National University of Samoa
Faculty of Science/Institute of Higher Education (Computing Department)

Research Report on Study on Factors that impact/influence failure rate in HCS081 Course

by
Edna Temese, Elisapeta Mauai, Foilagi Maua-Faamau

Abstract:

This research was conducted to determine what factors contribute to the success and failure of students in the Foundation Computer studies (HCS081) course at the National University of Samoa. The model included cohort, PSSC Computer studies, PSSC Maths, PSSC English, secondary school attended and gender as possible predictive factors for success in the Foundation computer studies course. Data used were: student performance in Year 13 (last year of secondary school in Samoa) Mathematics, Computer Studies, and English, students' PSSC aggregate and attended, for the years 2002 to 2006 and Foundation Computer studies (HCS081) results, program enrolled within the Foundation year, and gender for the years 2003 to 2007. The study revealed PSSC Maths, PSSC English, PSSC Computing as strong predictive factors for Foundation Computer studies. There were significant differences in performance in Foundation Computer studies from program to program. There were no gender effects for Foundation Computer studies. However there were gender effects for PSSC English where female students outperformed the males. The study also revealed significant variations in performance in Foundation Computer studies and PSSC Maths between cohorts.

INTRODUCTION:

Programs in the area of Computing have become increasingly popular in the National University of Samoa (NUS). In the last 5 years, the Computing department has experienced increased student enrolments particularly in Foundation Computing (HCS081). For example, HCS081 in the year 2007, there were 219 students enrolled in the first semester and 359 enrolled in the second semester. This increase has now created some major concerns among the department which now need to be addressed. Hence our research will focus on the factors which contribute to these concerns. For this study the research team consisted of three lecturers currently within the Computing Department at the National University of Samoa (NUS).

HCS081 is a course offered by the Computing Department for all students enrolled in the Foundation Certificate Program. Prior to 2004, this course was only offered in the 3 Faculties – Science, Arts and Commerce when the program was then called – University Preparatory Year (UPY).

The year 2004 saw the change of program name to Foundation Certificate and the inclusion of the Faculties of Education and Nursing into the program. This change also implied that HCS081 could now be offered to foundation students in all faculties.

Up until present, the department has witnessed a remarkable increase in enrolment numbers every year. And with these developments, the department is now faced with several challenges. One such challenge is to provide sufficient resources to cater for the increasing student enrolments. Another concern is to determine what factors contribute to success or failure in foundation computer studies and impact on student performance. It is hoped that the outcomes of this research will provide information about the factors contributing to the increase in failure rate in HCS081 and how these can be addressed leading to an improvement in student performance as well as improving our course offering.

The main objective of this research was to investigate the factors which contribute to the success and failure of students in HCS081 Course. Hence the research question is as follows:

"What are the factors that contribute to the success and failure of students in HCS081 Course?"

Hypotheses:

From the research question, a set of hypotheses was generated. The set of hypotheses correspond to the factors or variables investigated, in terms of their contribution to student success or failure in Foundation Computer Studies (HCS081). The factors which were investigated from the year 2003 to 2007 are:

1. students prior mathematical ability(Year 13)
2. students prior English language ability (Year 13)
3. students prior computer studies ability (Year 13)
4. students PSSC aggregate – English and best 3 subjects (Year 13)
5. student data on HCS081 such as
    a. final mark
    b. year and semester of enrollment
    c. gender

Hypothesis 1: Student prior mathematical ability (PSSC Maths) has a correlation with student performance in Foundation Computer Studies

Hypothesis 2: Student prior English language ability (PSSC English) has a correlation with student performance in Foundation Computer Studies

Hypothesis 3: Student prior computer studies experience (PSSC Computing) has a correlation with student performance in Foundation Computer Studies

Hypothesis 4: There is a correlation between the program a student enrolls in within the Foundation program at NUS (i.e., Arts, Science, Commerce, Nursing, and Education) and student performance in Foundation Computer Studies (HCS081)

Hypothesis 5: Student gender (HCS081) has a correlation with the performance in Foundation Computer Studies

Literature Review:

An interest in factors which could predict success in a CSI (1st year Computer Studies) course became prominent recently due to the rapid growth in popularity of first year programming courses, the varying level of student ability, and the consequent demand placed on faculty resources (Leeper and Silver 1982; Barker and Unger 1983; Chowdhury et al. 1987). Previously, research interest had largely been focused on occupational aptitude tests, the selection and evaluation of personnel most likely to have a successful and fulfilling career in the new computing industry (Mayer et al. 1968; Cross 1970; Wolfe 1971).

