STUDENT BEHAVIOUR IN A FLEXIBLE LEARNING COURSE FRAMEWORK

Dr Gordon Russell
Edinburgh Napier University
Merchiston Campus, 10 Colinton Road, Edinburgh, EH10 5TD, UK
g.russell@napier.ac.uk

Andrew Cumming
Edinburgh Napier University
Merchiston Campus, 10 Colinton Road, Edinburgh, EH10 5TD, UK
a.cumming@napier.ac.uk

ABSTRACT

Flexible learning approaches to education are important in modern Universities. Students should be able to choose how they will study their courses, and educators should be prepared to support students in their choices, and guide students to employ sound educational methods. This paper considers the experience gained by teaching 500+ students over a period of 5 years using a custom virtual learning environment for teaching Operating System Administration. It highlights some of the common concerns educators may have with flexible study, and demonstrates the statistics around these issues. It also considers the future direction of this style of education to best support the different learning styles of the students involved.

KEYWORDS

Peer support, Flexible Learning, LinuxZoo, Operating Systems, Cohort Analysis.

1. INTRODUCTION

Flexible learning approaches to courses are becoming more prevalent in modern Universities. This is partially down to Universities looking to part-time and continuing professional development markets, but also to support the current student mentality towards study. Statistically significant numbers of our students consider lectures and practicals to be optional, and expect to meet course learning outcomes using other resources. The Universities in turn expect such resources to be made available to students, as students are seen in a more customer-centred light. This shift has been detectable over many years (Moran & Myringer, 1999).

This paper considers the effect of this trend, using 5 years of behavioral data gathered through a virtual learning environment written here at Edinburgh Napier University. This VLE, known as LinuxZoo, provides a microworld-style (Rieber, 1992) learning environment which supports students learning Linux operating system administration. It provides students with a virtualized PC, accessed over the internet, which can be configured by the student via standard operating system interfaces such as telnet and ssh. The VLE contains reference and lecture material, as well as an integrated tutorial environment, such that students complete tasks and the system evaluates the student's virtualized PC to identify whether the task has been completed. This information is then returned immediately to the student in terms of a "pass" or "fail" for that task. If the task is a fail then the student can continue with that task until the feedback system identifies that the student has succeeded with the task, in which case the student can continue to the next task.

Each tutorial session is made up of a tutorial containing multiple tasks which the student has to complete. The students have two hours per week timetabled to work on the tutorials supervised by a lecturer, but many students prefer to work on this off-site. Lectures are also presented each week, but again attendance is optional. After 9 weeks the students undertake a supervised practical assessment using the same interface. Figure 1 shows actual course attendance in 2010/11 for our main cohort in timetabled events, from the start of the course to the start of their coursework assessment. This shows that students already study this course flexibly, and with a key performance indicator requiring modules at Edinburgh Napier at this level to achieve an 85% pass rate at first diet assessments, there is an implication that even those who do not attend frequently must still be well supported for the course to meet its targets.

