching approach from a predominantly cognitive apprenticeship approach to include exploratory, collaborative and problem solving tasks akin to a constructivist approach. She also used the notions of purpose and utility (Ainley, Pratt, & Hansen, 2006) in her learning activities by creating tasks that necessitated the use of real and authentic data from internet sources. In this context factors related to ZPA such as an emphasis on professional development in online learning in the VET sector helped her in making better use of her ZFM such as access to computers and resources for teaching in an online learning environment. However, it appears that other ZFM factors such as assessment and learning outcome requirements constrained her from engaging in more open ended and authentic problem solving tasks.

Teaching in a blended learning format increased Cathy’s administrative responsibilities and apart from ensuring appropriate timetabling and computer laboratory allocations for her mathematics class she also had to deal with administrative issues related to students’ accounts for WebCT and manage course discussion board communication. While the online mode increased flexibility of access for students, it also increased demand on Cathy’s time beyond classroom contact hours as students emailed her and responded to her online tasks via discussion board postings.

At the technical level although Cathy did not seem to possess expert level technical skills, her pedagogical beliefs about the usefulness of technology helped her in implementing
the blended learning program. She was able to draw on peer support and institution based IT support to deal with day-to-day technical issues with students and acknowledged that she would need to improve her technical skills with online learning to be more effective with the use of online technologies with her mathematics class.
6.5 Attitude towards Mathematics

This section of the chapter focuses on the measurement of attitude towards mathematics and presents results from comparisons of pre and post attitude tests results within and between control and treatment group classes.

Our first conjecture in relation to students’ attitude towards mathematics was that at the start of the course both control and treatment group students would show very similar attitude towards mathematics and there is likely to be no significant difference between the two groups.

In addition, we also expected that the use of online learning environment in a blended learning format would make a positive affect on students’ attitude towards mathematics and as a result our second conjecture in relation to attitude towards mathematics was that there will be a clear improvement in treatment groups’ attitude towards mathematics in comparison with the control group.

6.5.1 Pre-test Attitude Comparison between Treatment and Control Groups

Students attitude towards mathematics were measured at the commencement of the module using the Aiken Mathematics Attitude Scale (Appendix 3.1). Results from the attitude scale were analysed for treatment (N=14) and control (N=15) group students for pre-treatment comparison. The Attitude Scale contained 20 items resulting in a possible score between –20 and + 20.

Table 6.7
Pre-test attitude scores comparison using t-test

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>df</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>5.93</td>
<td>12.03</td>
<td>27</td>
<td>1.21</td>
</tr>
<tr>
<td>Treatment group</td>
<td>0.50</td>
<td>12.25</td>
<td></td>
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</tr>
</tbody>
</table>
Pre-test attitude score comparison between treatment and control groups using all available scores as shown in Table 6.7 points out that the treatment group (n= 14) when compared with the control group (n= 15) did not show any significant differences, \( t(27) = 1.205, p > .05 \), two tailed, even though the mean score of control group (5.93) was higher than the treatment group (0.50).

During the course a number of students dropped out from both treatment and control groups. As a result some students had only pre-test scores available for comparison. By comparing pre and post-test records we discovered that nine students each from the treatment and control groups had taken part in both pre and post testing with the attitude scale. Paired sample analysis of pre-test attitude comparison between treatment and control groups using scores for only those students who participated in both pre and post treatment tests also shows some variation in mean scores (Table 6.8) but again this difference is also statistically insignificant, \( t(16) = 1.293, p > .05 \), two tailed, even though the mean score of the control group was higher than the treatment group.

<table>
<thead>
<tr>
<th></th>
<th>( M )</th>
<th>( SD )</th>
<th>( df )</th>
<th>( t )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>7.11</td>
<td>10.88</td>
<td>16</td>
<td>-1.29</td>
</tr>
<tr>
<td>Treatment group</td>
<td>-0.44</td>
<td>13.74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Two students from the control group showed high positive attitude towards mathematics with individual scores of a maximum of 20 and it seems that these outlier scores would have caused the mean score of the control group to be higher than the treatment group mean score. Based on these results and observations it can be concluded that the treatment and control groups were statistically similar in their attitude towards mathematics.

6.5.2 Pre-Post test comparison of Attitude
Using paired sample scores for treatment and control groups a comparison was drawn between pre and post-test scores for attitude towards mathematics. The pre-post treatment group results for t-test comparisons show that there was a significant improvement in students’ attitude.

