Introduction of E-learning Material to Engineering Students at the Vaal University of Technology: Measuring Academic Success

C. van Aardt, North-West University (Vaal Triangle Campus), Vanderbijlpark, South Africa, vanaardtc@vut.ac.za
R. Goede, North-West University (Potchefstroom Campus), Potchefstroom, South Africa, roelien.goede@nwu.ac.za
E. Taylor, North-West University (Potchefstroom Campus), Potchefstroom, South Africa, estelle.taylor@nwu.ac.za
P.D. Pretorius, North-West University (Vaal Triangle Campus), Vanderbijlpark, South Africa, philip.pretorius@nwu.ac.za
J.H. Kroeze, North-West University (Vaal Triangle Campus), Vanderbijlpark, South Africa, jan.kroeze@gmail.com

Abstract

Traditional learning and teaching methods are still an integral part of many academic institutions. Will the implementation of e-learning material as an additional resource to normal lectures have an effect on a student's academic success? Senior students enrolled for the Network Systems III module at the Vaal University of Technology (VUT) were introduced to e-learning material. A variety of different learning styles was combined to prepare the e-learning material. The activities of individual students with the e-learning material were recorded using the Moodle learner management system. An empirical assessment of the log activities of all the students who used the e-learning content was done. Quantitative data concerning Moodle logs, time spent on learning material, including test and examination results, were analysed and compared to find possible correlations.

Keywords

Learning styles, e-learning, web logs, learner activities, data analysis.

Introduction

Academic success depends on effective combinations of efficient teaching and successful learning. The main objective of learning is that the learner must understand the information in such a manner that it will be possible to retain the information for a reasonable period and reproduce information correctly. Computer systems engineering students at the Vaal University of Technology in South Africa find sections in the Networking systems module difficult to understand. In an action research project e-learning material sensitive to different learning styles were developed. This paper reports on the analysis of the success of this material that was used in a blended learning environment.

The use of the e-learning material will be monitored through a click-stream analysis, and the examination and test results will be analysed to determine whether or not the e-learning material had any effect on academic success.

Literature Review

Effective teaching, according to Kizlik (2008:1), is difficult to describe and measure. In this context, Gareis and Grant (2008:1) argue that “the act of teaching is not complete until learning has occurred”. Materna (2007:49) argues that effective combinations of learning and teaching strategies form the foundation for education. However, Tomlinson (1995:60) takes it a step further and argues that the connection between teaching, thinking and learning is critical and learners must use these resources effectively to progress towards success.

Popham *et al*. (1969:39) defined learning as a “change in behaviour and perception”. Behaviour may affect the way in which the learner reacts when new acquired knowledge is restructured into useful

information. Perception makes a substantial difference in individual learning styles and the way in which learners process information (Bonwell and Eison, 1991:1).

The intent of any cognitive learning culture is to acknowledge the processes of teaching and to identify the meaning of understanding (Engelbrecht *et al*., 1996:162). According to Gunter *et al.* (2003:4), research on learning styles has indicated that people learn differently; consequently, a learner will use the particular learning style that works best for him. Cognitive interpretation of data through the senses is encouraged through emotional interaction between the individual and the stimulation he or she receives (Gunter *et al.,* 2003:108; Power, 2008:8).

Learners become more skilled at learning as their communication skills progress between each other and with their peers (Forsyth *et al*., 1995:44; Hofer *et al*., 2007:21). Muijs and Reynolds (2005:18) and Jackson (2007:31) believe that development of the mind takes place during the course of social experiences.

When the traditional method of learning is combined with e-learning, more students will be reached and be encouraged to learn in a variety of ways (Gunter *et al.,* 2003:58; Collins *et al.,* 1997:62).

The most appropriate way to determine if multimedia instruction is effective is to analyse the student's frequency of interaction with the multimedia software and to compare that with the results obtained in tests or the examination.

The next section discusses the problem statement. The methodology used for this research with regard to data gathering, participants and the objectives of this study are discussed in the next section. The analysis and discussions of the results follows where specific attention is given in the descriptive statistics section to the examination success rate, the use of e-learning material, comparison of the time and number of sessions spent on e-learning material and an analysis of the time spent on e-learning material. The inferential statistics section describes the academic performance of students statistically. The last section concludes the paper and makes future research recommendations.

