Management of Large numbers of Student Projects in Computing Degrees

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Abstract

This paper examines the management of large numbers of project students on some computing courses during the period 2001 to 2009, describing the use of management software and procedures to develop, encourage as well as control staff and students. Evidence is provided of a consistent student output despite a rapidly increasing student body, listing the significant issues that arose with the operation of two project modules despite a system with good documentation and supporting material.

The distribution of results that were obtained, showed a process where the median grades were consistent for the period of 2001 to 2009 for over 8000 students completing projects in this period. Results show an overall pass rate of 90% for the group project and 86% for the individual project including both academic failures and withdrawal for domestic reasons. This is a report on practice in a rapidly changing environment with lessons and recommendations for the future.

Keywords: Undergraduate Projects, Individual, Group, Computing Science

Introduction

The project method was thought to have been invented in the early 1900’s by American school teachers. Knoll (1997) claims that it was invented in Italy in 16th and 17th century. Ashwin in Adderley et al. (1975) quotes the work of Swift and Johnson from the 18th century supporting earlier understanding of projects. According to Clive Ashwin (1975) Stephenson (1921), Dewey (1916) and Kilpatrick (1918), were primarily responsible for the development of the project method in the USA before the Second World War. By the early 1920’s the method was reported in schools in England (Ashwin 1975, Gowan, 1967, Parkhurst 1922, Gull 1933), but there is some evidence that the method was used in UK University departments in the late 1920’s (Ashwin 1975). Knoll (1997) claims that the rediscovery of the project method in Europe was after 1965 but engineering degrees at London University and elsewhere in the UK had individual projects before that time (Steed 1961). Pitt & Censlive (1994) used project based methods in teaching product design to electronics students

One definitions of student projects is from the Council for National Academic Awards (CNAA) (1971).

> A Project is an investigation fulfilling the requirements of a Specification approved by the Supervisor, and which has normally no uniquely correct answer. It is the culmination of the studies of an undergraduate and involves them in making judgements and comparisons. It is usually concerned with a real problem in the field in which the student is working, but it is often simplified to permit a suitable degree of finality to be approached in the time available. The student must write a detailed report on their work, which must come to clear and definite conclusions.

Major pedagogic advantages of project work stem from the feature that a project is active rather than passive. Projects also provide one of the few ways that combine knowledge from different taught disciplines with the integration taking place in the student's mind. Linking research, projects and the modus vivendi of industrial or business activities. Whilst projects are usually created by staff, students are encouraged to suggest problems to be solved, especially fruitful when the student is involved in a placement in industry. Projects require a detailed written report, an oral assessment, sometimes, a set of procedures and/or a computer program. The programme of work is carried out over a period of time, normally at the student timetable allocated at least 3 hours a week over one academic semester of 12 weeks for the group project, plus any extra time the student spent, this means that the student has to show motivation and commitment as well as resourcefulness. Teaching staff are in a supervisory capacity at most stages of the project, however the student can consult any members of staff, electronic sources of information and learn how to make best use of or validate this material.

Middlesex University admits students from every continent with several overseas campuses and on its computing courses over 100 countries worldwide from Europe, Asia and Africa are represented. Middlesex introduced projects into its computing courses in 2001, but had been using projects in its engineering courses since 1967 as well as in the first BSc degree in IT in 1985. To satisfy the British Computer Society (BCS) regulations for degree accreditation, both a group project and an individual project were included in the modularized undergraduate computing science degree programmes in 2001.

To accommodate group and individual projects two modules CMT3991 and CMT3992 were designed by Darren Dalcher and other staff. Later the first author improved the content and organization. To enable the management of a variety of different programmes in a period when computing student numbers were growing every year, a computerised system management software package (PAM) was designed by a number of senior school staff but produced by a London based software house for a large initial and continuing maintenance cost. The cost of maintenance became too great and an in-house piece of software of smaller scope was created after the period under discussion here.

The aim of this paper is to describe the management of the two project modules, the salient problems encountered with the solutions used to control the process quality using the management software. It is a report about practice in a different academic world to today with lessons and recommendations to be drawn for the future.

