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A Blended Approach to Collaborative Learning: Making Large Group Teaching More Student-Centred*

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Current educational thinking promotes a student-centred approach to teaching as more engaging and challenging for students, leading to improved learning outcomes. But what is 'student-centred' learning, and how can it be achieved in a higher education setting with very large classes and content-rich courses? In a materials engineering course for 300 first-year engineers, an online group project was introduced to add authenticity and collaborative activity into the course, and to improve student engagement. We explore the design, development and implementation of the project, and see if the intended outcomes were achieved.

Keywords: Student-centred, collaborative learning, problem-based learning, group work, large group teaching, online

INTRODUCTION

THE COURSE (MATERIALS ENGINEERING) is one with a large (300+) first-year cohort, and content-rich subject matter (materials science for engineers). In addition to lectures and laboratory sessions, the course was already successfully using computer-based tutorials [1]; when the central educational development unit at UNSW was requested by the School of Materials Science and Engineering to review these with the intention of providing them online via WebCT, it was seen as an ideal opportunity to use the online learning design to improve student engagement, and to incorporate learning for graduate attributes such as problem-solving and team-work.

The aims for the course development were:

- To enhance student engagement and motivation
- To improve the ability of students to apply their learning to real-life problems
- To encourage students to be more self-directed in their learning
- To support the development of generic skills
- To make student access to the course more flexible
- To improve efficiency for teachers managing the course.

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It was decided that for this course a student-centred approach could enhance the engagement and motivation of students, provide a more authentic learning experience and develop generic skills. An online, problem-based group project was planned that could incorporate these elements while utilising the upgraded computer-based material as project resources.

The online course was designed by a project team comprising the academics involved in implementing the course and an educational designer who advised on the design of the online components and built the online course. There was substantial production support, including a multimedia designer for 'Flash' elements in the online tutorials.

Student-centred learning

Knowles [2] proposed a teaching approach that placed students at the centre of their learning. Biggs [3] focused on 'what the student does' as being critical to what is learned, and suggests that the focus of teaching should then be on 'whether student activities leading to appropriate learning are being supported'. In content-rich courses there is a tendency to use a topic-based knowledge-transmission approach which, while it may effectively allow students to pass exams, does not support them in contextualising and synthesising their knowledge and applying it in real world contexts. This teacher-centric approach inhibits

the students from grounding knowledge in their own experience and from being able to transfer learning to different contexts also to solve open-ended problems, all of which are necessary skills for future learning and employment.

Hogan [4] voiced the realisation that she, as the teacher, 'was the most active learner in [her] class—because [she] had total responsibility for what was learned and how it was presented'. As Biggs [3] points out, 'It's not what *teachers* do, it's what *students* do that is the important thing'. If, with teacher guidance and support, students can take responsibility for what they learn and how they learn it, the learning process becomes more challenging, engaging and responsive. A key challenge for student-centred learning design is how to encourage and support students to take on this responsibility, with the teacher becoming a facilitator of learning rather than the provider of knowledge.

Based on Gibbs [5], Sparrow et al [6] suggest that student-centred learning displays three core characteristics: the student has input into 'what is learned, how it is learned and when it is learned'. They propose that this definition implies a need for students to assume a high level of responsibility in managing their learning.

Problem-based and collaborative learning

A strongly supported method for promoting student-centred learning is problem-based learning, a constructivist approach that requires learners to construct and develop their own knowledge through researching and developing solutions to an open-ended, 'real-life' problem [7].

Problems given for assessment are often well defined with a specific correct answer, which is comfortable for students, and easy to assess for teachers. But this does not prepare students for real-life problems, which tend to be ill-defined, and with a range of possible solutions [8]. Solving a problem that is more authentic requires an approach that is both constructive and critical.

Collaborative learning, where students work together and knowledge is socially constructed, is a complementary approach which supports the transfer of responsibility to students, while also developing important workplace skills such as discipline-based communication and the ability to work in a team. Livingstone and Lynch [9] suggest that:

> Given the demand among employers for graduates who can operate successfully in teams, it is important to engender a positive response from students for team working. . . . Well-structured and managed group work provides students with a set of transferable skills and a vehicle for critically examining their subject, both of which are important components of modern courses.

A collaborative approach, through group work, would not only provide the students with an authentic learning experience that would develop generic skills in communication, collaboration and team building [9, 10, 11], but would also assist teachers in the management and assessment of the large cohort.

A blended approach

A blended approach to teaching and learning has the potential to utilise the best aspects of face-to-face and online modes, to enhance the learning experience. Course content, with related activities, can be provided online, allowing face-to-face time to be utilised for activities that are more hands-on, such as labs and demonstrations. Therefore, some non-interactive face-to-face activities, such as lectures, can be replaced or supplemented by more interactive online activities. An online component can also support social aspects of the course, promoting a 'community of practice' during the group project, and enhancing teacher contact with, and responsiveness to, the students.

