Computer Science at Kent

An Analysis of Student Performance

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DRAFT

Introduction

The Computing Laboratory at the University of Kent delivers a range of modules to a variety of student cohorts. One aspect of the provision is the delivery of modules to students who are following specialist degree programmes in *Computer Science (CS)*, *Computer Systems Engineering (CSE)*, or who are following joint honours programmes with *Computer Science* as one part. Another aspect is the provision of distinct modules, classified as *Applied Computing (AC)* modules, to students who are also taking modules in the Social Sciences or Humanities faculties. Those students may be following joint honours programmes, or may be taking the Computing modules as wild modules.

We often see high failure rates for first year students on modules teaching programming, mathematics or subjects dealing with quantitative analysis. But particularly high failure rates have been noticed recently for many of the Applied Computing modules. This report concerns the results obtained by students on some of the modules that were examined in the summer of 2002 and 2003.

Analyses

Summary figures were available for a range of modules and detailed figures for a smaller set of modules. The analysis was performed in four parts.

Part 1

As part of the examining process, the results are summarised and presented to the relevant examiners' meetings. Data from these meetings is presented on the following pages and commented on.

Part 2

Additional data was available for one of the modules and this was analysed to compare the performance of students following different types of degree programme.
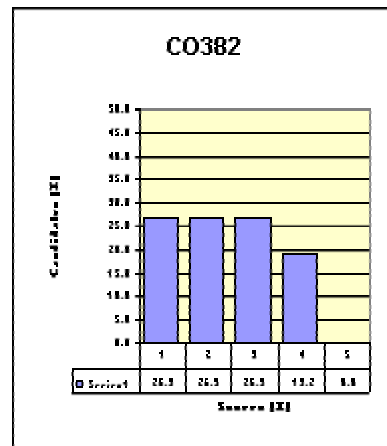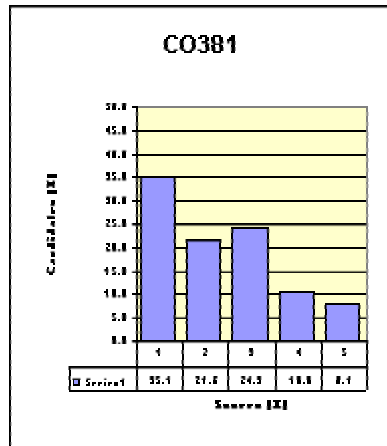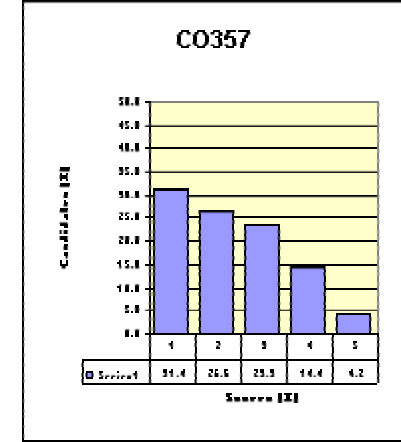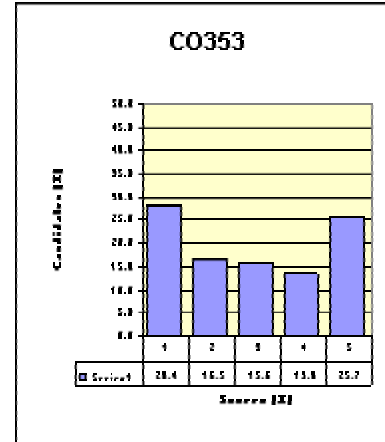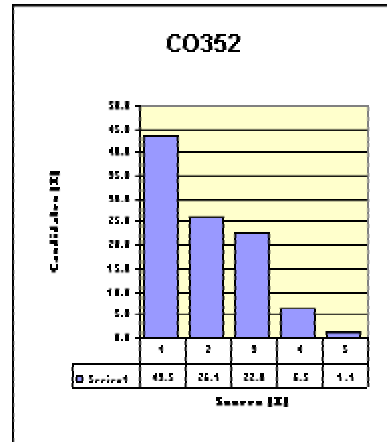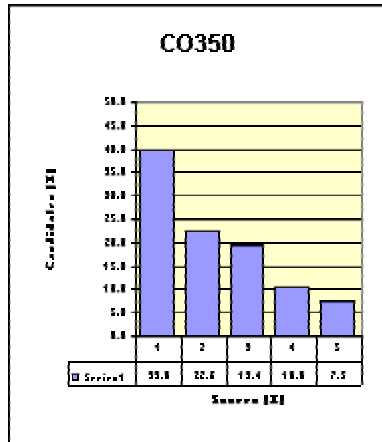
Part 3

The Applied Computing modules for 2003 were further analysed to see how far coursework results correlated with performance in examinations.

Part 4

Finally student performance on pairs of modules was compared to see to what extent students performed consistently on different modules.