Most studies on predicting achievement in the computing classes include Mathematics and English background and previous academic performance as "core" variables for deliberation. Cognitive factors, personality types, and learning styles are also given attention; for example, Piaget's intellectual development levels (Barker et al. 1983; Werth 1986), the Myers-Briggs personality type indicators (Bishop-Clark et al. 1994), and Kolb's learning style inventory (Goold and Rimmer 2000). However, despite the attention given to this topic, a reliable means of predicting the success of students who enter an introductory programming course remains elusive. There are several factors that make it hard to predict performance, including the sheer number of students who have a wide variety of background skills, differences in levels of motivation, and different expectations of the HCS081 course. There is also a relative lack of a Computing curriculum at high school level and often a negative student reaction toward the math content of programming courses (Rountree et al. 2004). What makes students succeed (or not) has been of particular interest in large classes with unrestricted entry, as well as programs where previous qualifications are used to determine entry (Gal-Ezer et al. 2003; Boyle et al. 2002).

The most extensive of recent studies predicting success was undertaken by Wilson and Shrock (2001) who developed a model of 12 possible factors including standard variables such as math background and previous programming experience, as well as students' self assessment. Two self assessment factors of particular insight were "comfort level" (questions designed to rate a student's perception of course/programming difficulty and level of anxiety) and "attributions" (questions designed to identify students' belief about their reasons for success or failure—these were ability, ease of task, luck, and effort). Results from this study identified comfort level and math background as having a positive association with success, and student attribution to luck as a negative influence.

This study has been conducted in the University of Otago but none had attempted this particular study on Samoan students. Therefore the purpose of this research is to conduct similar research on students who are studying Foundation Computing at the National University of Samoa.

Methodology:

The study was quantitative in nature. At the outset of the study, letters of consent were sent to obtain approval from the Ministry of Education and the National University for the use of student data for the study. Data on student performance in Year 13 Mathematics, Computer Studies, and English, students' PSSC aggregate and school attended, for the years 2002 to 2006 were obtained from the Ministry of Education. Data on Foundation Computer studies (HCS081) results, program enrolled within the Foundation year, and gender (2003-2007) were collected from the NUS Administration Office. These results were then used to compile both PSSC and HCS081 data for those students who took HCS081 between the years 2003 to 2007.
The data collected then was as follows:

- Year 13 or PSSC Mathematics, Computer Studies, and English, and attended, PSSC aggregate (2002-2006).
- HCS081 results and program enrolled within the Foundation year (2003-2007).

This compiled set of data was then used for data analysis. From the compilation above, the size of the sample collected for each variable are shown in the table below.

Table 1 Descriptive Statistics on Research variables

	Mean	Std. Deviation	N
cohort	4.70	2.198	1569
Final Mark HCS081	54.95	24.760	1569
PSSC English	3.37	1.510	1437
PSSC Maths	3.96	1.782	1199
PSSC Computing	3.28	1.372	518
Secondary school attended	409.80	12.537	1438
gendercode	.61	.488	1569

The sample of 1569 for HCS081 contained student data for students enrolled in HCS081 from 2003 – 2007 from which repeating students and those students who had withdrawn from the course and had no final mark, had been removed to avoid possible spurious effects on the data. The variations in sample size from subject to subject were due to PSSC Maths and PSSC Computing being both electives whereas PSSC English is a compulsory subject.

Assumptions

In any research there are many assumptions that must be made. The project assumed that the Foundation Computer studies mark is a reasonable indicator of Computer studies performance at Foundation level. It also assumed that the PSSC grades for Mathematic, English and Computer studies are reasonable indicators of previous or prior ability in these subjects.

Analysis:

As indicated earlier, the main objective of this research was to investigate the factors which contribute to the success and failure of students in the Foundation Computer studies (HCS081) Course. Hence for this study the dependent variable is the Final markHCS081 which is the final mark for Foundation Computer studies and is a continuous variable from 0 to 100. The independent or predictor variables were:

- Cohort an ordinal variable defined by the year and semester student was enrolled in within the NUS Foundation Computer studies.
- Program a string variable which represents the Foundation program the student was enrolled in, and has the following values:
- PSSC Mathematic: a scale variable from 1(highest) to 9(lowest) which represents the PSSC Mathematic grade
- PSSC English: scale variable from 1(highest) to 9(lowest) which represents the PSSC English grade
- PSSC Computer studies: scale variable from 1(highest) to 9(lowest) which represents the PSSC Computer studies grade
- School: an ordinal variable which codes represents what school the student attended in Year 13 or PSSC level.
- Gendercode: a variable which is coded with two values: 1 for female and 0 for male.