<table>
<thead>
<tr>
<th></th>
<th>Treatment Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test</td>
<td>M = -0.44, SD = 13.74</td>
<td>M = 7.11, SD = 10.88</td>
</tr>
<tr>
<td>Post-test</td>
<td>M = 6.78, SD = 11.11</td>
<td>M = 11.89, SD = 7.36</td>
</tr>
<tr>
<td></td>
<td>t(9) = 2.317, p &lt; .05</td>
<td>t(9) = 1.875, p &gt; .05</td>
</tr>
</tbody>
</table>

As shown in Table 6.9, attitude change between pre and post treatment scores for both treatment and control groups is positive but mean scores of the treatment group increased more than the control group. Observed results indicate that the attitude of students using blended online learning in the treatment group improved significantly, t(9) = 2.317, p < .05. In comparison control group results indicate no significant difference between pre and post treatment attitude scores, t(9) = 1.875, p > .05.

Table 6.10
*Analysis of variance results for attitude scores*

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>16</td>
<td>1.673</td>
</tr>
<tr>
<td>Post-test</td>
<td>16</td>
<td>1.324</td>
</tr>
<tr>
<td>Within Groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Group</td>
<td>8</td>
<td>5.37*</td>
</tr>
<tr>
<td>Control Group</td>
<td>8</td>
<td>3.52</td>
</tr>
</tbody>
</table>

* p < .05
Pre and post attitude scores comparison was also done using analysis of variance (ANOVA) repeated measures test. Observed F value of 5.368 shows that variation in the means of treatment group scores was statistically significant at the 95% confidence level (Table 6.10). However, observed F value for the control group test shows that the variation in means is not significant at 95% confidence level (Table 6.10). The ANOVA tests also confirm that the attitude of treatment group improves relative to the control group suggesting that the treatment was effective in improving students’ attitude towards mathematics.

The difference in relative improvement of attitude scores for the treatment and control groups can also be observed in the frequency charts of pre and post attitude test scores for the two groups as shown in Figures 6.12 and 6.13.

*Figure 6.12. A frequency chart of pre and post test attitude score comparison for the treatment group students.*
In the treatment group class there was an improvement in the attitude score of six out of nine students. The attitude score of remaining two students did not change while for one student it dropped by two points. Out of the six cases where the attitude score had improved in at least three cases the score improved by a margin of greater than ten points on the scale.

Figure 6.13 for the control group pre and post attitude score also shows that there was an improvement in the scores of six out of nine students, but in this group attitude scores of two students dropped compared to their pre test scores and one student’s score did not change. In the control group class attitude scores of only one student improved by a margin of greater than ten points on the scale.

In summary, the analysis of attitude scores at the pre-test using t-test comparison of mean scores showed that treatment and control groups were similar in their attitude towards mathematics and there was no significant difference in the attitude scores between the two groups. However, when pre-test scores were compared with post-test scores for both
treatment and control groups it was noticed that mean score of treatment group increased more in comparison with the mean score of control group. It suggests that there may have been a positive influence of online blended learning on students’ attitude in mathematics for the treatment group.

Students’ attitude towards mathematics had improved for both treatment and control groups as shown by post-test mean scores and although treatment group scores had improved significantly, t-test comparison of post-test mean scores shows that there was no significant difference between attitude scores of treatment and control groups at the post-test measurement of attitude. It is also important to note that the sample size being very small it is difficult to attach much importance to the statistical significance of the difference in attitude. Also, although the treatment group seems to have improved their attitude more, it would be incorrect to assume that the intervention was the only contributing factor for this improvement.

### 6.6 Achievement

This section of the chapter focuses on students’ performance in mathematics as measured by classroom tests. Students from both the treatment and control groups were administered a general mathematics ability test at the start of the course (Appendix 3.2) and a final test for the module at the end of the course (Appendix 6.1). The purpose of general mathematics ability test was to establish if the two groups differed significantly in their mathematics ability at the start of the blended learning program with the treatment group. Students also took six bi-weekly assessment tasks as discussed in Chapter 5.3.