Part I Computing Modules June 2002

Applied Computing

CO350

1	2	3	4	5
39.8	22.6	19.4	10.8	7.5

CO352

1	2	3	4	5
43.5	26.1	22.8	6.5	1.1

CO353

1	2	3	4	5
28.4	16.5	15.6	13.8	25.7

CO357

1	2	3	4	5
31.4	26.6	23.3	14.4	4.2

CO381

1	2	3	4	5
35.1	21.6	24.3	10.8	8.1

CO382

1	2	3	4	5
26.9	26.9	26.9	19.2	0.0

```
Key to graph bars:
1: Fail             <40%
2: Pass    >=40% and <50%
3: Pass    >=50% and <60%
4: Merit   >=60% and <70%
5: Distinction      >=70%
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Number of students per module:
CO350  CO352  CO353  CO357  CO381  CO382
   93     92    109    305     37     26
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Part 1

Applied Computing Modules CO350 to CO381

These modules are taken by students who combine Computing modules with modules from the Social Sciences and Humanities faculties. The students will be taking between one and four of these modules during their first year. They are a distinct population from the students taking the Computer Science modules which are shown on the following pages.

CO350 Introduction to Computing

This module is designed for students with no previous formal qualification in Computing. It contains quite a proportion of students taking it as a wild module, normally together with one other Computing module. Students may not take this module if they are also taking module CO357 or module CO382. Weight 1 unit. Exam 80% Coursework 20%

CO352 Computers and the World Wide Web

Like CO350, this module may be taken by students with no previous formal qualification in Computing. The students are following a broad mixture of degree programmes and may also be taking any of the other modules in this group. Weight 1 unit. Exam 80% Coursework 20%

CO353 Introduction to Programming

Students must have some previous Computing experience either from taking one of the other Applied Computing modules, or some other course leading to a formal qualification in Computing. The students are following a broad mixture of degree programmes. Weight 1 unit. Exam 80% Coursework 20%

CO357 Computing for Business and Accounting

This module is specially designed to meet the needs of students in the Business School and is only open to them. It is compulsory for many of them and may be the only Computing module that they study during their degree programme. It may not be taken in conjunction with CO350 or CO381. Weight 1 unit. Exam 80% Coursework 20%

CO381 Micro-based Applications

Is taken by students who have previously followed CO350 or CO352, or both. This group is distinct from those taking CO357. Weight 1 unit. Exam 80% Coursework 20%

CO382 Analysis and Design of Information Systems

This module is only open to first year students with a formal qualification, such as A-Level in IT or Computing. The syllabus is the same as for a Part II module with the same title but the student cohorts are examined separately. These students are distinct from those taking CO350. Weight 1 unit. Exam 80% Coursework 20%
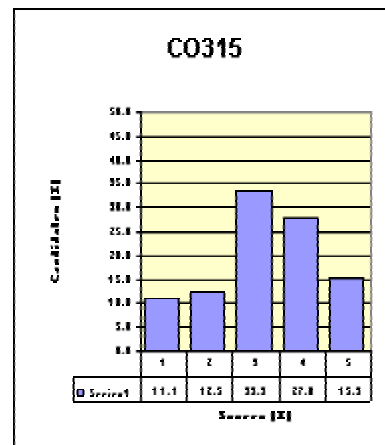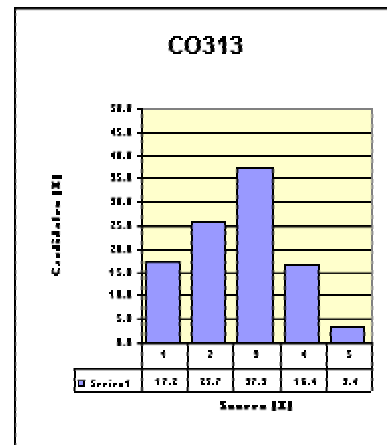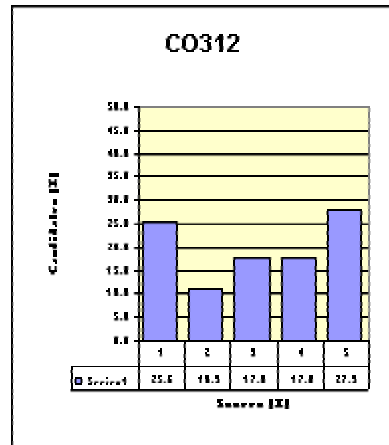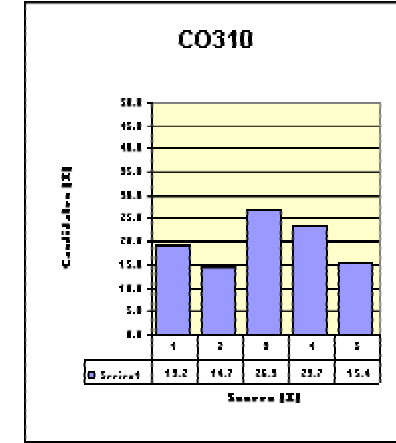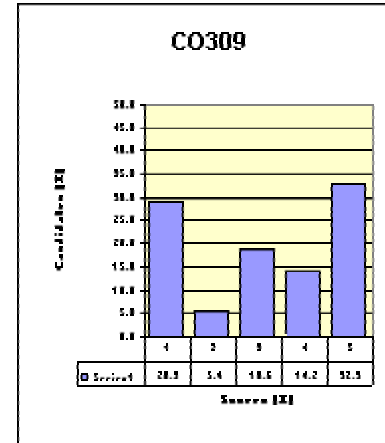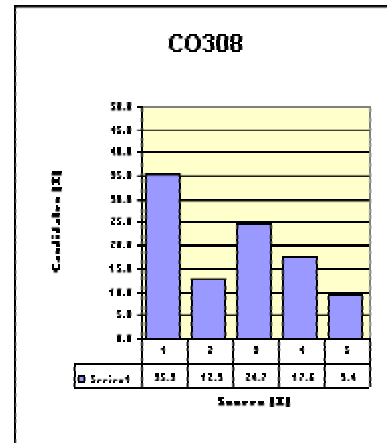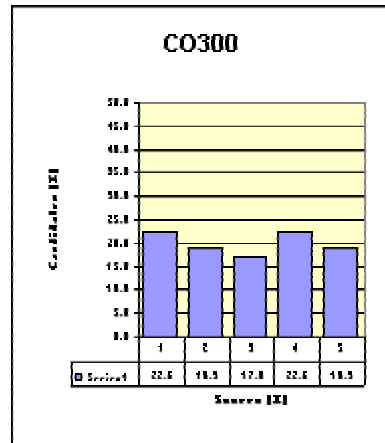
Comments on the Results

Generally we see a large proportion of the students in the fail category, with decreasing proportions in the low pass, high pass and merit categories with very few students gaining a distinction mark. We will see on later pages that these results profiles are rarely found in the other sets of modules being considered.