Organisation

The School undergraduate degree programmes all included initially, the same two project modules, CMT3991 and CMT3992. CMT3991 consisted of three elements; a lecture programme in project management based on "The Project Management Body of Knowledge" (1996) from the Project Management Institute. This was slightly simplified to make the message and methods of project organisation, Time planning and problem solving, clear to students. The second component was an assessed group project and the third, an assessed individual project proposal, if approved, would be undertaken as an individual project in CMT3992 the following semester. The first author was the projects coordinator for the undergraduate projects from 2002 to 2006 and the second author from 2006 to 2009.

Operation of the Software management package PAM

PAM (Project Assessment and Management software), was designed to enable student progress to be monitored, assessed consistently and fairly. Since this assessment is based on academic judgement, assessment criteria were incorporated into the software with prompts provided by the software that could be exceptionally overridden and individual staff comments could be added. There were two aspects to the operation of the management software, the student input and the lecturer input. Students submitted their work online via the PAM system with a printed set of final documents for the external and internal examiners. Large amounts of time and discussion resulted from students and staff losing their password access to the PAM system. This issue was almost entirely eliminated when control of passwords was handed to a dedicated administrator.

Allocation, organisation and supervision.

CMT3991 Group Project.

1. The group project for a given year was devised by the CMT3991 staff team and given to all students in the computing school except those on an accredited BEng scheme or joint honours, including those overseas. The BEng students were allocated a different project closely related to their core programme. Some joint honours students were allowed despite protests to enrol for the 3991 module but not 3992 and vice versa.
2. The groups around 7-8 students in size, were organised inside a weekly formal tutorial class. They were seen each week by their tutor. Each group were expected to have at least one weekly meeting outside the tutorial period. The tutorial was two hours in length usually three groups per tutorial class. The group meetings were minuted and these minutes had to be submitted in the final group report with attendance of student members listed. These minutes were signed off by their tutor. The students included a peer assessment of all contributions to the project.
3. The proposals for the students' individual projects, to be carried out in CMT3992, were created in the tutorial groups in CMT3991. Titles available from staff, were displayed on OASIS, an online Middlesex data base, but students could suggest their own after discussion with approval by a committee of senior staff. These ideas were worked up into a proposal, including a Gantt chart, for implementation in semester 2 in CMT3992. These proposals were presented orally to the rest of the class who peer assessed the work. A written proposal was submitted in week 9 of the 12 week semester. This was marked by the seminar tutor. The presentations were videoed for Quality Assurance purposes and to give feedback to the students.

Students were expected to spend around 3 hours on their work for this module outside the classroom. Together with the 2 hour tutorial and 1 hour lecture a total of 6 hours per week. The length of the module was 12 weeks.

CMT3992 Individual project.

1. The project was developed from the proposal initiated in semester 1 in CMT3991. A supervisor may have been found in semester 1 but if not, one would be allocated by the module leader taking account of staff expertise and the project topic. Students were required to spend at least 6 hours a week for 12 weeks
2. Each Student was expected to see their supervisor at least once a fortnight for at least 30 minutes.

Assessment.

All marking was completed on-line with the PAM system. The individual presentation was given a weighting of 10%, the individual written proposal weighted at 30% and the group project report at 60%. The group report was double blind marked using the weightings fixed in the PAM system. If a difference in mark occurred between markers of more than 10% then the markers had to negotiate an agreed mark. If they could not agree a third marker assessed the report. The seminar tutor also evaluated the individual contribution on the basis of their observations of contributions during the tutorial sessions and signed statements of peer contribution by the students in the group report.

Arrangements for meeting the British Computer Society (BCS) requirements for degree accreditation were in two parts:

1. The requirements of BCS were discussed with the students in the lecture programme for CMT 3991. In the module handbook the students were given the requirements in tabular form and were required to fill in the form and submit the form bound inside their CMT3992 report, together with a review to indicate their view of how the requirements were satisfied.
2. On the PAM marking grid staff had to indicate whether the project satisfied the BCS requirements.

   Access to PAM after the assessment was incorporated in the system to allow feedback to be provided to students. It was observed that around half of the students bothered to read the feedback.