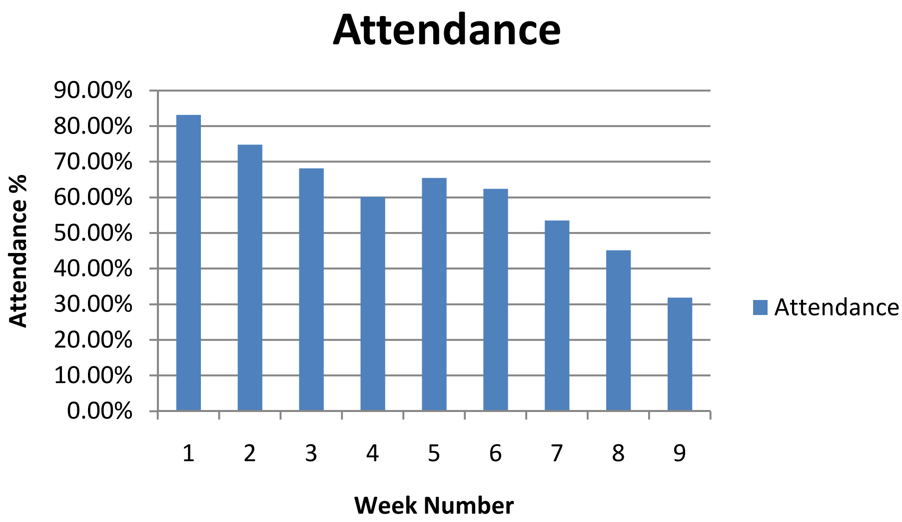

Figure 1: Student attendance over a trimester

While the student is logged into our VLE, a great deal of data is recorded about the student's interaction with the system, as well as the current virtual machine state. This paper examines this data in detail, which gives a useful insight into student behavior. Some students take the module by attending all events, some attend practically none, while others take the course remotely at an off-campus location without local expert supervision. With such a range of student learning models occurring simultaneously, the different student groups can be compared directly and student learning models identified for each group. This data allows the authors to identify learning strategies employed by each group, and more importantly categorize interaction behavior to identify weak students early in the course. This could be used to direct more support resources to weaker students without distracting the more capable students, and to identify student coping strategies which would ultimately lead to an inability to achieve the learning outcomes (e.g. overdependence on peer support in practical sessions leading to failure in the supervised individual assessments).

2. THE LINUXZOO VIRTUAL LEARNING ENVIRONMENT

Linuxzoo's main function is to allow students to "own" a virtual computer for the duration of their practical session. This is integrated into an online tutorial sheet (1 per week for 9 weeks), such that the students look at each question in turn, then access their virtual pc to attempt to complete that task. On completion (or suspected completion) they press a button and it indicates whether they have or have not completed the task. This is used to teach operating system administration, such as DNS server configuration, firewall configuration, web server configuration, and basic administrative operations (such as creating users). As the students may not have used Linux before, the course also teaches the basics of Linux, such as file copying. For instance Figure 2 shows a basic introductory question from the course.

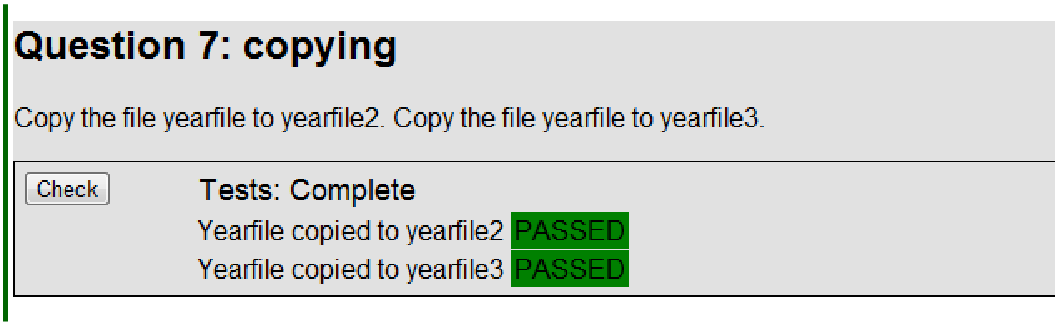

Figure 2. Basic example of the linuxzoo tutorial interface

While the students are working on a tutorial they can press the “check” button as many times as they like, and each time the system automatically logs into the student’s virtual PC and check to see if the question has been completed. This is done using hand-coded commands for each test, ran automatically by the system, which produces output that in turn is evaluated against a regular expression. This is all stored in a document formatted using the XML, the extensible markup language.

This approach to automatic feedback measures the current state of the student’s PC at the time the check button is pressed, rather than evaluating the commands that the student has actually typed. This is needed as there are in general a wide variety of commands which all effectively accomplish a task. This makes the automatic checking much harder than that employed for other systems with more limited commands in systems which lack side effects between commands (such as the author’s previous work on read-only SQL (Russell & Cumming, 2005). For instance Question 7 could be done in a range of ways including either:

cp yearfile1 yearfile2	*or*	cat yearfile1 > yearfile3
cp yearfile1 yearfile3		cat yearfile3 > yearfile2

Although not a requirement of the correct function of the system, a great deal of information about student behavior is recorded by the system. Each button press made by a student is recorded, as well as where the student is accessing the site from, along with a range of factors concerning their virtual PC. This information allows the authors to better understand how the site is being used, and to evaluate changes to the system year on year.