One exception is CO353 which introduces students to programming. This has results that are recognised as typical of programming modules, with a large proportions of students in both the fail and the distinction categories. We will see on later pages that this results profile has more in common with other programming and quantitative modules than it does with the remaining Applied Computing modules.
The other exception is CO381 that has a lower enrolment than the other modules and caters for students with previous Computing experience. Here there are no students with a distinction but they are almost evenly distributed between the remaining categories.

Part I Computing Modules June 2002

Computer science

CO300

Series1	22.6	18.5	17.0	22.6	18.5

CO308

Series1	35.3	12.9	24.7	17.6	9.4

CO309

Series1	28.9	5.4	18.6	14.2	32.5

CO310

Series1	19.2	14.7	26.9	23.7	15.4

CO312

Series1	25.6	10.9	17.8	17.8	27.9

CO313

Series1	17.2	25.7	37.3	16.4	3.4

CO315

Series1	11.1	12.5	33.3	27.8	15.3

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Key to graph bars:
1: Fail               <40%
2: Pass    >=40% and <50%
3: Pass    >=50% and <60%
4: Merit   >=60% and <70%
5: Distinction      >=70%
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Students per module:
CO300  53      CO312 129
CO308  85      CO313 268
CO309 204      CO315  72
CO310 156
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Computer Science Modules CO300 to CO315

Students on these modules are enroled on degree programmes consisting entirely of Computer Science, or including a Computer Science component. They are a distinct group from those taking the Applied Computing modules. There is some variation between modules in the weighting of exam and coursework within the overall results, unlike the Applied Computing modules.

CO300 Mathematics (from GCSE) for Computer Science

Is taken by Computer Science specialists who do not have A-level Maths. These are a distinct group from those taking CO308. Weight: 2 units. Exam 80% Coursework 20%

CO308 Mathematics for Computer Science

Is taken by Computer Science specialists who have passed A-level Maths. A distinct group from those taking CO300. Weight: 1 unit. Exam 80% Coursework 20%

CO309 Object-Oriented Design and Implementation with Java

Introduces all Computer Science students to programming with Java. Is also taken by some students following joint honours programmes and by Computer Systems Engineering students. Weight: 2 units. Exam 80% Coursework 20%

CO310 Foundations of Computer Science

Is taken by Computer Science specialists and some joint honours students. Covers essential theory as well as introducing a second programming language. Weight: 1 unit. Exam 60% Coursework 40%

CO312 Computing Case Studies

Taken by Computer Science specialists. Has been described as a *composting* module in that it is designed to reinforce material covered in other modules. It includes significant work on programming using the languages from CO309 and CO310. Weight: 1 unit. Exam 50% Coursework 50%.

CO313 Information Systems

Taken by all Computer Science students and by Computer Systems Engineering students. Weight: 1 unit. Exam 50% Coursework 50%.

CO315 Computers, Systems and Software

Taken by Computer Science students who are taking CO308. Weight: 1 unit. Exam 70% Coursework 30%

Comments on the Results

Here we see a much more varied pattern than with the Applied Computing modules seen earlier. The only module with a similar results profile is CO308, and this was dropped after 2002.

CO309 exhibits the familiar profile for programming courses. That is also evident to a lesser extent in another programming module, CO312. The smoothing in the latter case may be attributable to the higher coursework component.