Results

Distribution of grade results over a period of time from 2001 to 2009 for the two modules are shown in figs 1 & 2 illustrating how the grade distribution changed over the years 2001-2009 for the two modules.

At Middlesex a modular degree system was in place where the module grade ranges from 1 to 20 with an excellent performance awarded a grade 1. University pass grade was 16 with grades of 17 to 20 awarded if the student failed to satisfy either performance, submission or attendance criteria. It should be noted that these are grades not percentages and the boundaries between classes of degree are decided by the exam board. The percentage conversion and exam board decision process causes peaks at certain grades such as 3, 9 16 corresponding to first class, and second class and pass boundaries. The distributions show a consistent approach to the grade distribution across a number of years.

The correlation between student results for their performance on CMT3992 following CMT3991 show a 32% correlation for results for the years 2001 to 2009 including failure to submit, plagiarism and outright poor projects. If the first attempt pass students are examined. If they did well in 3991 they are very likely to do well in 3992. The correlation is now 90%.

The modules can be taken in a given year and in any of three semesters, hence a descriptor of 200530 indicates the year 2005 in semester 3. Apart from 200530 and 200730, not main stream courses and with very small student numbers, the median grades are consistently around the lower second band, grades 9-11. Students at the bottom of 3991 performance were able subsequently to improve their performance to pass the individual project.

A comparison of module grades was made with the overall final classification of the student's degree. This shows a correlation of 76% for CMT3992 for a first time pass, the individual project but only 47% for the group project module. White (1985) showed a 60% correlation between final classification and performance in individual projects for civil engineers.