Analyses were carried out using SPSS statistical software. For descriptive analyses graphs of the various results were plotted and means, standard deviations, variance calculated. For inferential statistical analyses, regression analyses and a correlation matix was generated. Seven predictor variables were originally chosen for regression analyses. However, since PSSC aggregate is an aggregate which contains English and possibly the other two subjects, it was decided to leave this out of the analyses to avoid multi-collinearity. All analyses used an alpha level of .05 to determine significance.

A residual plot was generated from the data confirming the multi-linear model. A correlation matrix using Pearsons correlation was generated to examine how each of the 6 factors correlated with the Final mark for Foundation Computer studies HCS081 and with each of the other predictor variables.

For regression analyses, the General Linear model was used using 5 predictor variables and 1dependent variable. By examining the R^2 and its p-value of the full-model regression equation, the proportion of variance in the Final mark for Foundation Computer studies (HCS081) accounted for by the 5 predictor variables was determined.

Results

The results of the study is categorized and presented according to the set of 5 hypotheses the study sets out to confirm.

Hypothesis 1: Student prior mathematical ability (PSSC Maths) has a correlation with student performance in Foundation Computer Studies

Hypothesis 2: Student prior English language ability (PSSC English) has a correlation with student performance in Foundation Computer Studies

Hypothesis 3: Student prior computer studies experience (PSSC Computing) has a correlation with student performance in Foundation Computer Studies

For the first three hypotheses, the correlation matrix indicated strong correlation between Foundation Computer studies mark and PSSC English, PSSC Maths and PSSC Computing with significance at $p = 0.0$ for all 3 predictors. However there were differences in Pearsons r within subjects and between subjects when case-wise analyses and when complete or list-wise analyses was performed (refer to Table 2 and Table 3). Case-wise analyses indicated PSSC English (-.424) had a stronger correlation with Foundation Computer Studies than PSSC Maths (-.420) and PSSC Computing (-.382). However listwise or complete analyses, indicated that PSSC Maths (-.467) had a stronger correlation with Foundation Computer Studies than PSSC English (-.393) and PSSC Computing (-.357).
The negative correlation for these 4 predictors is due to the fact that the PSSC scale is from 1 to 9 with 1 being the highest.

Table 2. Correlation Matrix of Predictor and Dependent Variables using Casewise analyses

		cohort	Final Mark HCS081	PSSC English	PSSC Maths	PSSC Computing	gendercode
cohort	Pearson Correlation	1	-.051(*)	.010	.076(**)	-.031	-.050(*)
	Sig. (2-tailed)		.043	.710	.008	.484	.048
	N	1569	1569	1437	1199	518	1569
Final Mark HCS081	Pearson Correlation	-.051(*)	1	-.424(**)	-.420(**)	-.382(**)	-.033
	Sig. (2-tailed)	.043		.000	.000	.000	.186
	N	1569	1569	1437	1199	518	1569
PSSC English	Pearson Correlation	.010	-.424(**)	1	.276(**)	.369(**)	-.078(**)
	Sig. (2-tailed)	.710	.000		.000	.000	.003
	N	1437	1437	1437	1199	518	1437
PSSC Maths	Pearson Correlation	.076(**)	-.420(**)	.276(**)	1	.298(**)	.054
	Sig. (2-tailed)	.008	.000	.000		.000	.063
	N	1199	1199	1199	1199	400	1199
PSSC Computing	Pearson Correlation	-.031	-.382(**)	.369(**)	.298(**)	1	.015
	Sig. (2-tailed)	.484	.000	.000	.000		.729
	N	518	518	518	400	518	518
gendercode	Pearson Correlation	-.050(*)	-.033	-.078(**)	.054	.015	1
	Sig. (2-tailed)	.048	.186	.003	.063	.729	
	N	1569	1569	1437	1199	518	1569