3. BEHAVIOUR ANALYSIS

The raw data stored concerning student interaction with LinuxZoo is held in an Oracle database. This has been extracted and processed in a number of ways, allowing us to investigate a number of different factors. These include physical attendance at practicals, virtual attendance (using the site outside tutorial times), the physical location of the student using IP (internet protocol) numbers, what the student was actually doing at any one time, and period of idle time between activities. The site also records if the student achieved the right answer or not for each question.

This data can be processed further, and additional behavior information inferred. This allows us to ask a number of questions which would be difficult to evaluate without using a VLE.

The students were informed that their data would be used for research and analysis before they first used the system, and indeed previous research results are shared with the students. All data was anonymised. The use of this information and the experimental procedure was discussed with our ethics committee and their guidance was followed.

3.1 The effect of peer support on student behavior

By knowing the physical IP number of the computer which each student was using at each particular instant, physical locations of each student can be inferred. If two students at the same time have IP numbers which are very close to each other, it can be inferred that their physical location is also very close to each other. Linear IP numbering is used extensively without our labspace, which makes this analysis much easier. This data was further analyzed statistically to filter out errors and co-incidences (e.g. students had to be sitting beside each other multiple times before they were considered to be in a peer support arrangement). This peering may happen in a timetabled practical session purely by sitting next to another student, so timetabled events were also filtered out of the calculation. Figure 3 shows one typical cohort's peering relationship, using a Force-Directed layout visualized using Protovis (Bostock & Heer 2009).

Figure 3. Peer support network for local student cohort

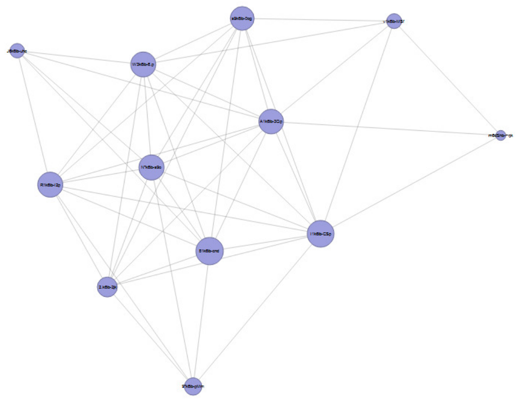

Figure 4. Peer support network of off-campus student cohort

The peering relationships are completely organic, in that no attempts were made to peer students off. There were 107 students in this cohort, and those without a support peer are not shown. What is significant is that students with a peer averaged 69% in the supervised assessment, against a cohort average of 61%.

In contrast Figure 4 shows what happened in one particular year for an off-campus cohort. In that year this cohort suffered from lack of local supervision during their timetabled sessions, plus additional disruption due to local accommodation issues. Here the students seem to have built an extensive peer network as a coping strategy to allow them to complete the course. All students in this cohort formed at least one peer. Everyone ultimately passed the assessment.

It seems clear that a support peering is a strong factor in passing the course. However the more flexible the course the harder this is to facilitate. In any 10 minute period the average number of students using the system is <1, so peering opportunities would not often happen spontaneously in a flexible study mode without arranging "peering up" events.

Forums are used in the VLE to provided flexible students a way to ask support questions. By having a strict policy that posting subject headers should include tutorial name and question title, the forum itself has grown into a useful knowledge base. However detailed analysis of the forum posters in 2010/11 indicates that a poster is statistically more likely to fail the course than someone who has never posted. As the authors allow questions to also be asked by email, it turns out those students who eventually pass at first diet who want to ask a question will ask by email. The reasons for this are unclear, and worthy of further analysis.