PRESENTATION

Introduction

The project design is focused not upon the course content but upon the activity that students complete [8]. The project was designed to require critical thinking and application of understanding derived from research, with the presentation of a 'real life' problem providing the students with an authentic learning experience, and the other components of the course serving as resources for the project.

While this course still has elements requiring face-to-face contact (lectures, laboratories), a particular challenge with the large cohort is to manage facilitation of the group learning, without requiring substantially more teacher input. Hannafin and Land [12] acknowledge the logistical problems in managing a student-centred approach, and suggest that ' . . . technology-enhanced, student-centered learning environments . . . use technology to enable flexible methods through which processes can be supported'.

The tutorials were already computer based and planned for online delivery, so using the online environment to manage the group learning for a large cohort was practical for teachers and had student benefits in providing flexibility and encouraging self-directed learning. Some lecture hours were replaced with online facilitation time and some of the group facilitation responsibility was shifted to the students by requiring the project groups to be self-facilitating, and to participate in a peer review of another group's submission.

Authentic problem

Student groups could select a topic from a list of everyday items (e.g bicycle frame or a golf club), for which they would investigate the characteristics of materials and select those materials most appropriate for the task, and suggest a manufacturing

route, with justification based on research. The research and documentation process was left up to the group to organise, although a template for submissions was provided to assist in organising the information. To provide formative feedback and to check on group functionality, groups were required to make several submissions during the process, some of which were summatively assessed, including a peer review.

Peer review

Intrinsic to the experiential learning cycle propagated by Kolb [13], among others, is the opportunity to reflect upon learning. Peer review offers the opportunity for students to not only become aware of how other learners approach a similar problem, but also develop an understanding of the criteria by which they may evaluate their own work, thereby promoting constructive reflection. For this project, one of the submissions was peer reviewed, with each group peer reviewing a project with a different topic from their own. Group members were then graded on their performance as reviewers.

Distribution of marks frequently emerges as an issue in group work. So that student grades could be influenced by their group participation, a group peer review process, whereby the performance of the individual members of groups was assessed and graded by other team members, was also included.

Resources and support

Other aspects of the course retained a more traditional approach. Hannafin and Land [12] suggest that 'Many learners cannot effectively engage higher-order tasks until they acquire sufficient background knowledge or skill. In such instances, conventional directed learning approaches support the automization of important foundation knowledge and skills'. It was expected that the lectures, labs and online tutorials, where a more directed approach was taken (including self-tests and quizzes), would provide prerequisite knowledge and constitute a major resource for students researching the project. Links to relevant web sites provided a starting point for independent research.

Other online support was provided, including a discussion forum (Help forum) moderated on a daily basis, detailed project guidelines and resources to support the group facilitation process. Students were encouraged to address course-related queries to the online Help forum, rather than contact the teacher directly. This successfully allowed all students to see the feedback and often to answer each other's queries. The requirement to submit several submissions for the project, as well as a peer review for the work of another group, provided multiple formative feedback opportunities.

Group facilitation and orientation

The groups were randomly generated to provide the best mix of ability, diversity of experience, and ethnicity, as well as to simulate the real world situation [10]. Groups were generated to consist of four students since this size was considered large enough to accommodate future 'drop-outs' while being small enough to promote inclusivity. The students were from first-year engineering who mostly had little experience of either group work or online learning. To support the group facilitation, they were provided with some online information about how to work in groups, and a template for a group contract to assist with establishing group roles. Salmon's 'five-step' model for enabling online learning [14] recommends the inclusion of an initial socialisation phase, so orientation activities were included to introduce students, firstly to the online environment, then to the communication tools and to their group members.

Implementation

The course comprises one eighth of the session workload for the students. It is at introductory level but, for most students, it is the only learning provided in materials science during their programme and it is therefore also comprehensive. The assessment for the course is 10% from laboratory reports, 10% from online tutorials, 20% from the group project, 20% from a midsession quiz and 40% from the end of session exam.

There have been six implementations (through to 2007) of the online project, which runs for the full semester (14 weeks). The first, in 2004, used WebCT CE 4 as the online learning management system (LMS), while since 2005 WebCT Vista 3 has been used. It should be mentioned that the 2005 implementation was a pilot project in UNSW's use of Vista, and some technical issues caused problems for students. Since 2006 there have been two implementations of the course each year.

The intention of the group project was that the groups be self-facilitating; to assist in the management they were asked to appoint a spokesperson who would communicate with the instructor and submit work on behalf of the group. Each group was provided with a private discussion board to allow them to communicate online. The group was also required to negotiate a group contract and to post it on their group discussion board by the end of Week 3.