Problem Statement

This study is part of an action research methodology that will be used to analyse the usage and success of e-learning material. Students enrolled for the Network Systems III module at the Vaal University of Technology struggled with the section about subnetting in their present syllabus. Lecturers indicated that students may have a better chance to pass the module if they understand the section about subnetting.

A wide variety of preferred learning styles was identified through the analysis of a questionnaire that was sent to the students. In this questionnaire, multimedia and e-learning were identified as the most effective instrument to distribute information through the Moodle learner management system (LMS) to students via the Internet.

Firstly, this research will investigate the use of e-learning material by determining each student's number of activities on the e-learning material and analysing their examination and test results to look for any resemblance between times spent on e-learning material and academic success. Secondly, the research will look for academic improvement and higher use of e-learning material between the first semester and second semester; therefore, the same research will be repeated in the second semester.

Methodology

The quantitative data for this research were gathered from the Moodle learner management system and data about academic progress were obtained from test and examination papers. The participants were students from the VUT and will be described in the section about the participants.

Data Gathering

Moodle is an open-source learner management system that allows the classroom to extend onto the Internet. The Moodle logs allow the administrator to collect and analyse the logging activities of the students, indicating which pages were visited and in what order and the time duration of each activity. The logging activities are the results of combinations of mouse clicks, also called click streams, each user makes and are reported by combining all the data.

Participants

The participants in this study were senior students enrolled for semester 2 of 2007 and semester 1 of 2008. These students enrolled for the module Network Systems III, which forms part of the Computer Systems course at the Vaal University of Technology.

Objectives

The following objectives were addressed in this research:

- Explain the examination pass rate for groups in this research.
- Compare the time spent on e-learning material between the two groups.
- Compare the number of sessions spent on e-learning material between the two groups.
- To identify the Moodle log activities to determine the usage of the e-learning material.
- Discuss the statistical analysis of the two groups.

Results and Discussion

A quantitative approach was followed in analysing the Moodle keystrokes and the test and exam results of learners enrolled for the module Network Systems III.

Table 1's most left column indicates the semester. The next column indicates the number of students enrolled for this module for that specific semester. The third column indicates students that did not complete the module, the values in this column were split between the number of dropouts and the percentage value of their numbers. The next column explains the number of students registered for the previous semester that are repeating the module again. This column also indicates the number of students and their percentage value. The last column addresses examination and has three different categories namely: The first category address the number of students who complied with all the conditions for the module and were allowed to write the examination. The second category looks at the number of students who wrote the examination and passed. The third category shows the percentage of students who wrote the examination and passed.

Table 1 indicates that 189 students were registered for the first semester in 2007. The pass rate percentage of students who wrote the examination in this semester was 67.6%. There were definite signs of a steady increase in student examination throughput percentages from 53.9% in 2007_1 to 56.2% in 2007_2 and 59.6% in 2008_1.

The e-learning material was implemented in semester 2 of 2007 and semester 1 of 2008 during which time data was collected from the Moodle logs and from the test and examination results.

Table 1: Semester Pass Rate Comparison

Semes-ter	**Students enrolled**	**Drop-outs**		**Repeaters**		**Examination**			
		N	***%***	***N***	*%*	***Write***	***Pass***	***Pass Rate %***	***Throughput***
2007_1	189	38	20.11%	70	37%	151	102	67.60%	53.9%

2007_2	153	11	7.12%	26	17%	142	86	60.60%	56.2%
2008_1	114	40	35.09%	4	3.50 %	74	68	92%	59.6%

Descriptive Statistics

Examination Success Rate

This section discusses the number of enrolments for each of the two semesters and considers the pass rate percentage of students for the module.

Semester 2 of 2007
In this semester only 52.3% of the students used the e-learning material. Records from this semester, as shown in table 1, indicated that there were 153 students enrolled for the Network Systems III module. Of the 142 remaining students, 56 failed and 86 passed. This means that the pass rate percentage of the students who wrote the examination was 60.6%.

Semester 1 of 2008
With reference to table 1, in semester 2008_1, 114 students were enrolled for the module Network Systems III. A total of 88.6% of the enrolled students used the e-learning material. Of the 74 remaining students, 6 failed and 68 passed. This means that the pass rate percentage of students writing the examination was 91.9%.

The following section further investigates the examination performance of users, as opposed to non-users of the e-learning material.

Examination Success of Users versus Non-users

Table 2 presents information on the examination success of students who used the e-learning material compared to students who did not use it.

This information is subsequently discussed for each semester.