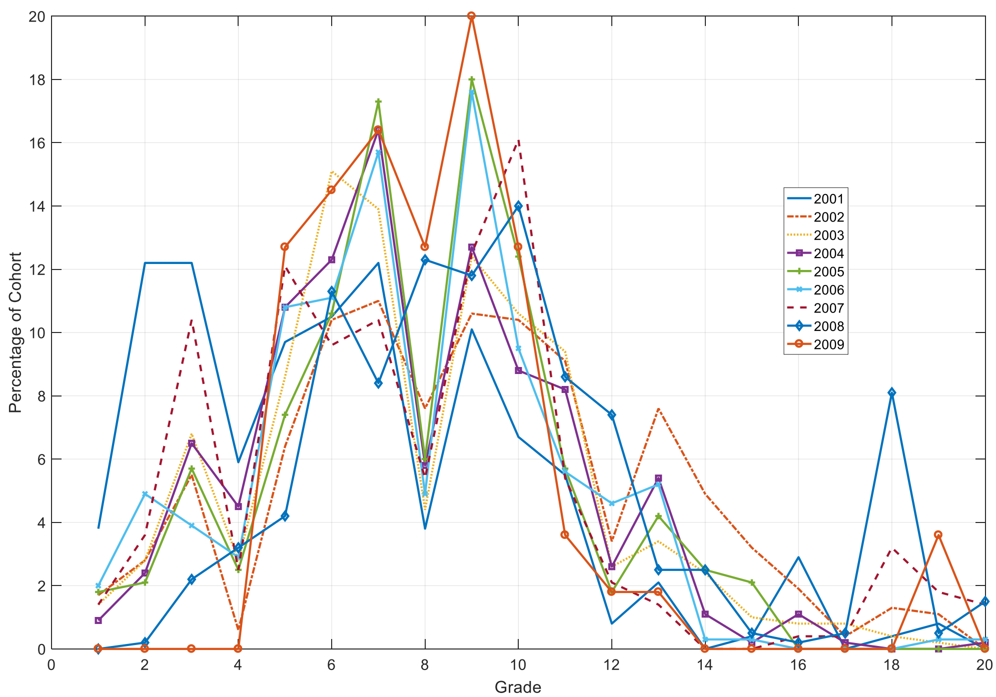

Figure 1

Grade results for module CMT 3991 for years 2001 to 2009

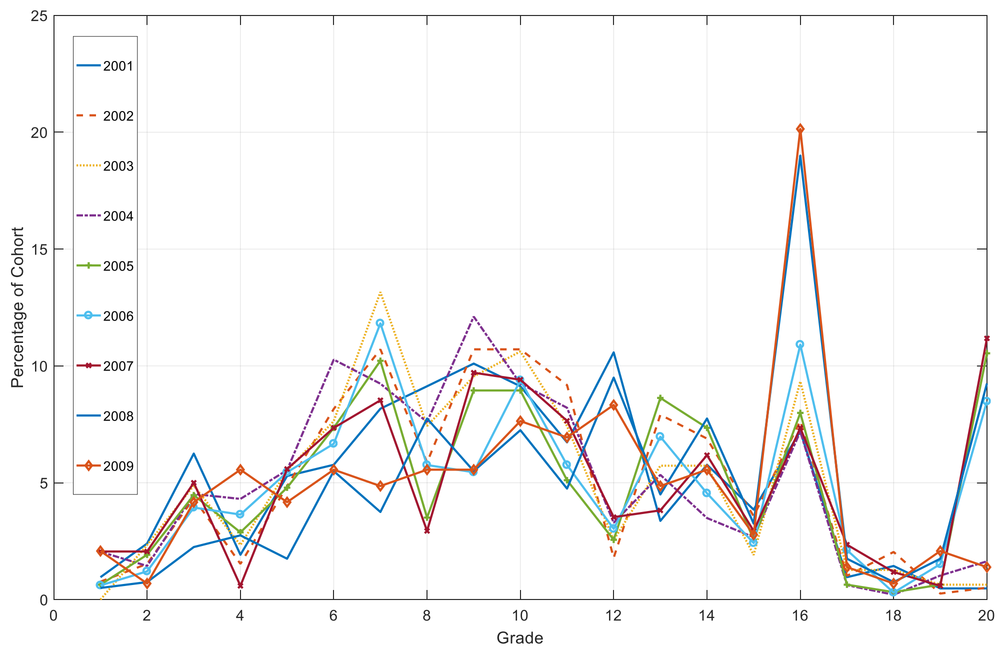

Figure 2

Grade results of module CMT3992 for years 2001 to 2009

The spike in grade 16 results is due to the university policy that repeating or resitting project students could only be awarded a grade 16. In 2001 there was a peak number of students in first class grades, unjustified by assessment guidelines and few lower grades as these students had self-deferred, producing a skewed rather than even distribution. Later results show a smaller number of first class grades with a more even distribution of grades for both CMT3991 and CMT3992. The mean grades (fig 3) for CMT3991 except for 2001 shows a range between grades 8 & 9 into the Lower Second class band. For CMT3992 the average grade range is 9 to 12. Results for 2008 seem to be anomalous, cause unknown.

The standard deviations graph figure 4 show results for CMT3991 around 2.4 a range of 2.4 to 3 less than 2.5 grades most of the years, while the CMT3992 curve shows a range of 2.4 to 2.5 these results are indicative of a tightly controlled process. For figures 3 & 4 the curves listed-r are for data with the failure grades 17 & removed i.e. for pass grades only.