One serious concern about this peer support strategy is the question as to whether students in a peer relationship are supporting each other in a sound educational way, or whether one is simply telling the other(s) what the answer is. In a physical tutorial this can often be detected by proper supervision, but in a flexible attendance mode this is much harder to validate.

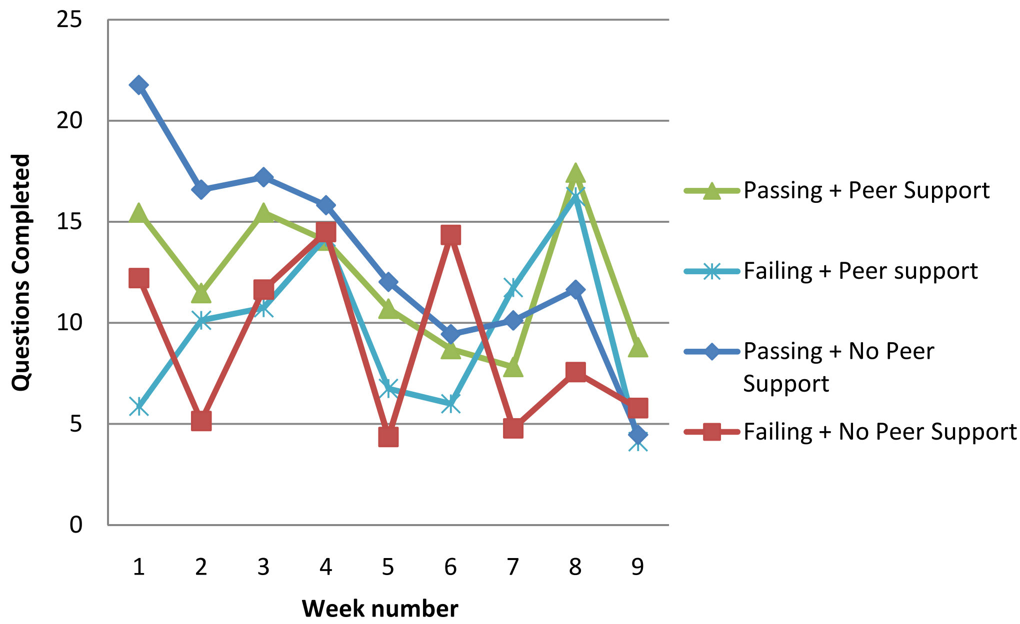

Figure 5. Question Completion Rate

Figure 5 shows the analysis of the number of questions the cohort made over 9 weeks of the practical. It has been broken down into students who eventually achieved passing grades and those who did not pass, as well as those with peer support and those without. It would seem that students without peer support who pass start out very strongly, completing the easy initial questions quickly (the question difficulty increases each week) while still returning a reasonable number of completed questions each week.

Failing students without peers are more sporadic. They start out slower and have patchy weeks (e.g. in week 5 another course had a submission deadline, and this group of students did not really work on our material that week). In particular near the end of the course they do not complete many questions. The authors surmise that at this stage, these students put in much time over weeks 7-9 (no statistical difference to the other groups) but they are unable to get questions right. Without a support strategy they become stuck. Basically they just left things too late…

Compare that to Passing with Peer Support. Not as strong a start as those passing without peers, but much more balanced in their approach over the weeks. In the last stages they are able to put significant amounts of productive time into the work, and achieve all the needed questions. Their study methodology appears to have worked well in that group.

What is particularly interesting is whether the Passing with Peers group passed through hard work or through unacceptable degrees of collusion. From Figure 5 you can see that this group in weeks 8-9 were completing large numbers of questions, and from Figure 6 you can see that this group over the same period made many errors per question. This seems to suggest that although in a peer relationship their work was largely experimental, suggesting in turn that good educational processes are being followed. A similar effect can be seen in the Failing with Peers cohort. This is suggestive that the type of tutorial and feedback model (e.g. evaluating the result of student actions) employed in LinuxZoo is less likely to arise that in systems where the student’s actual commands are the things being evaluated (such as the collusion previously reported in our

SQL VLE (Russell & Cumming, 2005b). This is a useful result, as collusion detection in a system where no record is made of the commands that each student typed would be highly circumstantial in nature, which in turn would prevent difficulties in proving the case at any academic misconduct proceedings.