Our first conjecture in relation to students’ achievement in mathematics was that at the start of the course the mathematics achievement scores of both groups would be very similar and there will be no significant difference between the two groups when their pre-test achievement scores are compared.
At the end of the semester mathematics achievement scores of both groups were once again compared using their final test scores (post-test). The final test was different in content and difficulty from the general mathematics ability test and aimed at testing students’ knowledge and skills on the subject matter learned during the course. Since students in the treatment group were using additional online learning resources and activities in a blended learning format we expected them to perform better. Consequently our second conjecture in relation to students’ achievement in mathematics was that the treatment group students would have significantly higher post-test achievement scores when compared with the control group.

Data obtained from pre-test and post-test measurements was subjected to t-test analysis for the significance of difference in mean scores between two groups. In addition, analysis of variance (ANOVA) and Pearson correlations tests were also performed to ascertain the significance of any difference in pre-test and post-test mean scores and whether the post-test scores were strongly correlated with pre-test scores. Results from these tests are explained in the following sections.

### 6.6.1 Pre-test Comparison of Achievement Scores

Students from both treatment and control groups participated in a mathematics general ability test at the start of the course to find their pre-test achievement scores and if there were any significant differences between the two groups in terms of their mathematical performance. The test consisted of ten questions drawn from topics of number skills and algebra pre-requisite for the module (Appendix 3.1).

The pre-test achievement comparison between treatment and control groups using all available scores showed no significant difference, \( t(27) = 0.114, p>.05 \), two tailed as shown in Table 6.12.

| Table 6.12 |
Pre-test comparison of achievement scores using t-test

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Df</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>30.42</td>
<td>16.44</td>
<td>27</td>
<td>0.11</td>
</tr>
<tr>
<td>Treatment group</td>
<td>31.18</td>
<td>18.42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When comparison was made between two groups using scores for only those students who participated in both pre and post achievement tests the mean scores for the treatment group was 33.12 compared with the mean score of 27.14 for the control group, but the t-test statistic shows that this difference was statistically not significant, t (13) = 0.636, p>.05, two tailed (Table 6.13).

Table 6.13
Pre-test comparison of achievement scores using t-test analysis for paired samples only

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Df</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>27.14</td>
<td>16.24</td>
<td>13</td>
<td>0.54</td>
</tr>
<tr>
<td>Treatment group</td>
<td>33.13</td>
<td>20.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analysis of Variance (ANOVA) analysis for pre-test achievement scores between treatment and control groups shows an observed F value of 0.405 (Table 6.14) suggesting no significant difference between treatment and control groups for the pre-test achievement scores.

Table 6.14
Analysis of variance results for achievement scores of paired samples only

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>14</td>
<td>0.41</td>
</tr>
<tr>
<td>Post-test</td>
<td>14</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Pre-test scores of both treatment and control groups showed that the two groups were very similar in their mathematical ability and skills as measured by the general
It was important for the design of the study that the two groups were statistically similar in their mathematical ability at the start of the module to enable a fair comparison between the two groups at the post-test.

### 6.6.2 Post-test comparison of Achievement Scores

Post-test achievement test consisted of the final test for the module and comprised of questions taken from all topics covered during the module. It was a different test from the test given at the start of the course as pre-test and students’ final grades for the module were determined on the basis of this final test. Analysis of post-test scores was conducted using t-test and ANOVA measures to determine the significance of difference between the mean scores of treatment and control groups.

Table 6.15

<table>
<thead>
<tr>
<th></th>
<th>$M$</th>
<th>$SD$</th>
<th>$Df$</th>
<th>$t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>69.14</td>
<td>20.04</td>
<td>13</td>
<td>0.76</td>
</tr>
<tr>
<td>Treatment group</td>
<td>60.63</td>
<td>22.96</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results obtained from t-test shows that the mean score of control group (69.14) was greater than the mean score of treatment group (60.62) but this difference in mean scores was not significant, $t (13) = 0.760, p>.05$, two tailed as shown in Table 6.15. The results suggest that the use of blended online learning innovation with the treatment group had no significant effect on their achievement scores in comparison with the control group who had done the module using traditional teaching methods.

When post-test scores on achievement were compared using the ANOVA measure an observed $F$ value of 0.577 was obtained again suggesting that no significant difference existed between control and treatment group scores at post-test stage (Table 6.14).
An analysis of covariance (ANCOVA) using achievement post-test scores as the dependent variable, teaching groups as the independent variable and pre-test scores as a covariate also failed to confirm any significant difference between treatment and control groups with an observed $F (14)$ value of 2.263. This analysis suggests that even when achievement pre-test scores are treated as a covariate in order to reduce their influence on post-test comparison, it produces no significant difference between control and treatment group post test achievement scores.