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Correlation Matrix of Predictor and Dependent Variables using Listwise analyses

		cohort	Final Mark HCS081	PSSC English	PSSC Maths	PSSC Computing	gendercode
cohort	Pearson Correlation	1	-.149(**)	-.018	.123(*)	.005	-.064
	Sig. (2-tailed)		.003	.720	.014	.913	.203
Final Mark HCS081	Pearson Correlation	-.149(**)	1	-.393(**)	-.467(**)	-.354(**)	.049
	Sig. (2-tailed)	.003		.000	.000	.000	.327
PSSC English	Pearson Correlation	-.018	-.393(**)	1	.306(**)	.379(**)	-.118(*)
	Sig. (2-tailed)	.720	.000		.000	.000	.018
PSSC Maths	Pearson Correlation	.123(*)	-.467(**)	.306(**)	1	.298(**)	-.023
	Sig. (2-tailed)	.014	.000	.000		.000	.644
PSSC Computing	Pearson Correlation	.005	-.354(**)	.379(**)	.298(**)	1	-.018
	Sig. (2-tailed)	.913	.000	.000	.000		.725
gendercode	Pearson Correlation	-.064	.049	-.118(*)	-.023	-.018	1
	Sig. (2-tailed)	.203	.327	.018	.644	.725	

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Listwise N=400

When stepwise multiple regression was applied, these 3 factors showed significant influence on the dependent variable in the 5 factor model: PSSC Maths, PSSC English and PSSC Computing.

The proportion of variance in the Final mark score for Foundation Computer Studies accounted for by the linear combination of the 5 predictor variables was approximately .33, R^2 .311 which was statistically significant, F(59.62,3) p = .000. This also inidcated that the three predictor variables contributed a significant difference in the final mark at the .01 level.

Table 4. Model Summary for Stepwise Regression using Listwise Regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.467(a)	.218	.216	18.818	.218	111.041	1	398	.000
2	.536(b)	.287	.283	17.993	.069	38.354	1	397	.000
3	.556(c)	.309	.304	17.730	.022	12.833	1	396	.000

a Predictors: (Constant), PSSC Maths
b Predictors: (Constant), PSSC Maths, PSSC English
c Predictors: (Constant), PSSC Maths, PSSC English, PSSC Computing

Table 5.ANOVA

ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	39322.406	1	39322.406	111.041	.000[a]
	Residual	140941.8	398	354.125		
	Total	180264.2	399			
2	Regression	51739.202	2	25869.601	79.908	.000[b]
	Residual	128525.0	397	323.740		
	Total	180264.2	399			
3	Regression	55773.620	3	18591.207	59.138	.000[c]
	Residual	124490.5	396	314.370		
	Total	180264.2	399			

a. Predictors: (Constant), PSSC Maths

b. Predictors: (Constant), PSSC Maths, PSSC English

c. Predictors: (Constant), PSSC Maths, PSSC English, PSSC Computing

d. Dependent Variable: Final Mark HCS081

Despite the strong correlation as indicated by the correlation matrix, regression analyses generated a small value of R (.556) and R^2(.309)indicating a weak relationship. Inspection of the means and standard deviations indicated that this may be due to large variability in the distributions as shown in Table 6 and Table 7.

Table 6 Descriptive Statistics from Casewise analyses

	Mean	Std. Deviation	N
cohort	4.70	2.198	1569
Final Mark HCS081	54.95	24.760	1569
PSSC English	3.37	1.510	1437
PSSC Maths	3.96	1.782	1199
PSSC Computing	3.28	1.372	518
gendercode	.61	.488	1569

Table 7. Descriptive Statistics from Listwise analyses

	Mean	Std. Deviation	N
cohort	5.28	2.036	400
Final Mark HCS081	66.14	21.255	400
PSSC English	3.03	1.544	400
PSSC Maths	3.84	1.920	400
PSSC Computing	3.18	1.399	400
gendercode	.60	.492	400

Hypothesis 4: There is a correlation between the program a student enrolls in within the Foundation program at NUS (i.e., Arts, Science, Commerce, Nursing, and Education) and student performance in Foundation Computer Studies (HCS081)

In terms of programme enrolled in at NUS, one way ANOVA and regression analyses indicated a significant difference in performance in Foundation Computer studies between programmes F(63.25,7) p = 0.00 as indicated in the table and graph below. Inspection of means indicate a range of means from 29 to 71 across programmes. Within the Foundation programmes, the means range from 71.72 in Foundation Science to 41.58 in Foundation Education. However, the values of R and R-squared (.221) are quite small which again indicates wide variability in the data sets. This is also indicated by the value of the variances as shown in Table 8.

Table 8. Foundation Computer Studies Performance per NUS programme student enrolled in.