Semester 2 of 2007
According to table 2, the number of students not using e-learning at all was 73 (47.7%). There were 15 students who used the e-learning material for 1 session only. Time spent by those students could not be recorded for the reason explained.

Eighty students (52.3% of the total students enrolled) used the e-learning material on the Moodle LMS during this period. The percentage of students who used e-learning material and passed the examination is 69.4% (50 out of 72). The examination pass rate of users (69.4%) is substantially higher than that of non-users (51.4%)

Table 2: E-learning Material Usage and Pass Rates

	2007_2			**2008_1**		
	E-learning material			**E-learning material**		
Students	**Non-users**	**Users**	**Total**	**Non-users**	**Users**	**Total**
Total enrolled	73	80	153	13	101	114
Total to write examination	70	**72**	**142**	9	**65**	**74**

Drop-outs	3	8	11	4	36	40
Fail	34	22	56	1	5	6
Pass	36	50	86	8	60	68
% e-learning usage		72/142 = 50.7%			65/74 = 87.8%	
Pass rate percentage	36/70 = 51.4%	50/72 = 69.4%		8/9 = 88.9%	60/65 = 92.3%	

Semester 1 of 2008
During 2008_1, 101 students made use of the e-learning material, representing 88.6% of the total number of students enrolled for the module. Sixty of these passed. Thirteen students used the material for one session only.

Percentages of students enrolled, but not using the e-learning material were 47.7% in 2007_2 and 11.4% (13 out of 114) in 2008_1. Percentage of students who used the e-learning material and passed the examination is 92.3% (60 out of 65), compared to the 88.9% of non-users.

Up to this point, students were grouped into users and non-users. The following section analyses the amount of time spent on e-learning material by users and the effect thereof on their examination pass rate.

Comparison of Time Spent on E-learning Material

The time spent on e-learning content will be compared with the pass rate for each semester to find a relationship between this and pass rates. Efforts by lecturers to promote e-learning material improved the usage of it on the Moodle LMS. This in turn led to better pass rates.

Table 3: Pass Rate vs Time Spent on E-learning Material

Semester	***Enrolled students***	***Using e-learning***	***Total time spent on e-learning material***	***Average time for each student***	***Examination pass rate of users***
2007_2	153	80	33:57:01	00:25:28	69.4%
2008_1	114	101	54:37:57	00:32:27	92.3%

From table 3, there seems to be a relationship between time spent on e-learning material and examination pass rates. The average time spent by a student on e-learning material for 2008_1 was more than that for students in 2007_2. The examination pass rate for 2008_1 was considerably higher than that for 2007_2.

A time duration layout for different time slots and pass rate percentage in each time slot will be given in section 5.3 for 2007_2 and 2008_1 respectively. It should be noted that students who used the e-learning material only once could not be considered, as the duration of the final session of each student could not be computed.

Semester 2007_2
Results in table 4 indicate that pass rate percentages of students in the two time slots (30 minutes to 59 minutes and 59 minutes to 1½ hour) are both 83.3%. These two time slots also have the highest pass rate percentage for semester 2007_2.

There is a steady growth in the pass rate percentage from the lowest time slot (0-59 seconds) with a pass rate percentage of 55.5% to 77.7% in time slot (10 minutes to 30 minutes). However, the pass rate percentage in time slot (1½ hours to 3 hours) is 33.3%. The best results, according to table 4, occured between 30 minutes and 1½hours.

Table 4: Time Layout of E-learning Material Usage for 2007_2

	0-59 sec.	***60 sec – 10 min.***	***10–30 min.***	***30–59 min.***	***59 min. - 1½ hr***	***1½-3 hr***	***3–5 hr***	***5–10 hr***	***Total***
Enrolled	11	26	20	13	6	3	0	1	80
Drop-outs	2	2	2	1	0	0	0	1	8
Examina-tion	9	24	18	12	6	3	0	0	72
Pass	5	15	14	10	5	1	0	0	50
Failed	4	9	4	2	1	2	0	0	22
Pass rate %	55.5 %	62.5%	77.7 %	83.3 %	83.3%	33.3%			***69.4 %***

Semester 2008_1

Results in table 5 indicate that most of the students spent between 1 minute and 59 minutes on the e-learning material. The pass rate percentage for time slot (60 seconds to 10 minutes) is 94.4% and the pass rate percentage for time slot (10 minutes to 30 minutes) is 88.8%.