In terms of achievement scores, it appears that there was no significant difference between the treatment and control group post treatment achievement scores. Statistical analysis based on a final test results appears to indicate that instruction using blended learning approach may not have had any impact on students’ performance in mathematics. On the surface these results are consistent with research findings reported in literature but there are some interesting observations to be made upon a closer examination of these results.

![Comparative Pass Rate](image)

*Figure 6.14. A comparison of pass rate between treatment and control groups on bi-weekly assessment tasks.*
In our study the post treatment final test for the subject was a paper based conventional test and took no account of the learning with online technology. Interestingly, in bi-weekly ongoing assessments where some tests included web based tasks, the results were different (Figure 6.14). Results from these tests show that at least on four occasions the treatment group had better pass rate than control group. Arguably, two tests where web based activities were integral to assessment task; treatment group students had a clear lead in pass rate scores.

In summary, the measurement of achievement scores at both pre-test stage and at post-test stage did not show any significant difference between the treatment and control groups. Since students final assessment was used as a post-test and it was different from the pre-test, a comparison of mean scores between pre-test and post-test could not be used as a valid measure for effectiveness comparison. The treatment group class was taught using blended online methods and alternate learning activities and resources were used in teaching the treatment group but when comparisons were made on the basis of post-test scores no significant difference was found between achievement scores of the treatment and control groups. The testing conducted for pre and post-test scores was based on traditional print based questions and required students to read worded mathematics problems and apply appropriate formulas and processes to calculate the answer. Although during the study we had hoped that by participating in online activities and doing practice questions in online mode students would show improvement in paper based testing and assessment, the results from post-test comparison did not show that this occurred. However, it was clear from the comparisons of mean scores that blended online learning did not do any harm to the treatment group and there was no negative affect of using online learning activities on their results. It can be argued that blended online learning affected the design and content of learning substantially for the treatment group and traditional assessment methods were unable to account for gains achieved by the use of blended online learning methods as presented previously in chapter 5.4 and discussed further in the next section.
6.7 Blended online learning and Assessment

This section of the chapter focuses on the issue of assessment and how teaching and learning in a blended learning environment creates challenges for assessment in mathematics. The blended online learning model offers a unique mix of face-to-face learning complemented by the use of web based tools, resources and communication (R. Brown, 2003; Cashion & Palmieri, 2002). Integration of online activities in a campus based face-to-face course adds new dimensions to the content and pedagogy of learning. It helps to bring more authentic and real life learning tasks to classroom, prepare students to work with new technologies in their chosen field and provide opportunities for problem-based learning. However, when only traditional assessment methods are used to assess students’ knowledge and performance in a subject taught by a blended online method, gains, if any, achieved by the use of new methods could remain largely ignored and unaccounted for in the final analysis.

In this study the treatment group was taught using both online methods and face-to-face traditional methods but final assessment test was offered only as a pen and paper test with no reference to online resources and applications. It required students to read, interpret and understand a set of print-based problems and expected them to write short answers and solutions within a given timeframe. The control group was also administered the same final assessment test and results were compared. Final test scores comparison between the treatment and control groups showed no significant difference in performance between two groups (see Section 6.6). On the surface it could be assumed that applying blended learning format with the treatment group did not have a positive affect on students’ learning in mathematics. But a closer look at learning activities and the formative assessment conducted during the course shows that when the teacher included online tasks for assessment, students’ participation and performance were better compared to their paper based assessment scores (See Chapter 5.4.2.2). However, when performance is measured using traditional pen and paper methods, the control group students appear to show slightly better results. One student who favoured the use of computer based tasks for assessment said:
It (assessment) is good, you’ve got both computer work and writing work as well, you’ve got a balance of things it’s not just writing the whole time, you’ve got the computer too...Well I’m probably advantaged to some people who don’t have computers or the internet at home. But I’m favouring it.[Interview transcript: student - Juang]

The purpose of the module under the study was to provide the learner with the knowledge and skills to apply mathematical techniques to a variety of business applications and decisions. The learning outcomes required that students be able to solve basic linear equations, use a calculator or computer to perform common commercial percentage calculations, perform simple and compound interest calculations, perform basic depreciation calculations, apply the principles of linear equations to break even analysis and prepare appropriate graphs from data and interpret them.