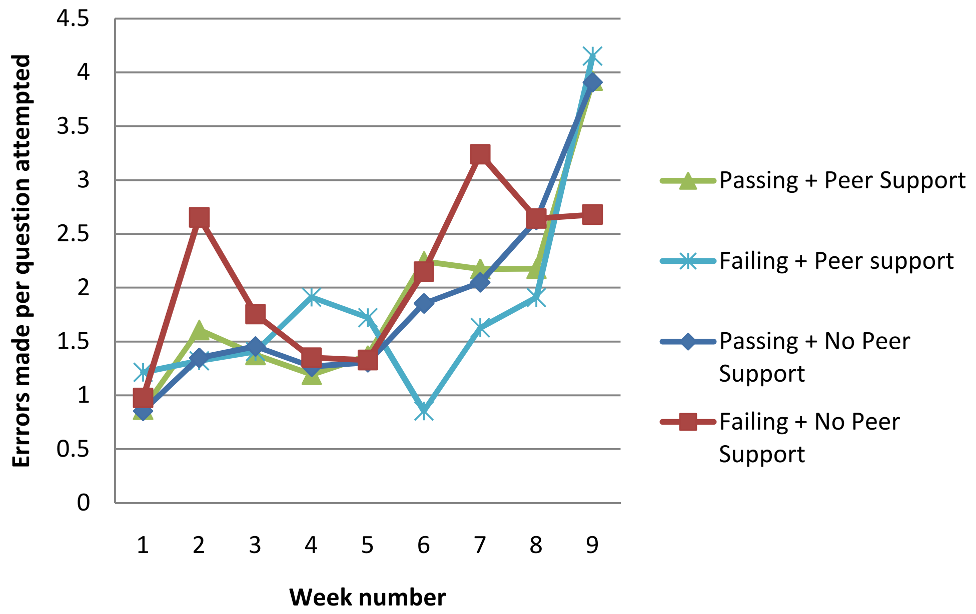

Figure 6. Average number of errors made before passing a question

2.2 Time in Tutorials and Self-Directed Study

It might be supposed that attendance time in a tutorial or practical session is proportional to the final mark received in a course, but this is not always the case. Often attendance is measures using a simple attendance register, but this misses out on late arrivals, early departures, and those who simply turn up but do not do the practical work assigned. During the tutorial attenders could be reading their email, playing games, socializing, etc. To investigate this logs were evaluated to produce “active” practical measures. In this case a student is active only if they pressed a button in the LinuxZoo site at least once every 10 minutes. There were a total of 18 hours of practical sessions per student during weeks 1 to 9. With this measure, the average student only spent 11.5 hours active in timetabled practicals, and an additional 17.1 hours outside scheduled times. This perhaps suggests that having only 1 hour per week of timetabled practical labs might be almost as effective.