Time slot (30 minutes to 59 minutes) has a pass rate percentage of 100%, while time slot (59 minutes to 1½ hours) has the same pass rate percentage (83.3%) as the corresponding time slot in 2007_2. All students who spent more than 1½ hours on the e-learning material in 2008_1 passed the module.

Table 5: Time Layout of E-Learning Material Usage for 2008_1

	0-59 sec.	***60 sec – 10 min.***	***10–30 min.***	***30–59 min.***	***59 min. - 1½ hr***	***1½-3 hr***	***3–5 hr***	***5–10 hr***	***Total***
Enrolled	8	29	32	16	7	6	2	1	101
Drop-outs	5	11	14	4	1	1	0	0	36
Examina-tion	3	18	18	12	6	5	2	1	65
Pass	2	17	16	12	5	5	2	1	60
Failed	1	1	2	0	1	0	0	0	5
Pass rate %	66.6 %	94.4%	88.8 %	100%	83.3%	100%	100%	100%	***92.3 %***

The following section analyses the number of sessions spent on e-learning material by users and the effect thereof on their pass rate percentage.

Comparison of Sessions Spent on E-Learning Material

The number of sessions spent on e-learning content will be compared with the pass rate for each semester to find a relationship between them. Efforts by lecturers to promote e-learning material improved the usage of it on the Moodle LMS, which in turn leads to better pass rates.

Table 6: Pass Rate versus Sessions Spent on E-learning Material

Semester	***Enrolled students***	***Using e-learning***	***Total sessions spent on e-learning material***	***Average sessions for each student***	***Examination pass rate of users***
2007_2	153	80	212	2.65	69.4%
2008_1	114	101	421	4.17	92.3%

From table 6, there seems to be a relationship between the number of sessions spent on e-learning material and examination pass rates. The average number of sessions spent by a student on e-learning material for 2008_1 was more than that for students in 2007_2. The examination pass rate for 2008_1 was considerably higher than that for 2007_2.

A session layout for different sessions and the pass rate percentage of students in each session slot will be given in section 5.4 for 2007_2 and 2008_1 respectively.

Semester 2007_2
Results in table 7 indicate that there is a steady growth in pass rate percentage from 63.6% of students who spent 1-2 sessions on the e-learning material to a 100% pass rate percentage of students who spent 7-10 sessions on the e-learning material. Table 7 indicates that students who spent more sessions on the e-learning material have a better pass rate percentage.

Table 7: Session Layout of E-learning Material Usage for 2007_2

	1-2	***3-4***	***5-6***	***7-8***	***9-10***	***11-12***	***13-14***	***15-16***	***Total***
Enrolled	50	17	8	3	2	0	0	0	80
Drop-outs	6	2	0	0	0	0	0	0	8
Examination	44	15	8	3	2	0	0	0	72
Pass	28	10	7	3	2	0	0	0	50
Failed	16	5	1	0	0	0	0	0	22
Pass rate %	63.6%	66.6 %	87.5%	100%	100%				***69.4 %***

Semester 2008_1
There is a clear indication in table 8 that better results are obtained when more sessions are spent on the e-learning material.

One student, who spent between 13 and 14 sessions on the e-learning material failed the module. It is not clear why. It is also interesting to note that students who hardly viewed the material (session 1-2) passed the examination. It is worthwhile to note that the material can be printed, and these students may have printed it during their first session.

Table 8: Session Layout of E-learning Material Usage for 2008_1

	1-2	***3-4***	***5-6***	***7-8***	***9-10***	***11-12***	***13-14***	***15-16***	***Total***
Enrolled	34	26	24	11	3	1	1	1	101
Drop-outs	14	9	9	3	1	0	0	0	36
Examina-tion	20	17	15	8	2	1	1	1	65
Pass	17	16	15	8	2	1	0	1	60
Failed	3	1	0	0	0	0	1	0	5
Pass rate %	85%	94.1%	100%	100%	100%	100%	0%	100%	***92.3 %***

Conclusions for the Descriptive Statistics Section

With regard to the examination success rate, it may be concluded that when e-learning material was used in a blended e-learning environment, the pass rate of students who were allowed to write the examination, accelerated from 67.6% in semester 2007_1 to 91.9% in semester 2008_1. These results

are encouraging, although further research must be focused on the relatively high drop-out number for this module.