NUS programme	Mean HCS081	Std. Deviation	N
DEd	29.21	26.599	29
FCA	56.54	21.280	306
FCC	65.91	19.534	295
FCE	41.58	22.740	374
FCG	58.16	21.954	203
FCN	48.41	21.995	41
FCS	71.72	22.361	206
NAw	39.26	24.187	115
Total	54.95	24.760	1569

Table 9. ANOVA of Foundation Computer studies (Final mark HCS081) versus NUS Programme

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Final Mark HCS081 * NUS programme	Between Groups	(Combined)	212403.9	7	30343.414	63.248	.000
	Within Groups		748896.8	1561	479.755		
	Total		961300.7	1568			

Table 10. Tests of Between-Subjects Effects Foundation Computer studies Performance across programme enrolled in.

Tests of Between-Subjects Effects

Dependent Variable: Final Mark HCS081

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	212403.901[a]	7	30343.414	63.248	.000	.221
Intercept	1946798.621	1	1946798.621	4057.906	.000	.722
Prog	212403.901	7	30343.414	63.248	.000	.221
Error	748896.795	1561	479.755			
Total	5699609.000	1569				
Corrected Total	961300.696	1568				

a. R Squared = .221 (Adjusted R Squared = .217)

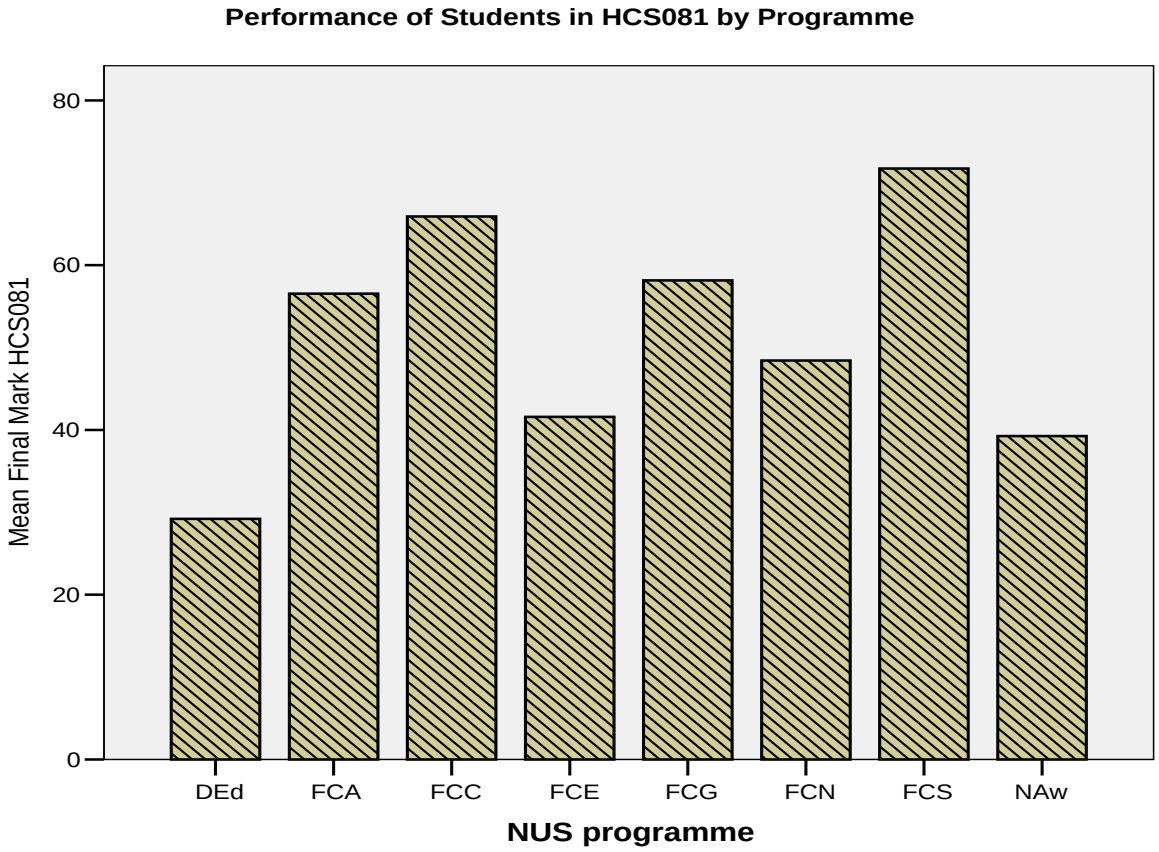

Fig 1. Graph of Student performance versus NUS programme.