During the study a number of online mathematics activities were integrated with face-to-face teaching. These online activities served two important but different roles. One type of activities focused on skill building and comprised interactive java applets and programs. Students used this interactive practice to reinforce particular mathematical skills such as transposition or order of operations. The other type of activities involved problem solving and investigations that invited students to explore mathematical concepts and skills using online communication, web tools and knowledge archives. In the following section I will describe and point out how learning afforded by online tasks extended students’ knowledge and skills and when assessment relied only on traditional assessment tasks these new dimensions of learning remained largely unaccounted for.

6.7.1 Drill and practice in an online environment

Firstly, let us take the case of drill and practice type online activities. These are activities where online technology provides a non-intrusive interactive tool to practice a specific mathematical skill. For example, during the first session on algebra the teacher started the session with a face-to-face teacher directed segment where simple algebraic equations were solved on the whiteboard. About midway through the session a transition was made
from the face-to-face teaching to online activities. The online program offered a transposition equation to the user and asked for an answer. Students had to work out the problem either mentally or using pen and paper, and type their response on the screen. The program checked the response and returned a screen with feedback and correct solution. Lesh and Doerr (2003) point out that mastery of basic skills and procedures to solve certain mathematical problems efficiently is a desirable learning goal. Research has also shown that auto correction activities allows students to notice their errors and attempt remedy without intervention by teacher, and students are less anxious about their mathematics skill when unsupervised (Delors, In'am, & Roberto, 1998). In this session we observed that during the online activity students were able to take more risks in attempting solutions and moved on quickly to attempt the next problem. They also appeared more willing to ask their peers for assistance when unable to find a reason for their errors in solving problems.

Class observation and WebCT logs from this session indicate that students’ engagement with this activity was positive and by attempting the interactive exercise as many time as they liked some students were able to self-correct their errors in solving problems. Overall, the exercise appeared to help them improve on their transposition skills. Final assessment test questions on this topic included print based questions where students had to transpose equations similar to those practised in the online activity. The advantage of online practise on this type of problem is clear from both weekly assessment result on algebra topic and also comparative performance on this problem in the final test (see Section 5.3.2.2). In this example, due to close similarity of online practice task and print based equations task, it can be argued that students had the opportunity to apply skills mastered in online environment to offline print based tasks. However, this is not true for most other situations where online activities did not have a direct and parallel offline print based task.

6.7.2 Writing mathematics in an online environment

The introduction of online activities created opportunities for writing mathematics and learning symbolic representation of mathematics in the online medium. In these online
activities students developed their skills and abilities in communicating mathematical ideas both in a symbolic form in online activities and in text form in online postings.

For example, in an online algebra activity students were required to input their algebra equation in a java based program and let the program solve the problem. In this activity students were required to use ASCII equivalent of mathematical operations and many students were totally unfamiliar with representation of mathematical operations in these symbolic forms for online usage. For example to type a fraction in an exponent form such as $x^{2/3}$ students needed to type $x^{(2/3)}$. The teacher provided clear instructions with examples of mathematical expressions for web based tools.

In another online algebra task students were asked to create a word problem based on a simple algebra equation. They had to post their problems on an online discussion board where other class members could see the problem and attempt solving and posting solution to it. The teacher presented this problem as a cooperative activity where students had to learn the language of writing algebra problems and think about everyday situations that can be used as a basis for creating worded problems. During this session students actively engaged in using the online discussion platform to post their questions and responses to other postings. This task was a new learning activity generated specifically for the online environment and although it did not involve solving typical algebraic problems, students had to position themselves as a problem generator and think about situations where an algebraic relationship could be created. A selection of sample postings is given:

Example 1

“Tony worked at the Albion fun market. His business specialised in selling mens shoes. If Johanny bought 15 pairs of formal shoes costing him a total of $450. the shoes would have originally cost Johanny $600. but since johanny and tony were good friends he gave him a discount of how much? The fun market quiz is to find out how much discount was given?”

Example 2
“Tony worked at Malvern Post office he works 25 hours on weekdays on a normal average rate of $14.57 per hour and works 5 hours on Saturdays which is a rate of one-a-half the normal rate. Tony also took some stamps home valued at $9 which will be deducted from his pay. How much wages is Tony going to get this week? All the best of luck to everyone solving the problem.”