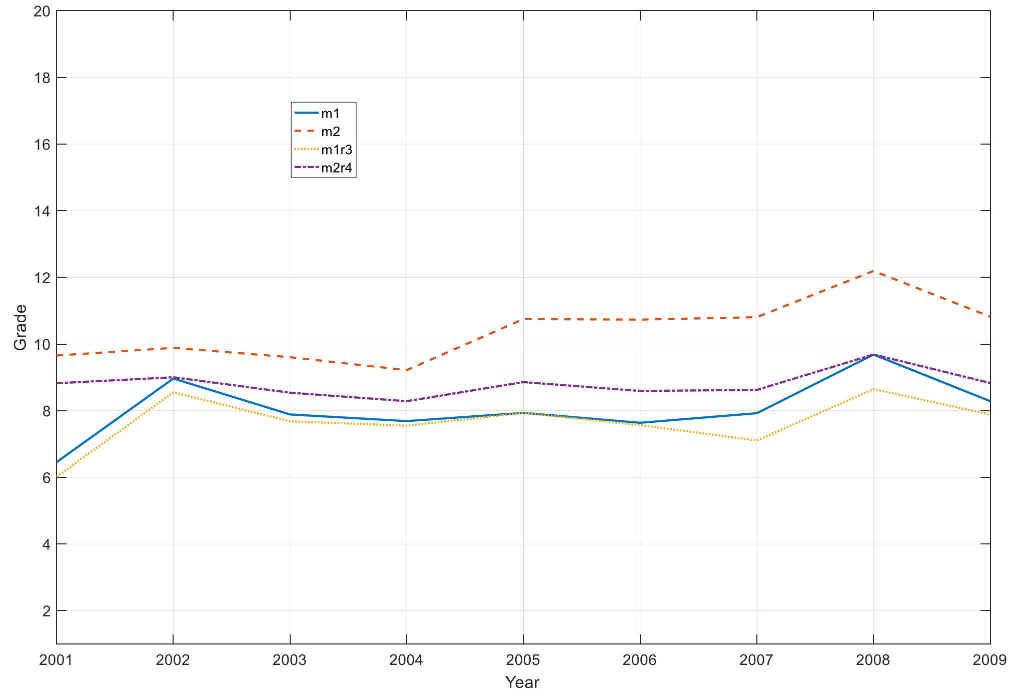

Figure 3

Mean grades for both modules versus year

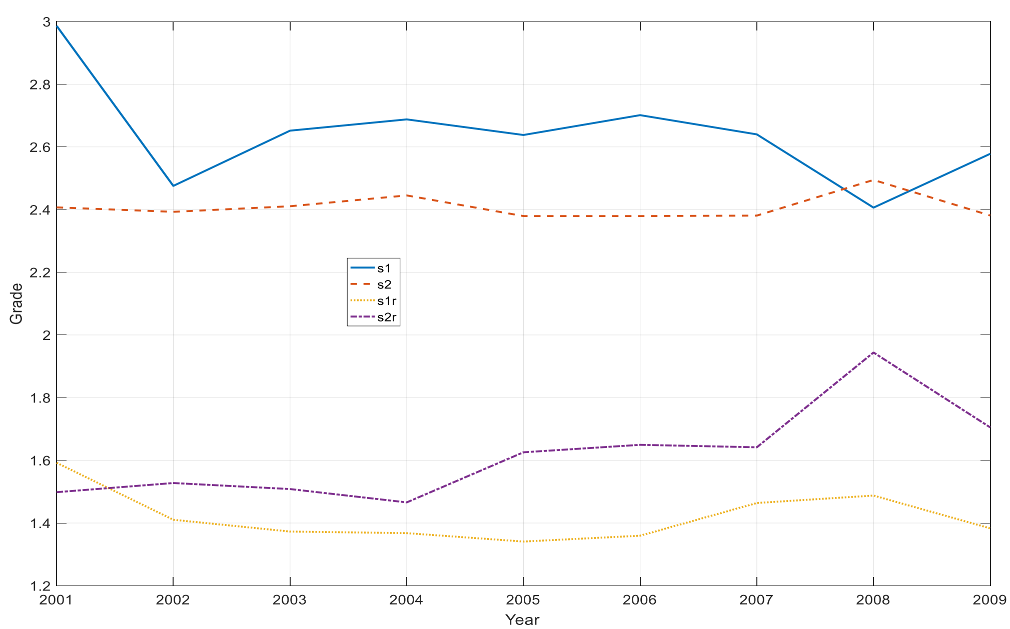

Figure 4

Standard Deviation for both modules versus year

Discussion

The two authors had many years of experience but did not devise the project modules under discussion, but they did take over the running of the schools *undergraduate* projects at a critical time in the introduction of the new programmes. It became immediately apparent that the whole project operation was in difficulty with too many failures or deferrals.

Problems

1. In the first year of operation, some projects, even though they were awarded a pass grade, were of only marginal quality
2. A serious problem existed in the disagreement of assessors as to the overall worth of a given project~ i.e. no assessment consistency! In 2001 too many first class marks were awarded for projects that did not fit the criteria listed in the degree assessment guidelines.
3. There was an alarming level of absenteeism in some of the group projects. This damaged the potential of the good students that did attend.
4. Attendance at lectures in CMT3991 was poor! Computing was taught at 4 sites as well as 1 overseas campus.
5. Students on joint honours were allowed by University module rules to take 3992 without 3991 and the attendant tutorial help. Some students were allowed to take 3992 before 3991 to chagrin of the authors.