The usage of e-learning material content increased immensely from 52.3% in semester 2007_2 to 88.6% in semester 2008_1. The pass rate of students permitted to write the examination in 2007_2 was also notably higher. It appears as if the increased usage of e-learning material had a positive impact on the students' results. The pass rate percentage of e-learners increased from 69.4% in semester 2007_2 to 92.3% in semester 2008_1, an increase of 22.9% (92.3% - 69.4%) between the two semesters.

With regard to the time spent on e-learning material, it may be concluded that, when comparing the two semesters (2007_2 and 2008_1), there is a relationship between time spent on e-learning material and the pass rate percentage.

With regard to the number of sessions spent on e-learning material, it may be concluded that there is a relationship between the number of sessions spent on e-learning material and the pass rate percentage, when comparing the two semesters (2007_2 and 2008_1). The pass rate compared to the number of sessions spent on e-learning material may be a result of students studying harder, or the fact that they found e-learning material helpful. It is clear that the pass rate percentage improved when more than four sessions were spent on e-learning content.

The issue of causality should be investigated to determine whether students did better because they used the e-learning material, or whether other factors were involved? One might argue in favour of the e-learning material in as far as the availability of the e-learning material and the motivation from the lecturers to use it. Although the relationship between usage and pass rate is somewhat unexpected, it is worth noting that the material can be printed.

The analysis of the data in the next section is conducted statistically using the Pearson correlation and t-tests on the data.

Inferential Statistics

Statistical Analysis of Time Spent on E-learning Material

Professor H.S. Steyn from the statistical consultation service of the North-West University in Potchefstroom assisted with the analysis of the data for this section. Firstly, an explanation of the most important terms used for this analysis will be given in the next section, followed by an explanation of the different variables used.

Discussion of Statistical Terms

This section provides short explanations of the statistical terms used in this study.

The term *mean of n numbers* is the sum of the values divided by *n* (Yang and Miller, 2007:378).

When there are two variables, for example, time taken to study and result obtained in the examination, *correlation* means the relationship between these two values (Urdan, 2005:75). A positive correlation means that the more a person studies, the higher the results will be and both variables move in the same direction. A negative correlation means that the more a person studies, the lower the results will be and the two variables will move in opposite directions. According to Urdan (2005:79), the *Pearson correlation coefficient* is powerful in that it allows a researcher to determine whether the values of one variable can be linearly related to values of another variable.

Urdan (2005:90) explained that the t-test is used to compare two groups with one another with regard to the means of two matched, or paired samples, in order to determine whether the two groups, as used in this study, are statistically significant or not. The term *meaningful* means that the result of a

statistical calculation has a significant value and meaning for the researcher (Gravetter and Wallnau, 2008:249).

According to Altman (1991:168) and Freund (1993:33), the probability value, denoted by the symbol *p,* shows the probability that something will occur. In the context of the statistical hypothesis testing to be used, p is the probability of wrongly rejecting the null-hypothesis of no difference in means or no correlation. When *p* is below 0.05, the result is "statistically significant". When it is lower than 0.01, it is "highly significant", but if *p* is higher than 0.05, it is "not significant".

Description of Data and Variables in this Section

Students doing the Network Systems III module at the VUT undergo formative and summative evaluation. In the formative evaluation, students write various tests to improve their understanding of the module content in smaller sections. For summative evaluation at the end of the semester, students' knowledge of the total learning content is tested.

Every question in the evaluations can be associated with a specific section of the module content. Thus, one is able to analyse the marks obtained by students according to specific content of the module. Lecturers kept track of specific marks obtained by each student for every question of each formative evaluation, as well as for the final examination.

In 2007_2 and 2008_1, two of the tests written during the semester addressed amongst others, subnet masking. For the purpose of this study, they are referred to as test 1 and test 2. There are three sets of marks for 2007_2 and three sets of marks for 2008_1, comprising two marks for tests and one mark for the examination. Evaluations are divided into two marks, the first being the mark for questions addressing subnet masking and the second mark for the complete evaluation.
The following variables are used in the statistical analysis of the data:

- Q1 is the mark obtained for the question about sub-netting in test 1
- T1 is the total mark obtained for test 1
- Q2 is the mark obtained for the question about sub-netting in test 2
- T2 is the total mark obtained for test 2
- QE is the mark obtained for the examination question about sub-netting
- E is the total mark obtained in the examination
- N is the number of sessions for e-learning

The results of the analysis is presented firstly for 2007_2 and then again for 2008_2.