Hypothesis 5: Student gender (HCS081) has a correlation with the performance in Foundation Computer Studies

There were no significant gender effects for Foundation Computer studies. However there were significant gender effects for PSSC English. This was confirmed from ANOVA which indicated that in PSSC English female students outperformed males $F(8.797,1)$ $p = .003$. These results are shown above in Table 2.

Summary of Findings

The findings of the study is summarized in relation to each of the hypotheses tested in this study. It must be pointed out that these results and findings are limited and can only be applied within the current educational settings and context and cannot be generalized beyond these settings.

Hypothesis 1: Student prior mathematical ability has a correlation with student performance in Foundation Computer Studies

The findings of the study indicate that prior mathematical ability has a strong positive correlation with student performance in Foundation Computer studies. Hence this hypothesis is accepted.

Hypothesis 2: Student prior English language ability has a correlation with student performance in Foundation Computer Studies

The findings of the study indicate that prior English ability has a strong positive correlation with student performance in Foundation Computer studies. Hence this hypothesis is accepted.

Hypothesis 3: Student prior computer studies experience (Year 13) has a correlation with student performance in Foundation Computer Studies

The findings of the study indicate that prior Computer studies ability has a strong positive correlation with student performance in Foundation Computer studies. Hence this hypothesis is accepted.

Hypothesis 4: There is a correlation between the program a student enrolls in within the Foundation program at NUS (i.e., Arts, Science, Commerce, Nursing, and Education) and student performance in Foundation Computer Studies (HCS081)

The findings of the study indicate that there is a significant difference in performance in Foundation Computer studies between programmes. Hence this hypothesis is accepted.

Hypothesis 5: Student gender (HCS081) has a correlation with the performance in Foundation Computer Studies

The findings of the study indicate that there is no significant correlation between gender and student performance in Foundation Computer studies. Hence this hypothesis is rejected.

Recommendations

The outcomes and findings from this research have provided important data on factors affecting student performance in Foundation Computer studies. The results have indicated that prior ability in English, Mathematics and Computing are strong predictors of performance in Foundation Computer studies. However it must be emphasized that the findings apply only within the educational setting of NUS and cannot be generalized beyond these settings.

From the findings of this study and taking into account the limitations of this study, the following recommendations are made:

1) The current study is based solely on administrative data. It is recommended that in future that this study is supplemented and accompanied by a student attitudinal survey which evaluates such self assessment factors as "comfort level" (questions designed to rate a student's perception of course/programming difficulty and level of anxiety) and "attributions" (questions designed to identify students' belief about their reasons for success or failure) (Wilson & Shrock, 2001)
2) Students entering the Foundation Computer studies course at the National University of Samoa should have as prerequisites previous Mathematic, English and Computer studies ability.
3) Results on this research can implement solutions in improving the course and can also use to pursue for further studies in the future.

Acknowledgement

We would like to express our deepest appreciation to the Ministry of Education for releasing the PSSC results, and the NUS Administration office for the HCS081 results. We also thank the students involved in taking their time out of their studies to extract data for data entry.
Special thanks also go to Dr Muagututia Ioana Chan Mow. Her guidance and persistent help this dissertation would not have been possible. In addition a thank you to Rev Vavatau Taufao and Lealaolesau Fitu who shared their expertise in analyzing the data. Last but not least, we convey our thank you to the UREC committee for their approval and the expectation that we can do this research.

References:

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National University of Samoa, Calendar (2001-2007)

National University of Samoa, Faculty of Science Final Results (2003-2007)

Appendices

Time Frame:

The duration of the research will require approximately 1 year starting June/July 2008

April- Consent letter from MESC
May-June-: Data Collection
July-September: Data Entry
Oct-November: Data Finding & Analysis
Dec-:1st Draft write up
January: CSS presentation and Peer Review
February: Final Amendments
March- April: Submit to JSS at CSS
May- Publication in Press

Researchers
The research team will consist of Computing Lecturers teaching this course:

Elisapeta Mauai (Lecturer Grade 2)
Edna Temese-Ualesi (Lecturer Grade 2)
Foilagi Maua – Faamau (HOD)

Detailed Budget:

Travel Costs:
Petrol for use of private car

Equipment and Consumables:

Paper	$200.00
Envelopes	
Pens	
Computer Toner	$750.00
Photocopy Toner	$550.00

Research Support Staff
Data entry for appr. 4,662 sets of students
@ $3.00 per PSSC student entry and $1.00 per UPY entry $9324.00

Data analyst

Miscellaneous

TOTAL **$10,824**