Example 3

“It's half time here at the "G", and we have witnessed a fierce clash between the traditional rivals the Moscow Moo-Cows and the Adelaide Gerbals.

We have witnessed a total of 99 points scored at the great stadium this afternoon, of course 6 being awarded for a goal and one for a behind.

The Moscow Moo-cows have kicked a total of 66 points, including 10 goals.

The Adelaide Gerbals have kicked 10 behinds in their first-half score.

Can anyone out there at home tell me

a) How many behinds did the Moo-Cows kick for the first-half?

b) What was the Adelaide Gerbals Total first-half score?

c) How many goals did the Gerbals kick in the first half?”

The selection of postings above shows students’ imaginative use of everyday situations to create a context for algebra problems. Although, the task of writing mathematical problems on the topic of solving algebra equations did not provide direct practice for equation solving skills, Cathy included this task to give students a chance to see and experiment with relationships with numbers and quantities in everyday situations. Research on writing mathematics shows that writing word problems is a powerful tool for learning algorithms (Fennell & Ammon, 1985). Students who practise writing worded problems on algorithms appear to have a greater sense and understanding of the meaning behind an algorithm (Golembo, 2000).
The online activities on the topic of algebra led to an active use of the discussion board immediately after the face-to-face sessions and generated 44 postings from students. The online sessions also provided students with opportunities to practise equation solving, using symbols for mathematical operations and reasoning and language associated with generating worded problems. But as far as assessment is concerned, traditional test format used for the final test focussed only on traditional print based algebra questions and placed no value on language and writing skills gained. Interestingly, the task of writing worded problems could have been used in a face to face pen and paper based learning environment as well but the online discussion board made the job of posting and sharing problems with each other much easier than possible in a pen and paper based learning environment.

6.7.3 Searching and locating mathematical knowledge online

The Internet offers vast archives of mathematical knowledge and new interactive tools to perform complex calculations. Modern banking, finance and trade practices make use of these web based interactive tools in their daily practice (Gunningham, 2003; Zevenbergen & Zevenbergen, 2004). Collaboratively developed knowledge repositories are also becoming increasingly popular. In the field of mathematics, questions and answers archive developed on Ask Dr Math website is a unique collection of mathematical knowledge derived by student-teacher questions and answers on various maths topics from primary to university grade students.

Considering the relevance and appropriateness of these online resources for her students Cathy included a number of online activities on the topic of percentages and interest where students had to search and locate information to solve a given problem. For example Cathy posted a problem activity on the discussion board after teaching the topic of simple and compound interest in a face-to-face session. In this activity students were asked to search and find a popular business mathematics rule and test it with problems from their exercises (see Chapter 5, Section 5.4.3).
In the context of learning mathematics in a blended online environment this activity proved to be very successful in opening up a new avenue of knowledge seeking for students. They learned to locate and find answers to their problems from an online archive built with the help of an online community of mathematics teachers and students. It was interesting to note that this activity forced many students to focus on estimating their answers with a quick mental calculation. Use of mental calculations in estimating answers is increasingly emphasised in research literature, especially when students are relying on calculators (Goos, 2002; Gunningham, 2002).

Similarly, in another online activity during the topic of percentages students were expected to make use of online calculators to explore mathematical relationships between different variables. In one task students were asked to use an online home loan calculator to explore the affect of frequency of loan repayment on loan period. Students were also expected to learn to use these calculators to work out borrowing limits and repayment amount for various scenarios. Obviously here students are not using pen and paper to manipulate variables in a given algebraic algorithm. Instead, they are using the efficiency of automation afforded by an online calculator to explore mathematical relationships between different variables applied to a home loan context. Research by Hoyles and Noss (cited in Ainley, Pratt, & Hansen, 2006, p. 29) have labelled this way of using technology as ‘using before knowing’ and they claim that students’ use of technology in meaningful ways empowers them to learn mathematics.

During this task initially many students could not work out the problem correctly because of their inexperience in manipulating screen based variables where some fields required numeric entries and other fields expected users to choose from a drop down list of choices. Some students also struggled with repeating online calculations by changing just one variable because applying reset calculation resulted in all entries being wiped blank. It required some careful observation and understanding of how various inputs impacted on the calculation. But once this aspect was mastered, students showed a keen interest in experimenting with various combinations of variables. Although by using the online calculator students did not have an opportunity for learning the mathematical processes
involved in home loan calculations, classroom discussion after the activity revealed that the exercise clearly helped students in developing an understanding of the relationship between different variables and how various home loan amounts were affected by changing these variables.