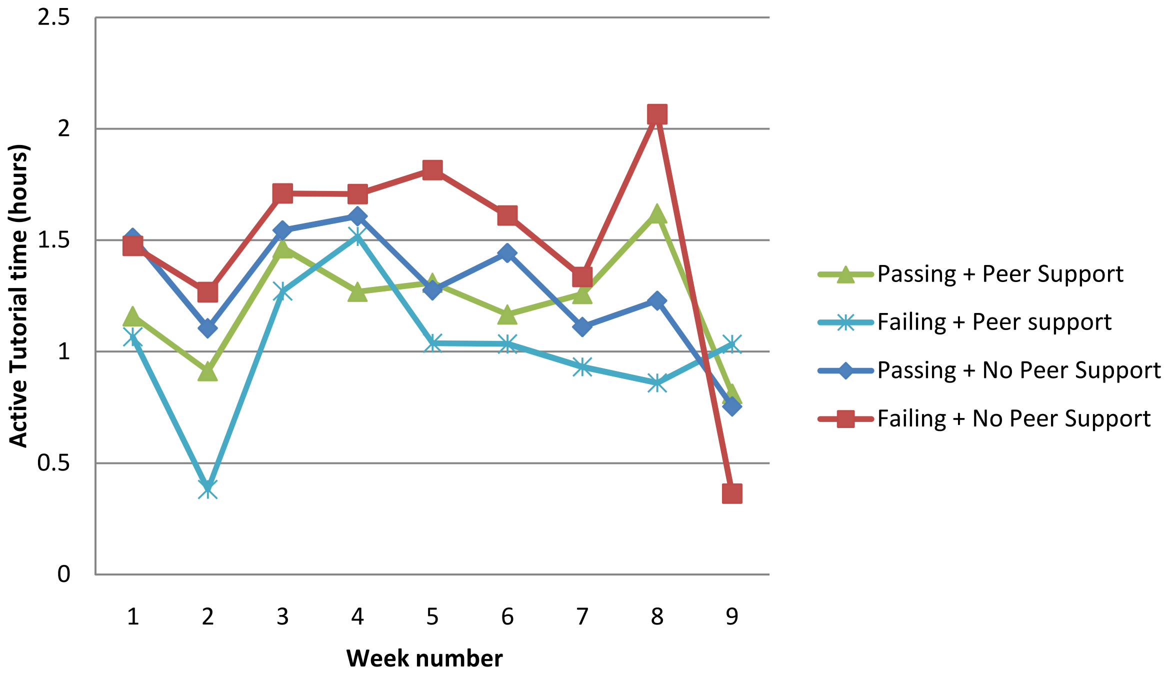

Figure 7. Active time per week in practical sessions

The same cohort groupings as before are shown in Figure 7, but this time showing active time in practicals for each group. Here is it is perhaps surprising to see that the weaker students without peers are the hardest working, whereas the weaker students with peers are the worst workers in practicals. What is particularly interesting is that weak students really have a hard push in these sessions in the final weeks, indicative of an attempt to catch up ready for the assessment in week 10. Weak students with peers almost seem lulled into a belief that everything is fine, suggestive of a peer relationship which is damaging educationally.