Correlation between Usage and Student Performance for 2007_2

The aim of this section is to use a Pearson correlation test to determine if there is a meaningful correlation between the usage of the e-learning material and the student's performance. The results of this analysis are presented in table 9. Usage is studied in terms of number of sessions, as well as minutes spent using the e-learning material.

Table 9: Pearson Correlations 2007_2

	All users		**E-learning users**	
	Correlations N=142 (Casewise deletion of missing data)		***Correlations) N=72 (Casewise deletion of missing data) Include condition: Users=1***	
Variables	***Time (minutes)***	***Sessions (N)***	***Time (minutes)***	***Sessions (N)***
Q1	.0078 p=.927	-.0112 p=.895	-.0005 p=.997	-.0450 p=.707
T1	.0134 p=.874	.0427 p=.614	-.0164 p=.891	.0150 p=.900
Q2	.0085	.0952	-.1145	-.0110

	p=.920	p=.260	p=.338	p=.927
T2	-.0290 p=.697	***.1770**** **p=.035**	-.217 p=.066	.0501 p=.676
QE	***.3629**** ***p=.000***	***.3297**** ***p=.000***	***.2801**** **p=.017**	.0936 p=.434
E	.1024 p=.218	***.2710**** **p=.001**	-.0604 p=.614	.1339 p=.262

****correlations are significant at p < .05***

For all the students the only meaningful correlations ($p < .05$), according to the results in table 9 are between:

- The mark obtained for the specific examination question on work related to the content of e-learning material (QE) and time spent on the e-learning material, (0.3629, p<.001).
- The mark obtained for the examination question on work related to the content of the e-learning material and the number of sessions spent on e-learning material (0.3297, p<.001).
- The mark obtained for the total examination (E) and the number of sessions (N) spent on the e-learning material (0.2710, p=.001).
- The mark obtained for the total mark in test two (T2) and the number of sessions (N) spent on the e-learning material (0.1770, p=.035)

It may be concluded that the time spent on e-learning material and the number of sessions spent on e-learning material had a significant positive influence on the student's examination and test two results.

For users of the e-learning material the only meaningful correlation ($p < .05$), according to the results in table 9 is between:

- The mark obtained for the specific examination question on work related to the content of e-learning material (QE in section 5.5) and time spent on the e-learning material (0.2801, p=.017).

It may be concluded, in this case as well, that for the users of the e-learning material, time spent on e-learning material had a significant positive influence on their examination results with regard to work covered by the e-learning material.

Statistical Analysis of Users versus Non-users in 2007_2

The aim of this section is to determine whether users of the e-learning material performed better in the tests and examination than non-users of the e-learning material. In order to do this, the t-tests were used. Results of this analysis for 2007_2 are presented in table 10.

Non-users are represented by columns with a 0 in the column heading, while users are represented by columns with a 1 in the heading. For example, the denotation *mean 0* is the average mark of students not using the e-learning material and *mean 1* is the average mark of students using the e-learning material.

In table 10, the first column of the t-test contains the variables discussed in the section about description of data and variables. The second column (*Valid N 0*) is the number of participants in group 0. The third column (*Valid N 1*) is the number of participants in group 1. In column four, the *Mean 0* is the mean value of group 0. Column five indicates *Mean 1* as the mean value for group 1. Column six shows the *Std.Dev 0,* which is the standard deviation from the mean of group 0. In column seven, Std.Dev 1 is the standard deviation from the mean of group 1. Column eight shows the p value of each variable.

Table 10: Student T-test for Unequal Variance 2007_2

Variables	*T-tests; Group 1: non-users Group 2: users*						
	Valid N 0	***Valid N 1***	***Mean 0***	***Mean 1***	***Std. Dev 0***	***Std. Dev 1***	***p***
Q1	73	80	55.43275	56.88920	36.79145	36.01646	0.805023
T1	73	80	52.35616	54.46250	15.23690	15.80594	0.403602
Q2	***73***	***80***	***73.39145***	***82.20013***	***30.32890***	***22.40649***	***0.041593***
T2	***73***	***80***	***63.94099***	***72.80288***	***21.20892***	***20.91842***	***0.010247***
QE	***70***	***72***	***47.82609***	***65.06410***	***19.15465***	***20.89495***	***0.000001***
E	***70***	***72***	***44.50000***	***52.77778***	***13.20600***	***13.84239***	***0.000377***

Mean 0 for the related question in test 2 is 73, while for the same question, *mean 1* is 82. The value of p is 0.04, which shows a very good correlation. The *mean 0* value for the second test (T2, all questions) is 63 and the *mean 1* value is 72 with a p value of 0.01. The *mean 0* value for the related question in the examination is 47 and the *mean 1* for the same question is 65 with a p value smaller than 0.01. The *mean 0* value for the total examination (E, all questions) is 44 and the *mean 1* value is 52 with a p value smaller than 0.01.