One of the advantages of doing online tasks in a classroom situation was that Cathy was able to switch between face-to-face and online mode to explain a particular concept. For example, in teaching compound interest problems, Cathy first used tabular method to demonstrate how interest is added to principal to calculate interest for the next period. Later she helped students derive the formula to calculate compound interest and gave them questions to practise manual calculations. So, when students moved to the online calculators for interest problems they had already done some practice with paper based questions. Therefore students’ experience of online calculation was not constructed with the view of “technology as master” but rather “technology as partner” (Goos, Galbraith, Renshaw, & Geiger, 2003). Given the skills learned with the compound interest algorithm students were able to calculate solutions for standard problems but the online calculators brought in the convenience and efficiency of calculations to explore relationships between various variables.

The efficiency afforded by online calculators allowed students to explore relationships between variables which would not have been achieved using pen and paper in the given timeframe. These online activities provided students opportunities for exploring and investigating various patterns and relationships between different variables involving topics such as currency conversions, interest rates, depreciation and linear graphs. They also learned the skills of using these online tools to solve realistic problems from their exercise sheets (See Chapter 5, Section 5.4.4 and 5.4.6).

Students’ exploration of online archives and the acquisitions of skills necessary for seeking knowledge and understanding from these sources points to new dimensions of learning afforded by a blended online environment but traditional assessment tasks lack the intent and design to be able to account for these dimensions of students’ achievement.
As part of a number of online activities students were required to conduct web searches for specific mathematical tools and calculators, and evaluate their usefulness for carrying out specific calculations. One of the main things about using these online calculators was the requirement that students be able to estimate their answers and compare it with their computed results. During the topic of depreciation, students learned about calculating depreciation by using the straight line and reducing balance methods. Cathy showed them these methods by modelling solutions on the white board and seeking student input while building up a solution. Students learned this method and practised paper based word problems on the topic of depreciation.

During the online session on this topic students were told that they can search and find a range of depreciation calculators on the Internet and students were given the task of finding and using a suitable depreciation calculator to solve given problems. They had to test the functionality of their calculator by solving a set of given problems. As a requirement for this task student were to post the web address and their evaluation of the calculator on the discussion board. As an example a response from a student is shown below:

Subject: Task1 Financial Calculator

I found a great depreciation calculator for working out the value of cars after a number of years, details are as follows:

a) Car Times Depreciation Calculator
b) www.cartimes.com/search/depreciation.shtml
c) It gives you salvage vehicle values after the chosen period.

Example that I did: Car cost 25,000, was bought new, its value after 10 years?

Total depreciation = 20,290,
Salvage value = 4,710.

Makes you wonder why some people think cars are any sought of asset. see ya.

[Posted on student discussion board by Jacoob]
A closer look at the posting reveals that working with online calculators to explore mathematical relationships allowed students time to reflect on the process as well as the outcome. His comment that “Makes you wonder why some people think cars are any sort of asset” is a clear indication that this student has been able to put the concept of depreciation in a broader context and show critical numeracy awareness. Surely, when students have to practice these questions in a manual pen and paper mode there is more time spent on algebraic manipulation and computation and there are fewer opportunities available for exploration and reflection.

Despite it being well known that workplace practices are increasingly dependent on the use of technology to perform manual computations, many teachers in vocational and school settings continue to focus an inordinate amount of attention to memorising algorithms and skills practise in using these algorithms. Highlighting the significance of technology in contemporary mathematics teaching and learning Gunningham (2003) in her keynote address to Mathematics Association of Victoria noted that:

*The era of humans thinking strategically and using estimations that are later supported by error-proof calculation performed by technology is upon us. Yet in many of our mathematics classrooms, little change has occurred in either the curriculum delivered or the manner in which that curriculum is delivered. Students still spend many hours completing a sea of algorithms, each one an almost duplication of the previous one, for little purpose other than to practice an already acquired skill. While this repetition may be a valuable aid to automatic recall, it does not develop thinking and build a network of strategies for solving unfamiliar tasks that the student may confront at another time. Teachers using such repetitive approach are ignoring the new ‘big picture’, clinging instead to outdated concepts of curriculum that will hinder our students’ potential to succeed beyond school.*

Echoing similar sentiments, researchers such as McIntosh, De Nardi and Swan (2004 p.5) have also reported that “at least 75% of all calculations” which adults use in daily life are based on mental estimations and calculations rather than use processes learned at school.
These researchers value the development of skills of number sense and estimation with numbers more than skill with algorithms.