If these problems are examined in detail, significant real issues of quality control existed.
Students failed CMT3991 because either:

- They were too heavily committed to their jobs or domestic activities outside the University. It was found that some students were working as night security guards and tended to fall asleep during their lectures.
- Some, a few, were lazy, relying on others to do the work in group projects.
- Some, a small minority, students had inadequate understanding of other subjects in their degree and so did not have the knowledge required for CMT3991 or 3992.
- There was evidence that very weak students should not have been progressed to the third year of their programme. Typically these last two groups were most of those who failed. Measure were introduced to help these students at a much earlier stage.

Students were allowed to self-defer, often quite late in the term. This caused extreme progression difficulties and data management. The deferral process was entirely administrative and not under academic control. It allowed students to postpone classes and assessment to a following year if acceptable evidence was produced.
Students tended to defer for several reasons:

- They started late. Many students arrived back late from holidays abroad due to visa delays.
- They had domestic problems, which they could not overcome in time to produce relevant work.
- A small minority felt they would get a better grade if they repeated the module. They could then spend all of the time in one session on five modules instead of six, concentrating solely on the project module.

In a small number of groups in CMT3991 some members of the group did not attend and/or contribute. This behaviour left the rest of the group penalised by this situation especially if the delinquent student had a level of expertise that was necessary. It was difficult to reach these students to rectify their poor contribution as they did not answer emails, phones etc. from other students or staff or the coordinator. Recorded letters were sent to gain their attention, but often students had moved without submitting their new address. This was mainly solved by an administrator sending weekly reminders about addresses and contact details. After trials a selection process for group membership was put in place that had a reasonable distribution of students selected by second year grade and not allowing students' choice in group membership, to simulate industrial practice. This procedure was however compromised by University rules allowing students to select their seminar times. This is an example of a number of well-meaning administrative rules devised for the modular system to maximise student choice, which had serious academic consequences, defeating the concept of an integrated academic programme. These rules were subsequently changed.

Similar problems existed in the individual project CMT3992 but on a smaller scale than for CMT3991 but here the main problem was found to be the interaction with their project supervisor.

- They often did not get on with and wanted to change their supervisor (often in week 5 of 12 week module!). Initially this resulted in 400 emails a week to the coordinator about this issue alone, costing at least 8 hours a week in urgent action.
- They did not manage their time well enough to see their supervisor until it was too late to get effective help. Many students came from cultures where they felt some embarrassment in admitting to having problems.
- Some staff were not sure exactly what counted as a good British Computer Society (BCS) accredited project, because guidelines initially issued by BCS were NOT clear. (This issue was later eliminated by presentations from BCS)
- Students did NOT understand how to apply principles they have been taught even when staff indicated that this was necessary. This led to a reappraisal of the way some modules were taught with more practical tutorial sessions.
- A minority of students seemed to feel programming was more than they should be expected to do, despite being on a Computer Science degree!
- A small number of students had limited initiative and thought that operation of packages such as Director was sufficient to give them a degree.

Staff numbers in the school had increased rapidly in the years from 2000 onwards and many staff were not experienced in the use of projects in teaching. PAM was only a recording system, not a methodology for producing "good" projects and could not force staff and students to produce quality projects. What it did do however, was to make staff think carefully about the grade they were awarding.

The first issue to tackle the problems outlined above therefore was to devise and implement a staff training regime with full staff timetabled attendance, including the school management team, to explain; what was meant by a project in the computing degrees, how it should be undertaken and what the outputs should be. This was also reinforced with individual training from the first author. This should have been put in place before the modules were started. Staff training in the use of the PAM assessment software was also introduced at the earliest stage with update seminars when changes were introduced. The average amount of training per staff member was 12 hours, some had considerably more individual attention. Quality assurance to improve content and delivery in earlier years of the degree programmes was also put in place. Exemplar project reports, anonymized, were placed in the library to help students to understand how to write a proper report. Also many viva components were introduced within the groups to inculcate a sense of confidence in students who lacked both confidence and motivation. This change in culture was very rapid and effective.