From table 10, it can be seen that students who used the e-learning material did significantly better in the question in the second test and overall results for the second test, as well as the examination question and total results for the examination than those not using the e-learning material.

Correlation between Usage and Student Performance for 2008_1

The aim of this section is to determine through a Pearson correlation test whether all the students who were allowed to participate in the examination performed better than non-users of the e-learning material. Results of this analysis for 2008_1 are presented in table 11.

Table 11: Pearson Correlations 2008_1

	All users		**E-learning users**	
	Correlations) N=74 (Casewise deletion of missing data)		***Correlations N=65 (Casewise deletion of missing data)***	
Variables	***Time (minutes)***	***Sessions (N)***	***Time (minutes)***	***Sessions (N)***
Q1	.1472 p=.211	.1433 p=.223	.1317 p=.296	.0957 p=.448
T1	.1046 p=.375	.1143 p=.332	.0802 p=.525	.0469 p=.710
Q2	-.0600 p=.612	.0498 p=.673	-.0795 p=.529	.0168 p=.894
T2	-.0348 p=.768	.1678 p=.153	-.0508 p=.688	.1508 p=.231
QE	.1019 p=.388	.0478 p=.686	.0674 p=.594	-.0586 p=.643
E	-.1081 p=.359	-.1238 p=.293	-.1245 p=.323	-.1662 p=.186

Table 11 shows no meaningful correlations between the number of sessions or time spent on e-learning and marks obtained for test questions and the examination question (Q1, Q2 and QE) and the tests marks and examination mark in total (T1, T2 and E). The results were the same for all the users and the users of the e-learning material. This result differs from the results in 2007_2.

Statistical Analysis of Users versus Non-users in 2008_1

In 2008, unlike 2007, comparing results of the group using the e-learning material to those not using it, revealed no significant difference in marks obtained for the tests and examination (table 12). This may be attributed to the fact that there was a much higher usage of e-learning material, resulting in a very small group (11.4%) not using it.
Table 12 has the same column layout as explained in table 10.

Table 12: Student T-test for Unequal Variance 2008_1

	T-tests; Grouping: Group 1: Non-users Group 2: Users						
Variable	Valid N 0	Valid N 1	Mean 0	Mean 1	Std. Dev 0	Std. Dev 1	p
Q1	13	101	56.04396	57.79349	40.28028	42.43195	0.888378
T1	13	101	54.77855	52.71527	25.41247	26.14795	0.788737
Q2	13	101	67.38462	70.12286	27.63934	27.03769	0.768053
T2	13	101	5.11111	11.54137	16.50019	16.05310	0.786422
QE	9	65	50.82540	67.90350	29.87404	25.50145	0.069126
E	9	65	58.11111	59.38462	10.25237	11.00950	0.744120

Conclusion of Statistical Analysis of Time Spent on E-Learning Material

In the inferential statistical section, seven variables were analysed to find possible statistical correlations among them. Two very significant correlations were found in 2007_2, firstly between time spent on using the e-learning material and the examination question on subnet masking, and secondly, sessions on the e-learning material and the examination question on subnet masking. Both correlations showed a high significance with $p < .001$ (table 9).

The t-test for unequal variance in semester 2 of 2007 (table 10) indicated that students using the e-learning material obtained a better result for questions in the examination on subnet masking than those not using it.

The Pearson results for 2008_1 indicated that there was no meaningful correlation between the examination question on subnet masking and time spent on e-learning material (table 11). There were also no correlations found in the t-test for 2008_1.

Conclusion and Recommendations

The aim was to determine the success of e-learning material on subnet masking.