As part of the preliminary activities, the students were provided online with background material on the benefits of, and the processes involved in, working in groups. A number of different topics were posted in Week 4 and the groups requested to select one. The topics were then assigned to the groups on a first-in basis. Approximately seven groups were assigned each of the different topics. A public topic discussion board was then provided for each of the topics.

The group project involved five separate submissions, three of which were assessable. The first submission (assessable) was a preliminary material selection (generic material selection) which

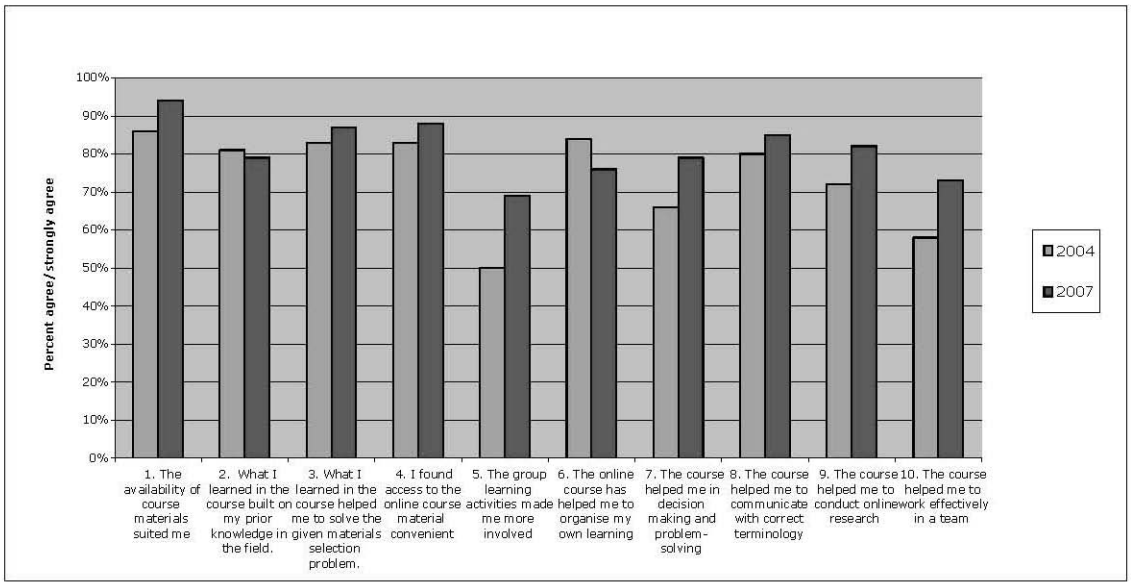

Fig. 1. Course feedback survey 2004–2007.

involved identifying the required material properties for the components in the item and identifying which generic classes of material would satisfy these. This submission was due in Week 7. The second submission, the peer review (again assessable), was due in Week 9 (the midsession quiz was held in Week 8). The third submission, due in Week 11, was non-assessable but was incorporated to ensure that students were progressing their work. This required the group to revise their first submission and to select specific (as against generic) materials for the components in their item. A fourth (non assessable) submission was due in Week 12 in which the groups had to outline the manufacturing route for their item. The final submission (assessable) collated the work done in Submissions 3 and 4 and additionally required identification of suppliers. This was due in Week 13.

In the design of the project it was recognized that it was necessary to ensure a comparable level of difficulty across the range of projects provided. This was a challenge since some items could be more complex than others. It was therefore suggested that the groups should usually examine two to three components from their item although in some cases (the more complex ones) only one component might be appropriate, a flexibility in keeping with the goal of making the problem ill-defined. Detailed instructions of the tasks required were provided online, together with a template for submissions, and the criteria for grading the project.

The groups were each given instructor feedback on their first and third submissions, as well as the peer review of their work for the first submission, which had been undertaken by one of the other groups. This feedback was intended to assist the groups in revising their earlier submissions for incorporation into the final submission. All final submissions were posted online in Week 14 for all students to view. The first submission and the peer review were each assigned 25% of the total project mark with the final submission making up the remaining 50%.

To accommodate the possibility that some students might contribute less than others a peer assessment was incorporated where students rated the performance of the others in their group. They were required to assign a mark of -3 to $+3$ to each of the members with the requirement that the total marks assigned summed to zero. Based on the peer assessment, the marks for the individual members were then moderated by up to plus or minus 10%. The peer assessment was required to be submitted in Week 13 at the completion of the project.

DISCUSSION

Were the aims achieved? Implementation 1, 2004

Substantial evaluation was done for each implementation of the course, assessing the design of the online component of the course in the context of the whole course. It particularly referenced the project aims detailed earlier and identified in the subheadings below. The evaluation design was both objectives-based and participant-orientated. The instruments used included student grades and survey data, student focus groups and teacher interviews. The results for 2004 were generally positive (Figure 1) although some problems were identified.