CO313 shows particularly high proportions in the pass categories. Factors which may account for this are that the coursework contributes 50% to the overall result, and the module has a large amount of group work.

CO315 is taken by a special subset of the students. It also is rather more concerned with knowledge acquisition and less with problem solving than some of the other modules. These factors may explain the unusual results profile.

Part I Modules June 2002

Business School
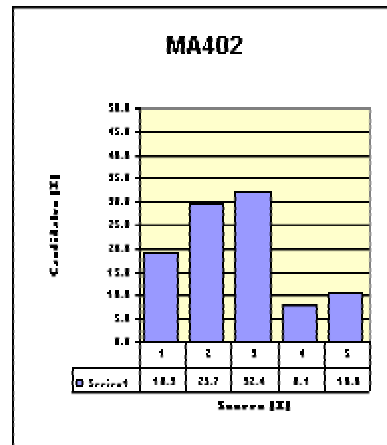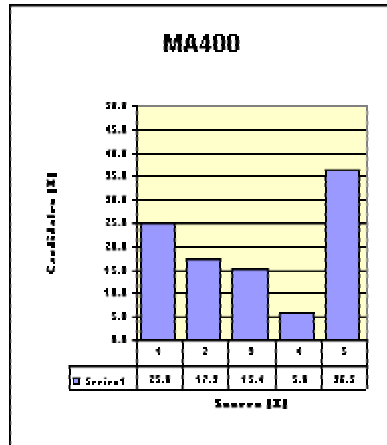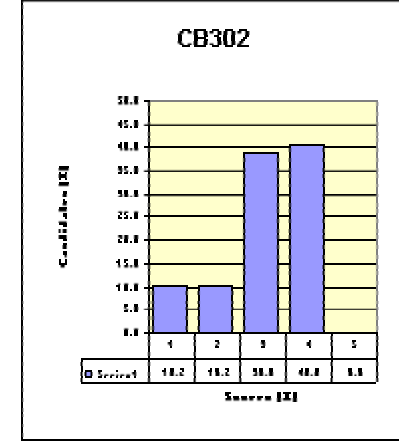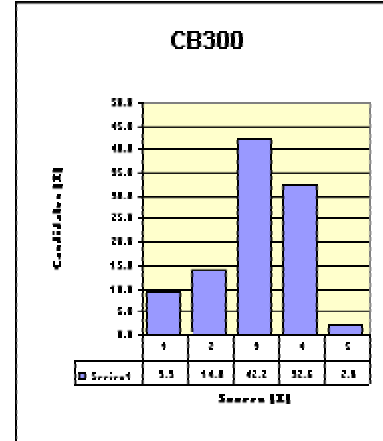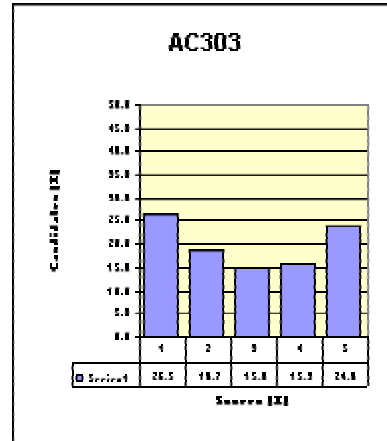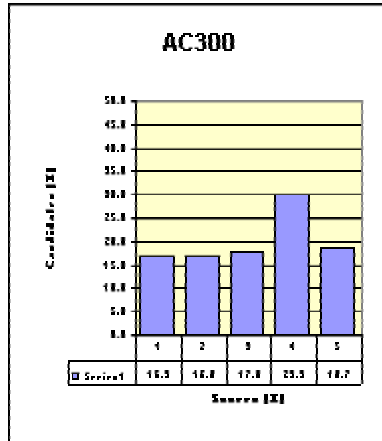
AC300

AC303

CB300

CB302

MA400

MA402

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Key to graph bars:
1: Fail              <40%
2: Pass    >=40% and <50%
3: Pass    >=50% and <60%
4: Merit   >=60% and <70%
5: Distinction      >=70%
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Number of students per module:
AC300   AC303   CB300   CB302   MA400   MA402
  107     246     301      49      52      37
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Business School Modules AC300 to MA402

These modules are being considered because some of the students taking the modules discussed earlier will also take some of these modules from the Business School. The figures pictured on the immediately previous page cover all students enroled on the modules, including the students taking the Computing modules.

AC300 Financial Accounting 1

Covers principles and practice of financial accounting plus an introduction to the use of computers in accounting. Restricted to students taking Accounting and Finance degrees. Includes some students taking Applied Computing modules. Weight 2 units. Exam 90% Coursework 10%

AC303 Quantitative Methods for Business and Accounting

Covers the mathematics and statistics of particular relevance to management and accounting. Restricted to students who have already taken module CO357. May not be taken with module MA402. Weight 1 unit. Exam 80% Coursework 20%

CB300 People and Organisations

Introduces the key concepts and theories of organisational behaviour. May not be taken with module CB302. Is taken by some students on Applied Computing *and* and *with* degrees and also some students on Computer Science joint honours degrees. Weight 2 units. Exam 80% Coursework 20%

CB302 Managers and Organisations

A one-unit module covering some of the material in CB300. May not be taken with module CB300. Weight 1 unit. Exam 80% Coursework 20%

MA400 Introduction to Operational Research and operations management

A one-unit module introducing the techniques of Management Science. Mainly taken by students on Management Science degrees. Exam 80% Coursework 20%

MA402 Applied Maths and Probability

A one-unit module studying quantitative techniques applied to management problems. Open to students who have A or AS level mathematics or stistics (or equivalent). May not be taken with module AC303. Exam 80% Coursework 20%

Comments on the results

Modules AC303 and MA402 cover quantitative techniques and the results profiles have the familiar pattern of such subject areas, and are similar to those found on the programming modules seen earlier.
Modules CB300 and CB302 are more discursive in nature. The results profiles show a small proportion of the candidates in the fail category and even less in the distinction category. This is characteristic of essay-based subject areas.

Stage I Modules June 2003