In 2008_1, 88.6% of the students used the e-learning material. There was however, no correlation between the usage of the e-learning material and the performance of students according to the t-tests or Pearson correlation. The pass rate of students using the e-learning material was 92.3%. These results are encouraging when interpreting the success of e-learning material.
A few observations should be made to qualify the apparent success of the e-learning material:

- Subnet masking is only a small part of the module content and although 92.3% of users of the e-learning material passed in 2008_1, they must have performed well in the other sections as well.
- Students using the e-learning material were encouraged to spent more time on the module than they would have done, had the e-learning material not been available.
- The e-learning material was printable, but the number of hours spent on reading printouts off-line is unknown.

In 2007_2, there was a correlation between time spent and number of sessions on e-learning material for the two groups (users and non-users). It was possible to determine the correlation between them, as there was more or less the same number of students in each group (70 and 72).

In 2008_1, the same tests as in 2007_2 were conducted but there was, however, no meaningful correlation between the two groups, as in this case, the non-user group was very small. It may be argued that the 2008_1 group was academically stronger than that of 2007_2, but it is also clear that the number of students who left the module (drop-outs) was higher in 2008_1 than in 2007_2. With this in mind it cannot convincingly be declared that the 2008_1 group was academically stronger than the 2007_2 group.
It may be concluded that the e-learning material did have a positive influence on the academic success of the Network Systems III module students.

Future research that may arise from this study:

- Improve methods to be able to calculate total time spent on e-learning material.
- Create shorter but more lessons with less lecturing contact time and synchronise the e-learning material with the class lecturing topic.
- Establish more interaction between the lecturer and students through discussion forums.
- Expand e-learning to include other modules.

Acknowledgements

This article is an extract of the first author's dissertation, "An investigation of the usage and success of blended e-learning material for computer networking students", supervised by Dr. R. Goede and co-supervised by Dr. E. Taylor.

References

Altman, D. G. (1991), Practical statistics for medical research, *Texts in Statistical Science Series*, CRC Press, London.

Bonwell, C. C. and Eison, J. A. (1991), 'Active learning: creating excitement in the classroom'. [Online], [Retrieved December 13, 2008], http://eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/23/6e/bd.pdf

Collins, J., Hammond, M. and Wellington, J. (1997), Teaching and learning with multimedia, Routledge, London.

Engelbrecht, P., Kriegler, S. and Booysen, M. (1996), Perspectives on learning difficulties: International concerns and South African realities, Van Schaiks, Pretoria.

Forsyth, I., Joliffe, A. and Stevens, D. (1995), Evaluating a course practical strategies for teachers, lecturers and trainers, Kogan Page, London.

Freund, J.E. (1993), Introduction to probability, *Dover Books on Advanced Mathematics,* Courier Dover Publications, Mineola, NY.

Gareis, C. and Grant, L. (2008), Teacher-made assessments: How to connect curriculum, instruction, and student learning, Eye on Education, New York.

Gravetter, F. J. and Wallnau, L.B. (2008), Statistics for the bahavioral sciences, 8th ed, Cengage Learning, Florence, KY.

Gunter, M.A., Estes, T.H. and Schwab, J. (2003), Instruction a models approach, 4th ed, Allyn and Bacon, Boston, Mass.

Hofer, M., Schmid, S., Fries, S., Dietz, F., Clausen, M. and Reinders, H. (2007), 'Individual values, motivational conflicts and learning for school', *Learning and Instruction*, 17, 17-28.

Jackson, J.F.L. (2007), Strengthening the American educational pipeline: Informing research, policy and practice, *G-Reference, Information and Interdisciplinary Subjects Series*, SUNY Press, New York.

Kizlik, B. (2008), 'Online education for teachers: advance your career,' [Online], [Retrieved December 9, 2008], http://www.adprima.com/distanted.htm

Materna, L. (2007), Jump start the adult learner: how to engage and motivate adults using brain-compatible strategies, Corwin Press, US.

Muijs, D. and Reynolds, D. (2005), Effective teaching, evidence and practice, 2nd ed, Sage, London.

Popham, W.J., Eisner, E., Sullivan, H. and Tyler, L. (1969), Instructional objectives, Rand McNally, Chicago.

Power, F.C. (2008), Moral education: M-Z, Greenwood, Abington.
Tomlinson, C.A. (1995), How to differentiate instruction in mixed-ability classrooms, ASCD, Alexandria, Va.

Urdan, T.C. (2005), Statistics in plain English, 2nd ed, Routledge, NY.

Yang, K. and Miller, G. (2007), Handbook of research methods in public administration, *Volume 134 of Public Administration and Public Policy,* 2nd ed, CRC Press, Boca Raton, FL.