The method adopted by Cathy in her online class provided students with a unique mix of skills acquisition and exposure to technology tools and estimation. During online activity sessions she frequently referred students to MCA online units for basic mathematics skills and interactive practice links available from the resource page of WebCT course home page. During the use of online calculators to perform calculations students were constantly challenged to estimate their answers before actually engaging in the use of technology. In this regard learning key concepts with the help of face-to-face sessions using whiteboard were invaluable in providing the scaffolding for estimation. The weekly assessment task on depreciation included both online work and paper-based calculations, and students’ performance on this task was comparatively better than the control group. However, the final assessment task had only paper-based questions on the topic of depreciation and any skills and knowledge students’ acquired in searching, evaluating, estimating and computing with technological aids accounted for little or no credit.

In summary, the blended online learning class in mathematics included a number of new and innovative activities to provide students opportunities for working with authentic and real life data. These activities helped students to develop a deeper understanding of the concepts learned and apply them in realistic contexts. While some online tasks helped students to practice conventional skills with the help of an automated online tool other tasks showed students ways to search for solutions on Internet archives. In addition to learning about finding and using online mathematics tools, treading through online mathematics archives and evaluating search results students also picked up number sense and estimation skills.

There was also a spin off in terms of learning to use an online learning environment, participating in online discussions, emailing, searching and becoming familiar with mathematics symbols used in an online environment. Clearly, most of this learning is difficult to assess using conventional methods of assessment. We also found that certain
weekly assessments where students had an opportunity to engage with tasks that included online components their result was relatively better compared with the control group (refer to chapter 5.4.2.2 and 5.4.5.2). Findings from the study offer a clear hint towards the inadequacy of traditional assessment methods to account for learning afforded by online environments. Educators need to recognise the challenge of bringing online learning to mathematics classrooms in a blended format with the view that assessment is an integral part of teaching practice and it must reflect new dimensions of learning afforded by online learning environments.

6.8 Conclusion

This chapter has presented an analysis of the findings emerging from the second research cycle. In an attempt to respond to research questions each section of this chapter has dealt with a particular research question and conjectures related to the issue.

In terms of factors affecting student participation in blended online learning in mathematics findings from this study suggest that students’ computer skills, motivation and attitude are important personal readiness factors. A comparison of students attitude towards mathematics with their online participation and final results reveals that although students with more positive attitude towards mathematics appeared to score more marks in assessment and final tests, students’ participation in online activities was not related to their attitude towards mathematics. In some cases students with very negative attitude were found to be most active in terms of online participation. However, students with a positive attitude towards mathematics seemed to access the online environment more selectively. The interactivity afforded by online activities and tasks requiring use of authentic and real data appeared to affect students’ motivation in participation in learning activities. But, course related factors such as the curriculum load, pace of teaching and lack of time for consolidation of learning seemed to put undue pressure on students and affected their participation in self directed and exploratory activities negatively.

In terms of access and use of online learning environment by students the findings reveal that students’ access and use of the online environment was predominantly during school
hours and from classroom computers. Students’ access and use of communication tools indicates that they used it selectively to respond to tasks set by the teacher. It appears that the use of discussion board to generate social contact was not necessary when the class was able to meet in a face-to-face situation.

The use of an online learning environment in teaching affected teacher’s role in a number of ways. It affected her pedagogical role and allowed her to incorporate more engaging, authentic, collaborative and problem-solving tasks in her traditional teacher led instruction. The blended learning approach also offered the teacher professional development opportunities to enhance her technical skills in designing and offering online learning.

While students’ attitude towards mathematics seemed to improve for both control and treatment group students after a semester of teaching the increase in attitude scores of treatment group students was more significant than the control group students. Students’ performance in the final test did not indicate any significant difference between the control and treatment group students, seemingly depicting that the use of online activities in learning did not have any impact on students’ performance. But a closer examination of assessment tasks and student results showed that online activities involved different skills and strategies and traditional assessment methods were not suited to assess them. The increasing use of online tools in industry and teaching methods demands a fresh look at assessment practice as well. In the next chapter a discussion on findings and issues emerging from this study is presented.


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