Applied Computing
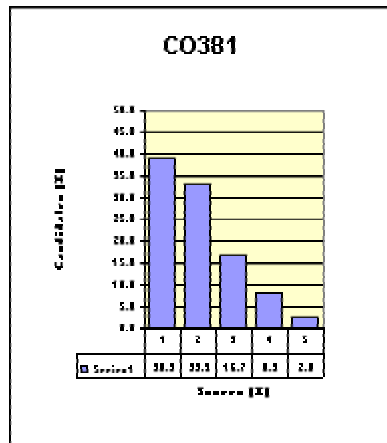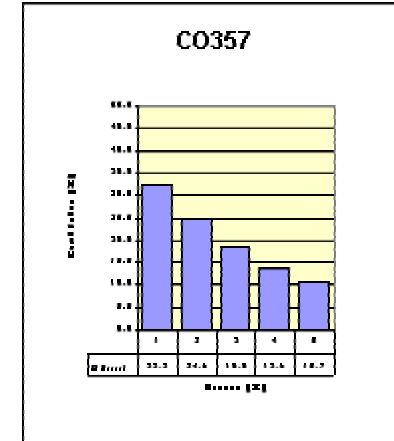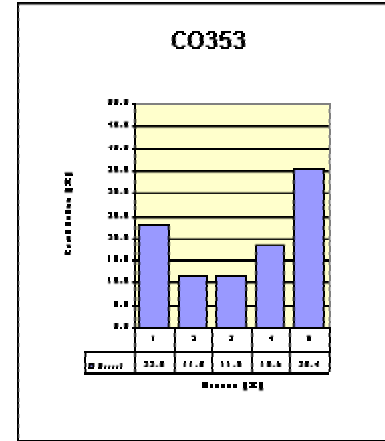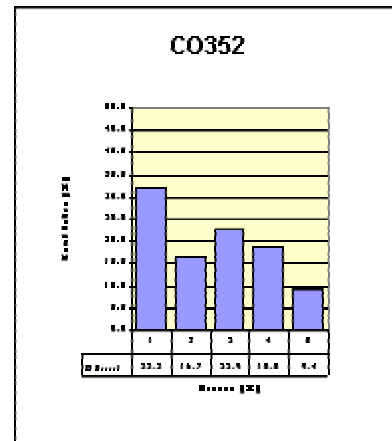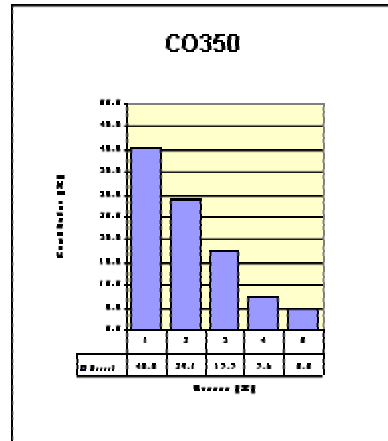
CO350

CO352

CO353

CO357

CO381

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Key to graph bars:
1: Fail              <40%
2: Pass   >=40% and <50%
3: Pass   >=50% and <60%
4: Merit  >=60% and <70%
5: Distinction     >=70%
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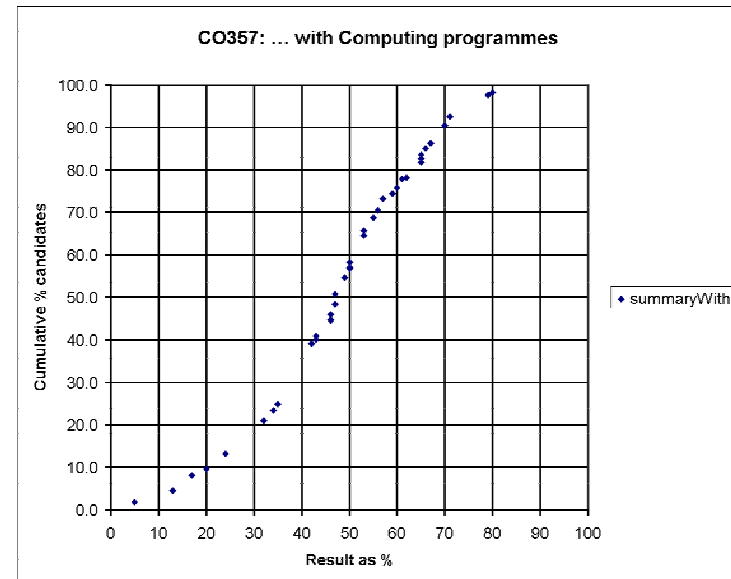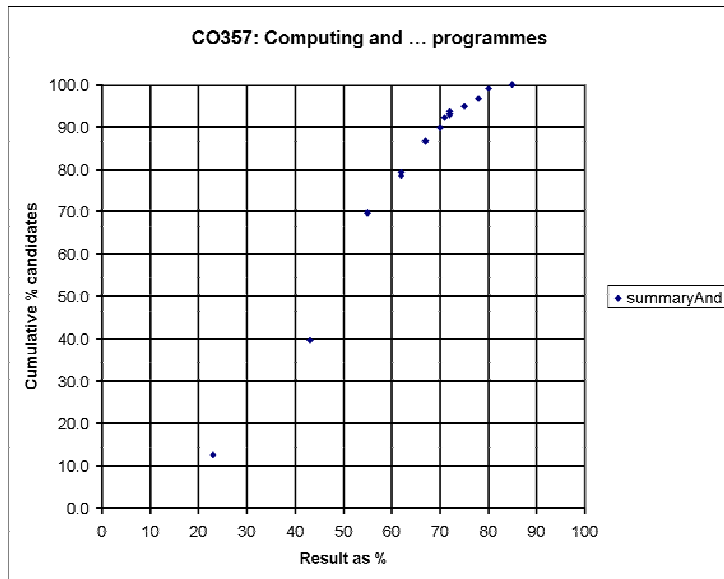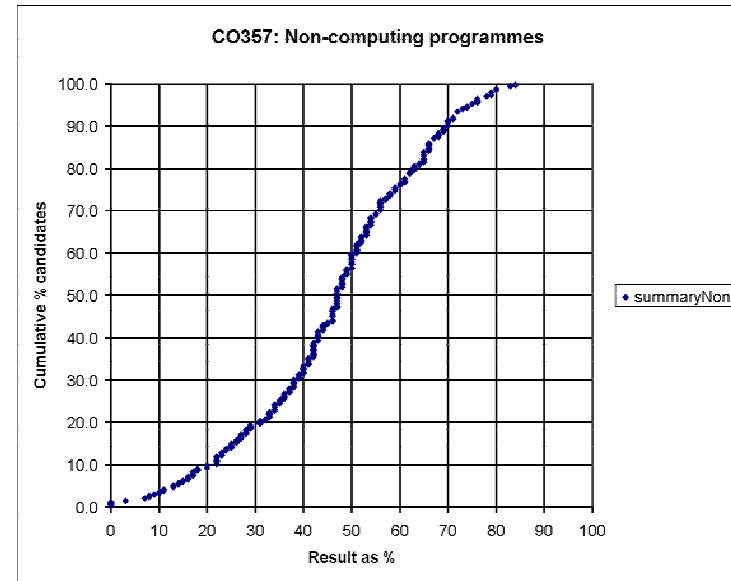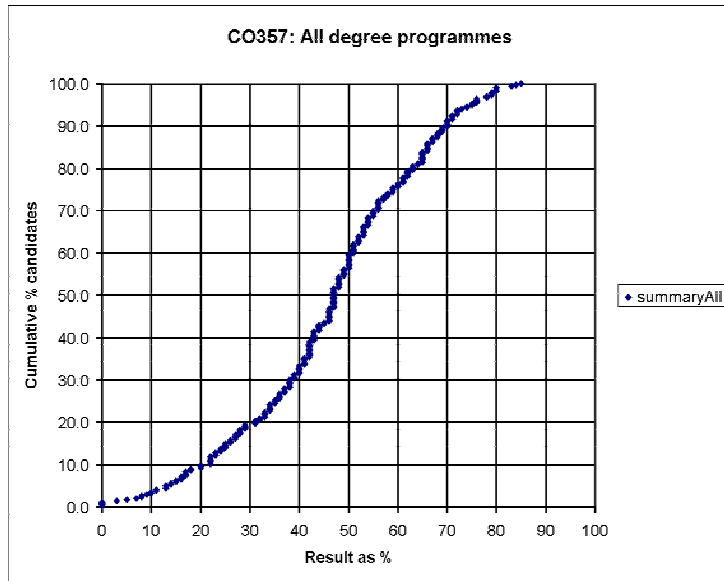
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Number of students per module:
CO350  CO352  CO353  CO357  CO381
   79     96    113    346     36
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Applied Computing Results 2003

After the examining was completed for 2002, the results of the exams were studied to find out if students had experienced problems with particular questions. The 2003 papers and marking schemes were later designed to attempt to overcome observed problems. Comparing the 2003 results with the 2002 Applied Computing results shown earlier, we can see that although there has been some improvement, the profiles of the results are broadly similar.

Conclusions for Part 1

For the Computer Science modules and the Business School modules, the results profiles generally match those expected for the nature of the subject matter (either programming/quantitative or discursive). This is not generally the case for the Applied Computing modules.

CO357: All degree programmes

CO357: Non-computing programmes

CO357: Computing and ... programmes

CO357: ... with Computing programmes

Part 2

Comparing results on different types of degree programmes

The hypothesis frequently postulated is that students whose degree programmes include more Computing units of study are more committed to this work and generally perform better on Computing modules than those who are, say, taking the module as a wild course.

Module CO357 was taken by 335 students on a variety of different degree programmes which all have some connection with the study of Business or of Accounting. The proportion of Computing units which these students take in their first year, and which they can expect to take in subsequent years, is very varied. The following descriptions outline what happens most often for students on the different types of programme, but there is flexibility in the programme specifications.

For some students CO357 will be the only Computing module they follow. These are the students on non-Computing programmes in the chart opposite. For them, the module may be compulsory or it may be an option.

Students taking programmes entitled *XXX with Computing* will have 25% of their units at Stages 2 and 3 as Computing modules. They will almost always take either two or three Computing modules at stage 1.

Full joint honours students, on programmes entitled *Computing and XXX* will take 50% of their units as Computing modules at stages 2 and 3, and between 2 and 4 units at Stage 1.

The bulk of students are on non-Computing degree programmes. This accounts for the close similarity in the two charts at the top of the page. However, it is noticeable that almost all of the students on the joint honours programmes perform well. It is not easy to draw conclusions about the students on the *with Computing* programmes.

The numbers of students on the different types of degree programmes are shown in this chart.

Programme types	
All students	335
Non-computing	280
Computing and ...	17