When the first author took over the control of the undergraduate projects all the groups in CMT 3991 were allowed to choose their own project topic. This was a complete disaster and large numbers of students on CMT3991 after 5 weeks were in groups that were likely to fail as many topics could not satisfy the honours requirements and meet the scrutiny of the external examiners. Rapid intervention had to be made to rescue these groups with extra supervision and coordinated staff guidance. The following semester all groups were required to undertake the same group project so that detailed comparisons could be made and standards maintained. This improvement had a knock on effect with the individual project, by the following semester the failure rate of groups was down to one or none and although the numbers of students did increase to around 500 on each module the overall performance as shown in figure 2 indicates a level of consistent performance. This is despite the fact that there were, in our opinion, too few staff to teach the large numbers of students and the project loading on staff was extremely high. Some staff were supervising up to 18 projects! This was on top of a high number of teaching hours but project supervision was not counted in staff contact hours. The possibility of group project failure was ever present and at least one group got into difficulties each year. These groups caused most staff effort. Some of the causes for these problems are discussed below. The workload on the coordinator to address these problems was around 50 hour per week and group tutor workloads were also high at around 15 to 20 hours a week.

In these years of rapid expansion in student numbers, many of the overseas students had difficulty with English, this proved to be a special challenge with projects and extra assistance was negotiated with support *English as a Foreign Language* (EFL) units. Extra library assistance and training was put in place to help the students' research their projects and reprise their first year induction Library training.

One of the complaints from students in the groups was that details of their solutions was leaking to other groups. This was addressed by introducing penalties to both leakers and recipients. Individual students who did not pull their weight caused bitter complaints to staff throughout the group projects. This was dealt with by allowing the groups to sack group members and they then could be reemployed at a penalty as consultants. If they did not deliver to the group satisfaction they would then fail the module!

Throughout the operation of the modules the handbooks and other online information was judged to be very good by the authors and the external examiners, needing only minor improvements.

The arrangement of having the group project and an individual project in the final year was changed after our tenure of management, with the group project work placed in the second year and the individual project lengthened to a whole year on our advice. The group project is an excellent vehicle for educating graduates who will operate in teams such as computing students but the resource limitations meant that it could not be operated effectively as a school wide system in this case. This is despite some groups producing excellent ideas and working them up to industry standard outputs.

Recommendations

Lessons learned from this exercise are based on experience prior to these modules on engineering programmes and from the experience of coping with the rapid change on these courses and are three-fold. One to improve the specific experience of the students and secondly to improve the management process for staff, thirdly to improve the educational process.

1. All the students on the Middlesex programmes are from different educational styles and of somewhat different content. Even after two years of study at Middlesex these differences were still visible, staff have therefore to be made aware of these. Contact time is important for smooth development of the project and so it is recommended that student contact time with supervisors should be at least an hour per week. This implies that the number of students supervised by one member of staff should be limited to 8 to 12, preferably 8. Staff should have this workload recognised in their timetable, not achieved at Middlesex and students need to have time-tabled sessions. This was achieved for the group projects here, but not for the individual projects. Group size is critical to the success of group projects. Too large a group allows students to hide and not fulfil their and the groups' potential. Too small a group and the loss of one member causes the group to implode a leads to multiple failures. In our experience across both computing and engineering courses the best group size is between 7 and 10, with a recommended size of 7 to 8.

2. Administration of projects does not become difficult until the numbers reach 300, provided they are on the same campus. Handling the data manually was certainly practical at numbers less than 200. At larger numbers some electronic data storage and processing is required to avoid errors. The PAM system was extremely novel for its' time but a more sophisticated system could be created now with additional AI features to recognise comments made by staff and ensure consistency of grading.