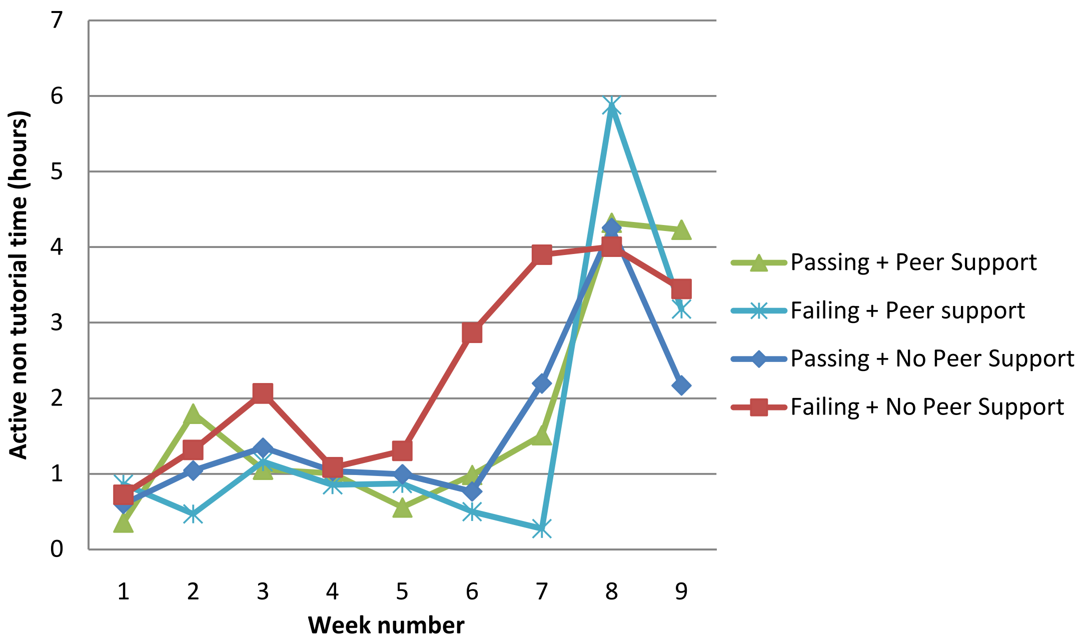

Figure 8. Active time per group outside timetabled periods

Outside the timetabled sessions things are significantly different. This is shown in Figure 8. Here the failing-and-no-peer group seem to realize that more effort is needed outside timetabled periods, and they actively put in much more time to attempt to solve the problem. In comparison the failing group with peers seem to tail off noticeably till week 7, then have a huge effort over a very short time period where they try to solve the problem. Again this seems to indicate that this particular group has a poor peer support strategy, while other groups seem similar.

One idea to improve overall performance would be to try and spread the fail-with-peer group out to be more like the fail-with-no-peer group. This would provide some weeks in which remedial events could be timetabled to help these students. One typical approach might be to introduce an earlier assessment, perhaps in week 5. However some students do not become active until week 3, so this in itself could be problematic. One strong factor which may be useful is that the fail and no peer group attend practicals and work hard, suggesting that additional events focused on those student from week 5 onwards would actually be beneficial.

4. CONCLUSION

This paper has raised a number of key issues. Firstly as educators we should not be overly concerned with attendance, whether online or physical. We have discovered no strong correlation between actual work done and final marks. Indeed, those who physically attend practical session on a regular basis may not even be working on the practical work. Statistically there were only 10 hours of productive practical time used per student during their 9 weeks of practical time, even though 80% of students attended 18 hours of practicals. However practicals may prove to be a strong mechanism in the creation of peer support relationships, and it has been shown here that peer support is much more significant in achieving a pass in a course than that achieved by good attendance. Peer support is very useful to the group who pass the course, producing measurable performance advantages over other groups. This should be encouraged. Yet peer support in the group who failed the course actually shows poorer performance and poorer educational processes than the failing group without peer support. It is this group which is particularly interesting to the authors, as it may be possible to utilize the peer relationships in a way which allows more students to achieve the learning outcomes. This could be by identifying these groups early, and taking them as a group into remedial sessions. For the future of the courses considered here a number of changes to the pedagogical approach will be implemented, and using the same analysis techniques shown in this paper it will be possible to measure quickly and comparatively the effect of these changes on each group.

REFERENCES

Michael Bostock & Jeffrey Heer. Protovis: A graphical toolkit for visualization. IEEE Trans-actions on Visualization and Computer Graphics, 15(6):1121–1128, Nov.-Dec. 2009.

Moran, L., & Myringer, B., 1999. *Flexible Learning and University Change*. In H. Keith (Ed.), Higher education through open and distance learning (pp. 57-71). London: Routledge.

Rieber, L. P., 1992. Computer-based microworlds: A bridge between constructivism and direct instruction. Educational Technology Research & Development, Vol 40, No 1, pp 93-106.

Russell, G. and Cumming, A. (2005). *Automatic Checking of SQL: Computerised Grading*. In Proceedings of the Twelfth International Conference on Learning, Granada, Spain. Published in the International Journal of Learning, Volume 12, Issue 3, pp. 127-134. ISSN 1447-9494

Russell, G. and Cumming, A. (2005b). *Online Assessment and Checking of SQL: Detecting and Preventing Plagiarism*. In 3rd Workshop on Teaching Learning and Assessment in Databases (TLAD 2005). Workshop part of 22nd British National Conference on Databases (BNCOD). Published in HEA-ICS Workshop on Teaching Learning and Assessment in Databases (TLAD05) (ed. Una O'Reilly, Richard Cooper), July 2005, Sunderland UK, LTSN-ICS, ISBN 0-9541927-8-8, page 46-50.