… with Computing	38

Conclusion for Part 2

Most students following Joint Honours programmes performed considerably better than average on module CO357.

Coursework result plotted against exam for all candidates

CO350 $y = 0.5325x + 27.966$ $R^2 = 0.27$

CO352

CO353

CO357

CO381 $y = 0.914x + 0.995$ $R^2 = 0.5903$

CO682
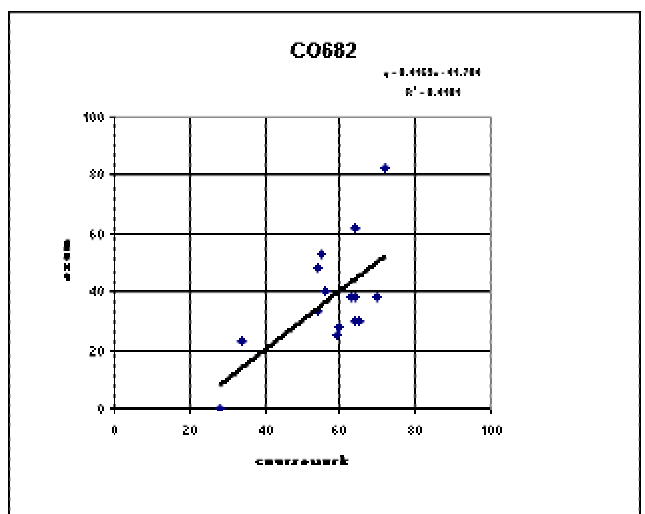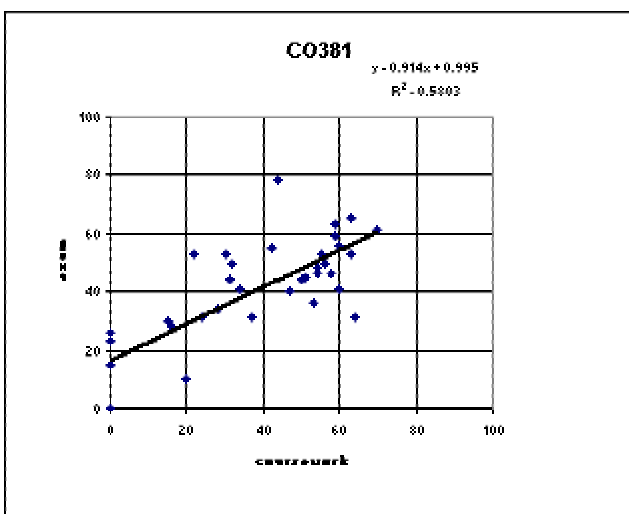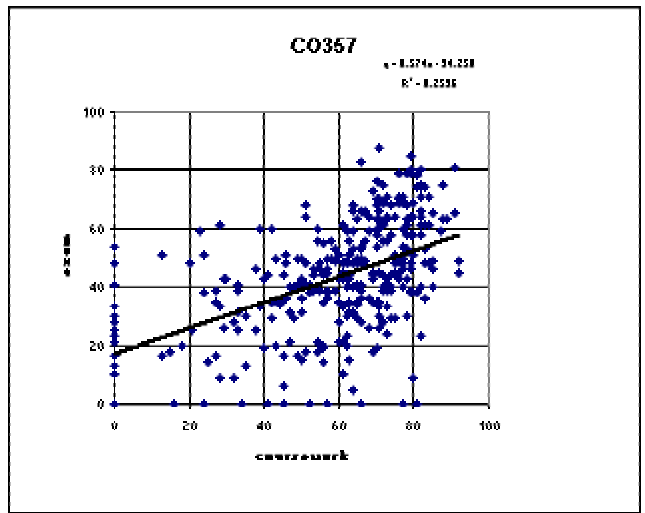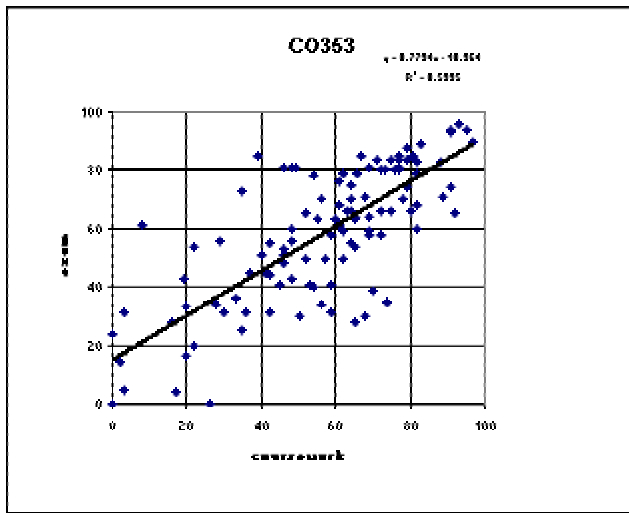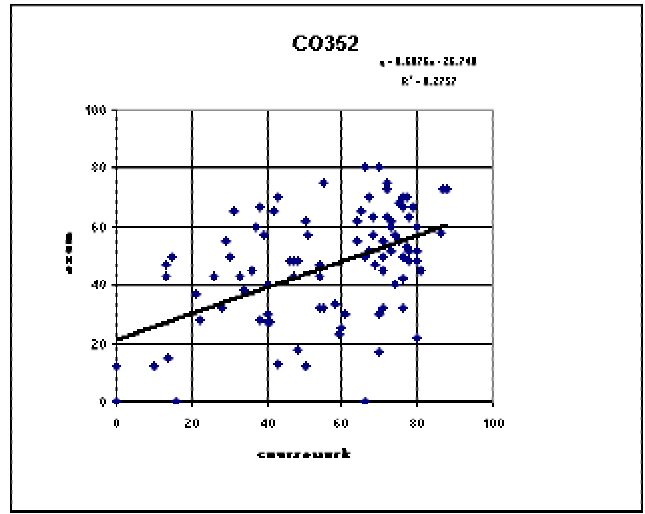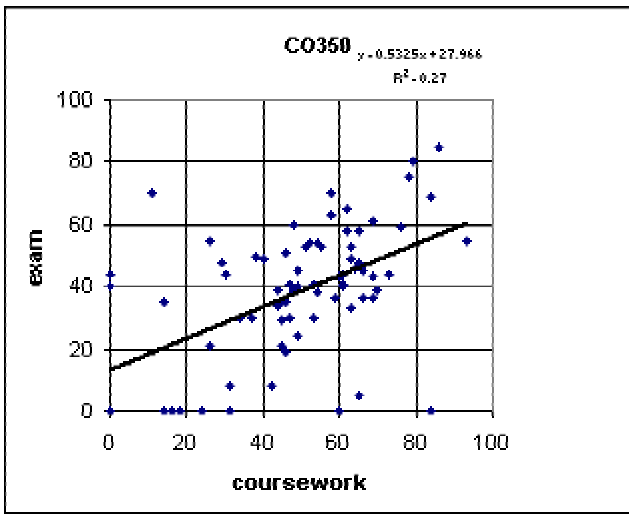
Part 3

Comparing Coursework and Exam Results

Exam and coursework results were then compared on each module to see how closely they correlate.

All Candidates

The first analysis in this part of the report included all candidates registered at the end of the module. What is noticeable is the large numbers of candidates on CO350 and on CO357 with a mark of zero on the exam. In general a mark of zero indicates that the candidate did not take the exam, although no distinction is available in these figures between those absent from the exam and those scoring zero.

The rate of students scoring zero was looked at for all the modules. Between 4% and 8% of candidates scored zero on the exam for all modules except CO350 where the figure was 14%. It is surprising that such a high proportion of the students were in this category and no clear explanation can be given for it. Quite a large proportion of the students on the module were taking it as a wild course but it is not known if these were over-represented amongst the students obtaining zero.
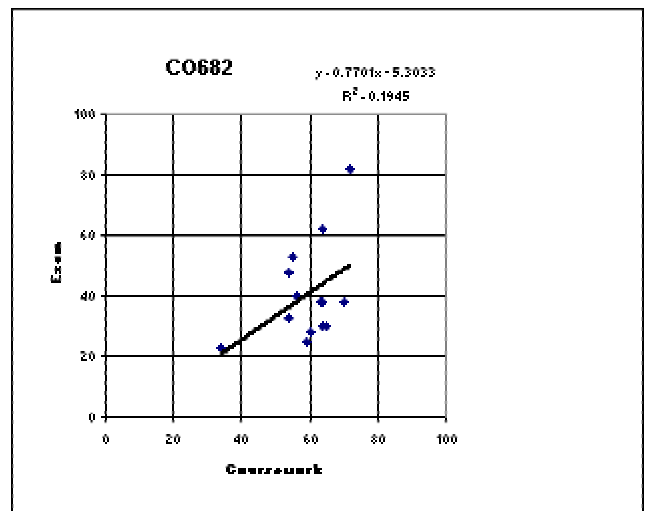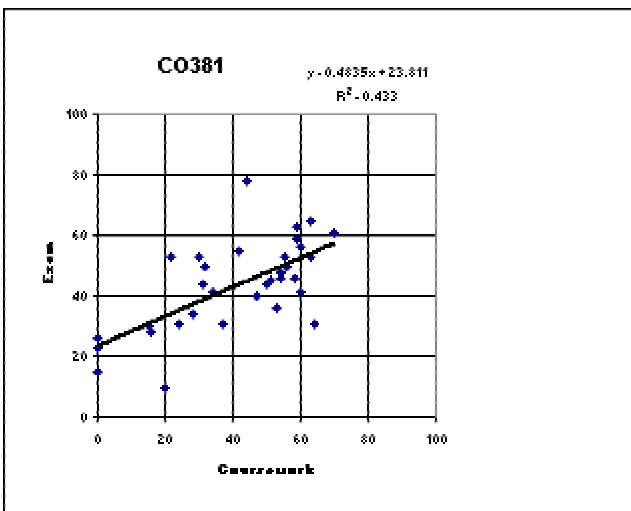
There are also noticeable numbers of candidates who had a zero coursework mark. No distinction is made between those who did no coursework and those who scored zero on it. Some candidates may have been awarded a mark of zero because of having been involved in plagiarism.

	CO350	CO352	CO353	CO357	CO381	CO682
Coursework mean	48.1	54.5	55.7	59.0	37.5	57.5
Coursework StdDev	22.1	23.2	24.5	22.2	22.5	12.1
Exam mean	37.8	45.6	57.4	43.1	40.0	37.9
Exam StdDev	19.9	20.0	23.4	19.4	18.8	18.8
Result mean	39.9	47.4	57.0	46.2	39.4	41.7
Result StdDev	19.9	18.8	23.1	18.2	18.6	16.6
Number of students	77	95	112	335	36	15
No. zero exam mark	11	5	4	15	3	1
% zero exam mark	14	5	4	4	8	7

It was not meaningful to measure the correlation between coursework and exam results with these zeros included. So the analysis was repeated with the zeros omitted. See next page.

Coursework against exam: 2003

Candidates with zero coursework or zero exam are omitted.

CO350 $y = 0.3981x + 22.796$
$R^2 = 0.158$

CO352 $y = 0.321x + 30.204$
$R^2 = 0.1475$

CO353 $y = 0.6992x + 19.237$
$R^2 = 0.5145$

CO357 $y = 0.5034x + 14.061$
$R^2 = 0.2336$

CO381 $y = 0.4835x + 23.811$
$R^2 = 0.433$

CO682 $y = 0.7701x - 5.3033$
$R^2 = 0.1945$
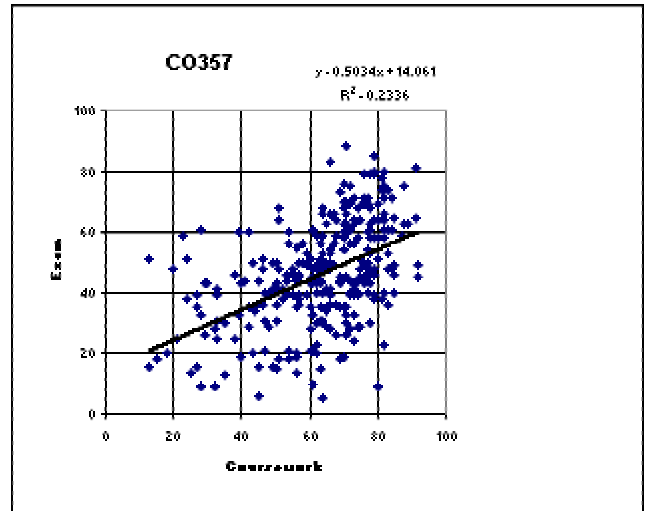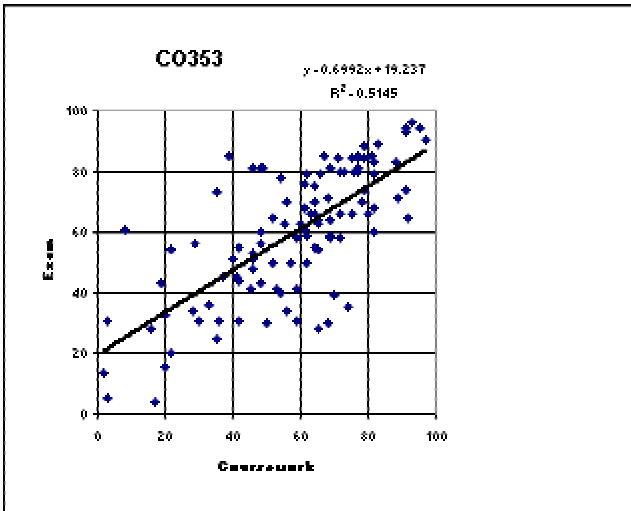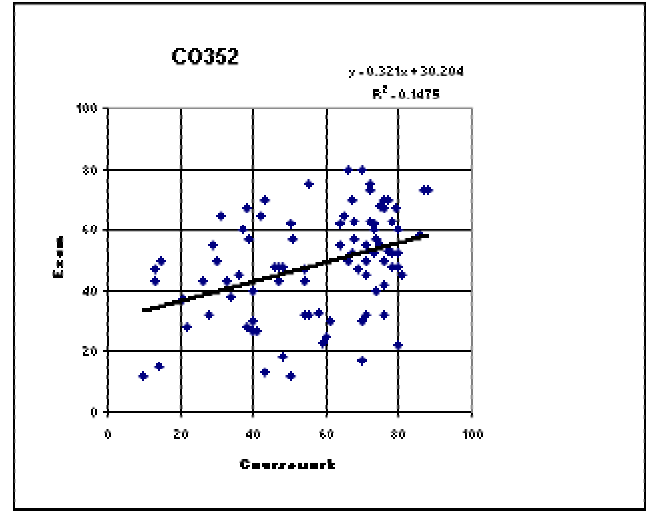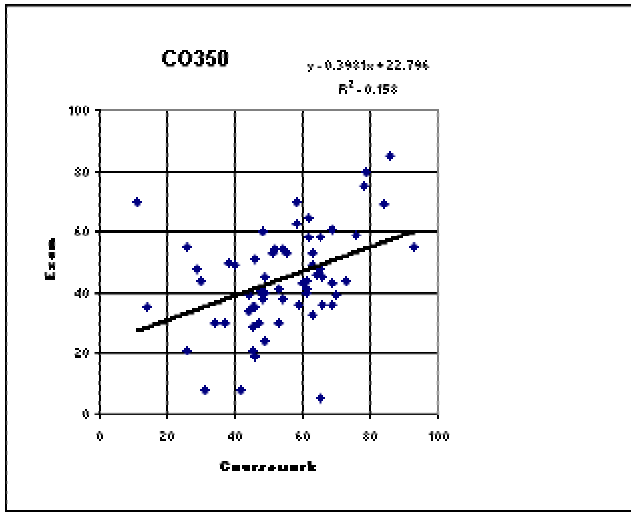
Candidates with positive scores on exam and coursework

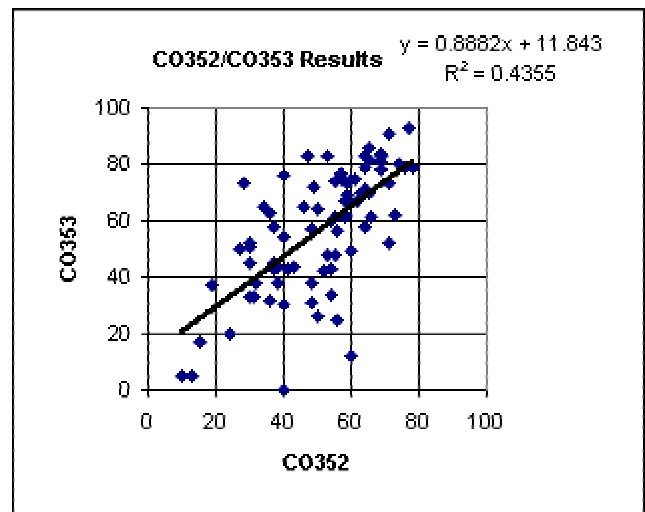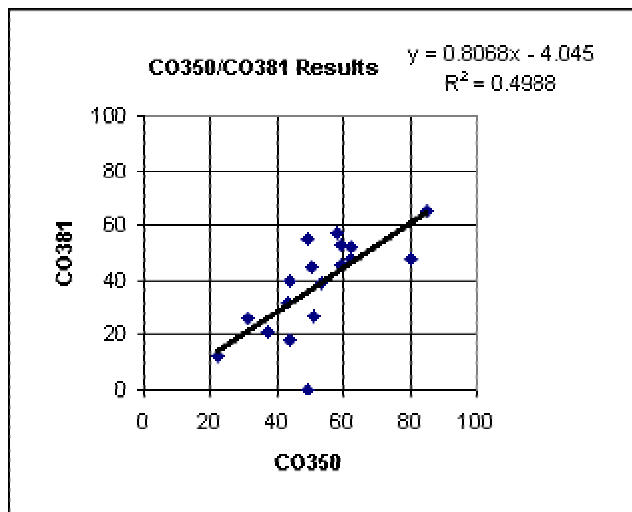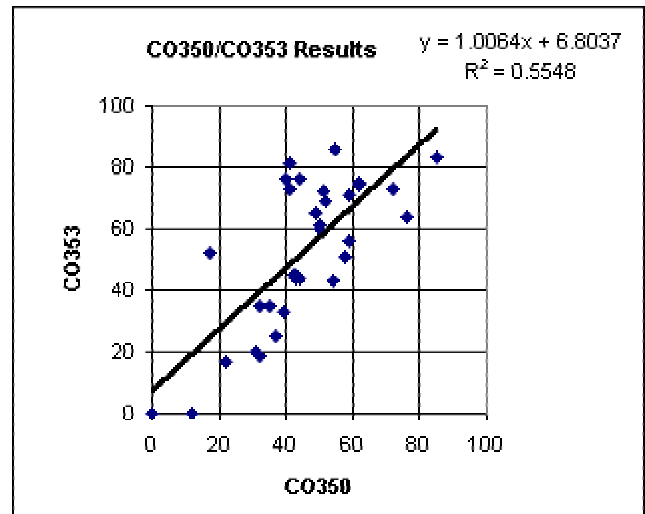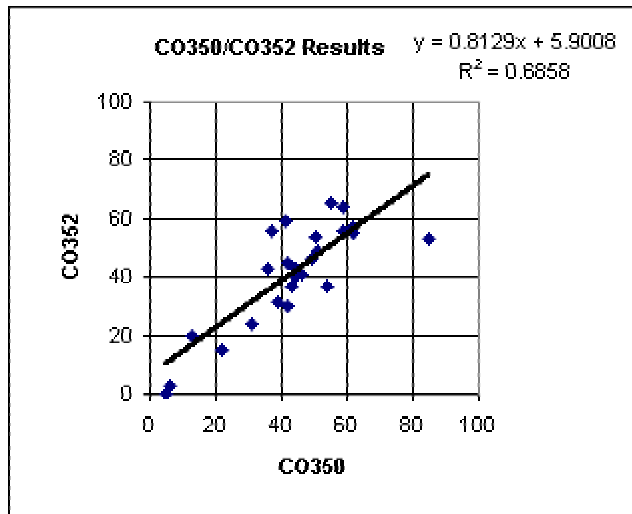Figures are given for comparison with the analysis covering all students. This shows the expected improved means, most notably on module CO350 where the students who had positive coursework and exam results performed comparably with those on other modules. Figures which stand out are the low coursework mean on module CO381 and the high exam result and overall result on module CO353. In these cases the standard deviation is also high indicating a very wide spread in the marks.