   Features, which were evaluated post processing such as grade distribution and global averaging, identifying continual under or over marking by individual staff could be flagged-up to the coordinator for real time intervention. However such a system should not be made fully automatic as the problems that arise are specific to individual students. Training needs should be timetabled for staff on a regular basis perhaps with quality circles established, but certainly with regular feedback to all staff. As implemented here, there must be a projects coordinator with sufficient seniority to challenge individual members of staff and management when matters become difficult.

3. To improve the educational benefit of the computer based assessment system it is suggested that students are required to enter a weekly diary of their work and meetings with their supervisors in order for students and coordinator to see the progress of their work. The system could prompt the students with a set of questions to be answered each week input by staff. The system could also be designed so that the draft report is entered on the system with AI output to propose improvements to the draft.

Conclusions

During the period 2001 to 2009 over 8000 students successfully undertook group and individual projects in the School of Computing Science at Middlesex University. The overall pass rate was 86% at first attempt. The rate of first class grades was 7% for the individual project and 10% for the group project module. The higher rate for the CMT3991 was partially due to a higher mark for the individual project proposal. The median grades for the individual projects was consistently in the lower second class level. Correlation of the individual pass project grade to the final degree class was 76%, while the correlation with the group project was less than 50%. For the case of first pass grade the correlation of CMT3991 to CMT3992 grades was around 84%.

One of the essential features of managing the projects was the critical administrative support necessary to control the project process properly.

The yearly mark distribution was very similar over the period 2002 to 2009. Peaks in that distribution correspond to grade boundaries 3 for first class performance and 9 for second class and 16 for pass grade.

The problems initially encountered by the authors, on what was a soundly designed module curriculum with good supporting material using an online marking and assessment software are described in detail but are similar to those encountered by many institutions today as observed by the first author as external examiner and in visits to institutions around the country but not on the scale reported here. These issues are dealt with by hard working and dedicated staff committing considerable time and effort to deal with students on an individual basis. The problems experienced by Middlesex, and the computing school in particular, at this time where it operated over 5 campuses, over twenty different degree programmes, student numbers increasing rapidly and increasing student /staff ratios (up to 100) are unlikely to be met again.

Despite problems outlined above the results tend to show a process that was well in control with an acceptable regular distribution of grades with a narrow dispersion.

The paper describes many of the procedures that had to be put in place to reduce these operational problems.

There is no doubt that most students taught in this regime, performed better than they would have done on a course without projects. Many students surprised themselves with the confidence in their own capability to tackle issues they would not have considered before they undertook their own projects. The group projects showed them all for the first time that interpersonal relations, communications and cooperation were key to project success in the classroom and the outside world.

Acknowledgements

We wish to thank all the project tutors who spent so many hours implementing this project system and to the many admin staff who contributed to the successful operation of these two project modules.

Ethical Issues

The coding and anonymization of the data is regarded as sufficient, as the retrieval or identification of an individual's data is not possible from material published here.

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Appendix 1

An example of a group project from 2005 is given below.

CMT 3991 GROUP PROJECT SEMESTER 1 2005

TITLE: Software for testing human response to screen icon movement

Background

As part of a National testing programme for the effects of ageing on usage of IT, Middlesex is aiming to test how users respond to the rate of movement, size and colour of screen icons. This has significant bearing on the design of games and other software that requires users to react dynamically to screen visual inputs.

Specification

The software you must design has to generate icons of various sizes at random positions on the screen. These must move at different rates in arbitrary directions on the screens. The user has to "capture" the icon by moving the mouse until the mouse symbol is over the icon.

- It is then required that the time from the first appearance of the icon to the capture is recorded,
- Together with the information of initial screen location, speed and direction of movement.
- This information must be displayed statistically and graphically.
- The icon size and colour should also be capable of being set.
- Extra marks will be given for software that records the track of the mouse input.
- Extra marks will also be given for additional functionality.
- The report should also include at least 12 sets of trial data.

Any tools or languages can be used but if proprietary software components are used then their use must be fully justified.

ALL software must be capable of being modified at a later date by Middlesex staff and source code must be submitted for inspection.

Note: this project was very successful. All the groups produced working software and the best groups analysed different populations of large numbers of students to produce very interesting results that formed the basis of a research proposal.