The correlation between coursework and exam results has been considered. The chart includes the coefficient R^2. The only module where there is significant correlation between coursework and exam results is on the programming module CO353. This finding is in line with earlier analyses of results where it was shown that coursework and exam performance are more highly correlated on programming modules than on other Computing modules.

It can be seen that for the modules here the coursework means are higher than the exam means in all cases except CO381. It is not unexpected that the coursework results will generally be better than the exam results. However the low means for exam results on all modules except CO353 are surprising. Since it seems that the coursework is measuring different things from the exam, it may be that additional practice in answering exam questions is needed on these modules.

	CO350	CO352	CO353	CO357	CO381	CO682
Coursework mean	53.8	57.2	58.1	63.2	40.9	59.6
Coursework StdDev	16.3	20.3	21.9	16.6	20.2	9.3
Exam mean	44.2	48.6	59.8	45.9	43.6	40.6
Exam StdDev	16.3	17.0	21.4	17.3	14.9	16.2
Result mean	46.1	50.3	59.5	49.3	43.0	44.2
Result StdDev	14.7	15.5	20.4	15.7	14.8	13.8
Number of students	64	89	108	304	33	14
R^2	**0.16**	**0.15**	**0.51**	**0.23**	**0.43**	**0.19**

Pairwise comparison of student performance

CO350/CO352 Results $y = 0.8129x + 5.9008$ $R^2 = 0.6858$

CO350/CO353 Results $y = 1.0064x + 6.8037$ $R^2 = 0.5548$

CO350/CO381 Results $y = 0.8068x - 4.045$ $R^2 = 0.4988$

CO352/CO353 Results $y = 0.8882x + 11.843$ $R^2 = 0.4355$

CO352/CO357 Results $y = 0.8418x + 11.284$ $R^2 = 0.6023$

CO352/CO381 Results $y = 0.6324x + 6.567$ $R^2 = 0.2321$
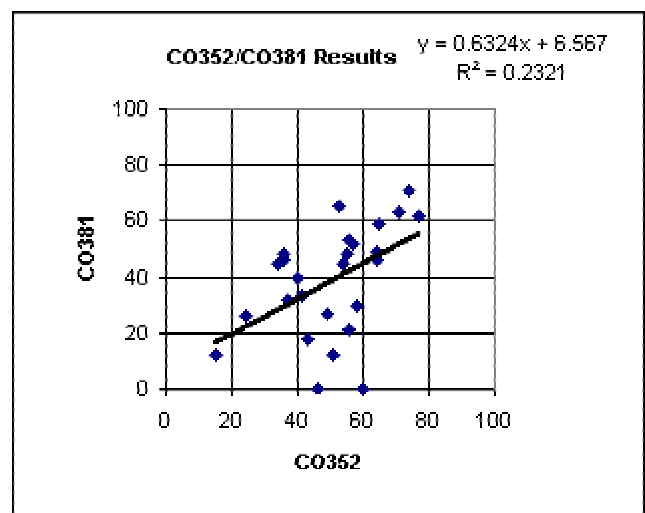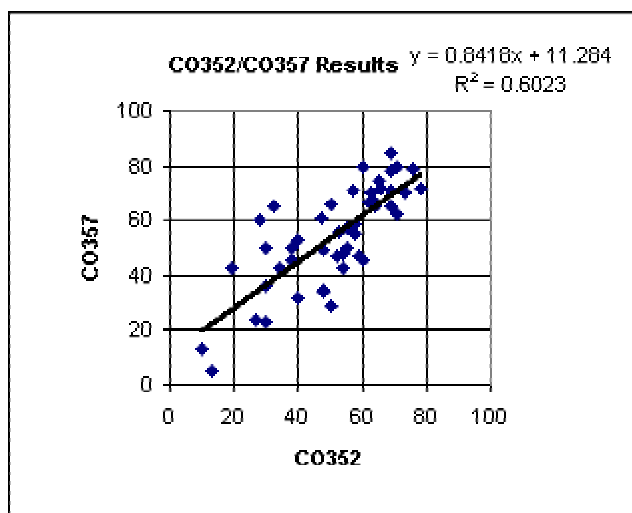
Part 4

Comparison of performance on module pairs

Some students take more than one of the Applied Computing modules. The modules were considered in pairs. Students who took both modules in a pair were identified and their results on the two modules were compared. Results are shown on these two and the following two pages.

The first table shows the correlation coefficient R^2 and it can be seen that there has a value of 0.5 or above on the pairs CO350/CO352, CO350/CO353, CO350/CO381, CO352/CO357 and CO353/CO357. It is interesting to note that in two cases the pairs involve the module CO357. Some concern has been expressed about this module because of the high failure rate, especially as some students pass their remaining Business School modules and fail just this module. The figures here indicate that performance is moderately well correlated for students taking CO357 with another Computing module. There is no indication that students perform worse on CO357 than on other Computing modules.

(Note: an X in the table indicates that no students took that combination of modules.)

Pairwise comparison: R^2

	CO350	CO352	CO353	CO357	CO381	CO682
CO350	*	0.69	0.55	X	0.50	X
CO352		*	0.44	0.69	0.23	0.10
CO353			*	0.70	0.39	0.14
CO357				*	X	X
CO381					*	0.24
CO682						*

The remaining tables on this page and the next show the figures relating to students who passed or failed the various modules.

CO350/CO352

Fail both	6	Fail CO350 Pass CO352	2	Total	25
Pass both	14	Pass CO350 Fail CO352	3		

CO350/CO353

Fail both	9	Fail CO350 Pass CO353	1	Total	33
Pass both	23	Pass CO350 Fail CO353	0		

CO350/CO381

Fail both	3	Fail CO350 Pass CO381	0	Total	18
Pass both	10	Pass CO350 Fail CO381	5		

CO352/CO353

Fail both	10	Fail CO352 Pass CO353	12	Total	80
Pass both	50	Pass CO352 Fail CO353	8		

CO352/CO357

Fail both	5	Fail CO352 Pass CO357	7	Total	47
Pass both	31	Pass CO352 Fail CO357	4		

CO352/CO381

Fail both	3	Fail CO352 Pass CO381	3	Total	26
Pass both	12	Pass CO352 Fail CO381	8		

CO352/CO682 Results

$y = 0.2979x + 28.727$
$R^2 = 0.1002$

x-axis: CO352 *y-axis:* CO682

CO353/CO357 Results

$y = 0.691x + 15.735$
$R^2 = 0.7042$

x-axis: CO353 *y-axis:* CO357

CO353/CO381 Results

$y = 0.5732x + 6.4565$
$R^2 = 0.3861$

x-axis: CO353 *y-axis:* CO381

CO353/CO682 Results

$y = 0.3628x + 17.333$
$R^2 = 0.1456$

x-axis: CO353 *y-axis:* CO682

CO381/CO682 Results

$y = 0.3843x + 19.877$
$R^2 = 0.244$

x-axis: CO381 *y-axis:* CO682
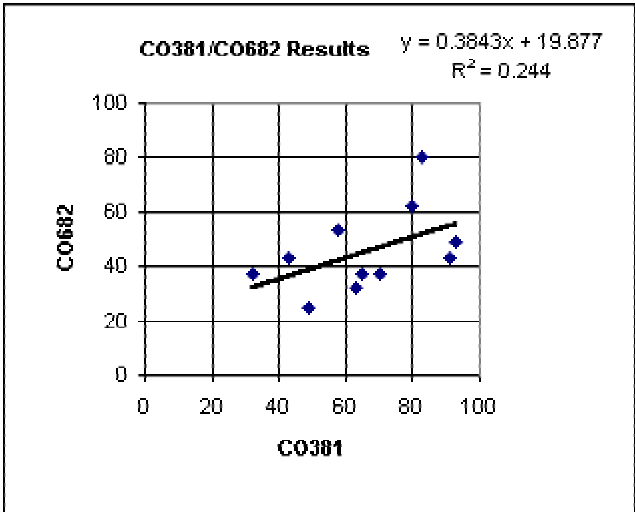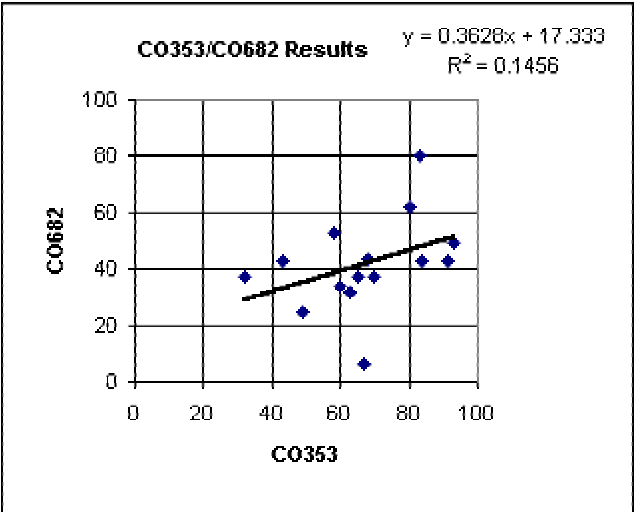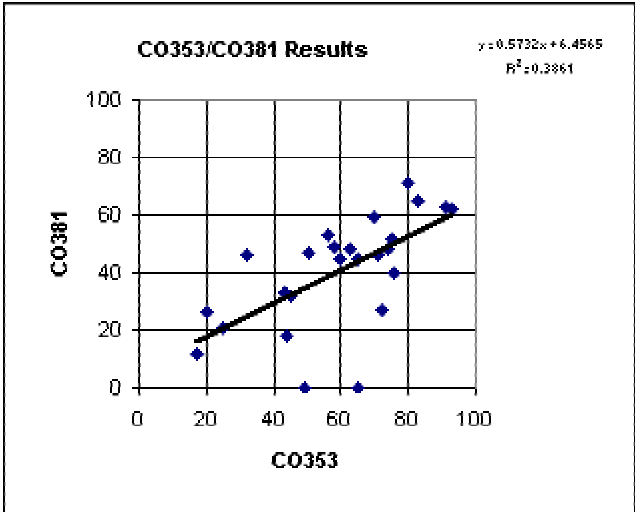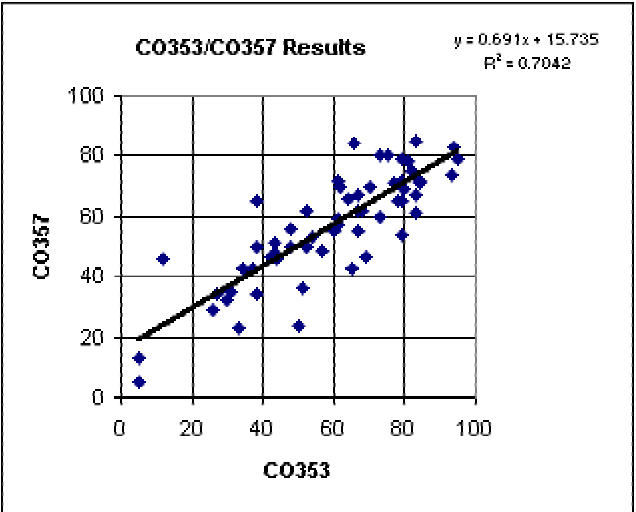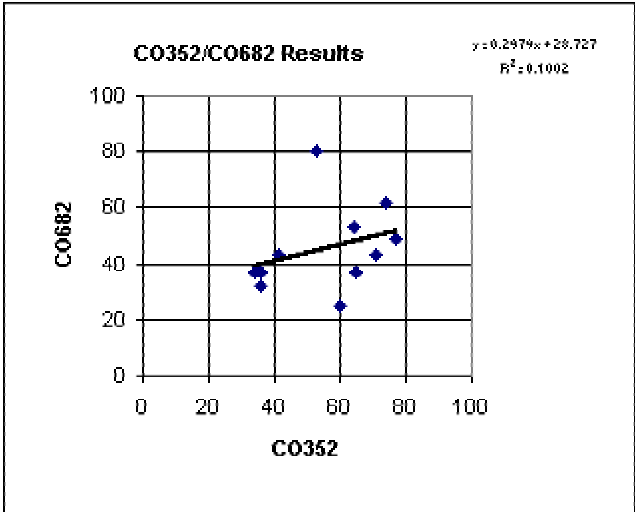
CO352/CO682

Fail both	3	Fail CO352 Pass CO682	0	Total	11
Pass both	6	Pass CO352 Fail CO682	2		

CO353/CO357

Fail both	8	Fail CO353 Pass CO357	5	Total	59
Pass both	44	Pass CO353 Fail CO357	2		

CO353/CO381

Fail both	3	Fail CO353 Pass CO381	1	Total	25
Pass both	15	Pass CO353 Fail CO381	6		

CO353/CO682

Fail both	1	Fail CO353 Pass CO682	0	Total	15
Pass both	8	Pass CO353 Fail CO682	6		

CO381/CO682

Fail both	1	Fail CO381 Pass CO682	0	Total	11
Pass both	6	Pass CO381 Fail CO682	4		

It can be seen that when CO682 is compared with another module (CO352, CO353 and CO381), then in cases where students have failed only one of the modules it is always CO682. This is a surprising result as CO682 is only open to first year students when they have previous Computing experience. The reason for the failures is not clear but it may be that students are registering for the module without having the required previous experience, either because they have not read and understood the handbook or because they have been ill advised. The module is also taken by second year and final year students and the overall results are satisfactory.

Conclusions for Part 4

The correlation coefficient has a value of 0.7 when comparing the performance of students taking *CO357 Computing for Business and Accounting* and another Computing module (CO352 or CO353). It has a value of 0.5 or above when comparing the performance of students taking *CO350 Introduction to Computing* and another Computing module (CO352, CO353 or CO381). It is tempting to presume that students who opt for more than one Computing module have some aptitude or enthusiasm for the subject and that they would tend to perform similarly on the modules. What is surprising is the much lower correlation when comparing modules with CO381 rather than CO357. Modules CO381 and CO357 have considerable amounts of material in common, which is why they are a proscribed combination. Therefore, one might expect that the students taking either of those modules would correlate in a similar way with, say, CO353 or CO352. But this is not the case.

Future Work

After 2004 the Applied Computing modules will be phased out. Starting in 2005, the Computing modules will be open to Computer Science students as well as to Applied Computing students. It is intended to track the performance of the students on different programmes and see how their performance compares. It will be especially interesting to see if the relatively good performance on the programming module CO353 is continued when the students follow the new programming module alongside the Computer Science students. There is feeling amongst some staff that the students on the Applied Computing modules are likely to perform poorly in comparison with the Computer Science students. It is the intention to find out.