Student engagement and motivation

Response to a survey question on engagement in the group project was equivocal, with only 50% of students agreeing to the statement 'The group learning activities made me more involved' (see

Q5, Figure 1). Management issues associated with group work dominated student feedback about the project. One student commented: 'the group activity sucked because it was all online. If we chose our groups we would not have problems with communication'. A student suggestion for improving the course was: 'Better group assignment allocations. Getting stuck with dropkicks is not fun'. Project workload also emerged as an issue, and likely contributed to the unsatisfactory participation rates.

It is recognised that collaboration is not an automatic result of team work [10], and that 'initial instructor awkwardness and student hostility are both common and natural' [15] while Sparrow et al [6] note that the introduction of student-centred methods to a cohort that is largely accustomed to teacher-centric approaches often results in negative evaluation responses. These attitudes were evident in focus groups and surveys, with the major issues being group management, non-participation of group members and the perceived value of group work. Oakley et al [10] suggest that 'Being part of an ineffective or dysfunctional team may well be inferior to independent study in promoting learning and can lead to extreme frustration and resentment', and propose that students need support to learn the skills required for high-performance teamwork. Because the size of the cohort required groups to be self-facilitating, additional support material on group facilitation was clearly needed, with a focus on how groups could collaborate more effectively on the problem.

Apply learning to real-life problems

There was some evidence of engagement engendered by an authentic problem. Comments on 'The best features of this course' were: 'Learning about how material properties relate to real-world problems and situations'; 'Enjoyed applying what we've learnt', 'Apply things learnt from the lectures and tutes to actual objects'. Survey data indicated that most students (83%) felt that what they learned in the course had helped them to solve the given problem (Q3, Figure 1).

Self-directed learning

Most students (84%) agreed that the online course had helped them to organise their own learning (Q6, Figure 1). They were also extremely positive about the flexible access to online aspects of the course, which seemed to engender a feeling of control and encourage self-responsibility. Comments on 'The best features of this course' included: 'the freedom of online tutorials and the web based communication and approach to material'. In focus groups, students were critical of some others who were not able to organise themselves effectively in doing the group work.

Development of generic skills

There was substantially positive response to survey questions relating to development of generic skills, particularly communicating with correct terminology (80% agreed, Q8), and conducting online research (72%, Q9). Slightly lower, but still positive, results for decision-making and problem solving (66%, Q7), and working effectively in a team (58%) were obtained (Q10, Figure 1).

Student access to the course more flexible

The flexibility of access to tutorials and group discussions was very much appreciated, reflected in both surveys and focus groups. Comments on 'The best features of this course' included: 'the course can be done online, that means we can study 7/24, I think it is good'; 'The fact that they made it flexible, you didn't have to meet face-to face, everything available on line'. 86% of students agreed that 'The availability of course materials suited me', while 83% agreed that they 'found access to the course material convenient' (Q1, Q4, Figure 1).

Efficiency for teachers managing the course

The flexibility suited teachers too, with much facilitation being able to be done by teaching assistants. The need to provide teaching assistants with facilitation guidance became evident, with some criticism expressed in student focus groups of the efficacy of online feedback in one implementation (2006). While lecture time was reduced, and time spent marking tutorial quizzes was eliminated by using computer-based grading, facilitation of the group project, and assessment of the project submissions, was time-consuming and did not lead to a net benefit in time-saving. Reduction in lecture time, and some use of teaching assistants mitigated this. A focus for ongoing implementation, however, must be to further improve efficiency. Improvements in group facilitation processes and in project structure and assessment criteria will support this aim.

Student grades

The introduction of the group project had no significant effect on the overall grades, indeed the relative grades over the years have remained remarkably consistent, with only a 0.1% variation. The group project was only weighted at 20% of the course, so it is perhaps not surprising that the grades did not improve. When student-centred methods are introduced, the continuation of traditional assessment methods (eg examinations) may not reflect the range of learning achieved (e.g ability to apply knowledge in new contexts, development of generic skills and knowledge). The group work effect of constraint on performance of high-achieving students, and improvement of performance for low-achievers was evident, with fewer students in either the distinction (75% plus) or the failure (<50%) grade range.

Collaboration v cooperation

As the groups were self-facilitated, it was required that each group negotiate roles and

develop its own plan for doing the project work. Ideally, each group member would have input into each project aspect, but it was possible for there to be a 'vertical' division of tasks, with each member producing one part of a submission—more of a co-operative approach than true collaboration [16]. A student commented: '[The project was] easy to separate into different sections, you didn't have to meet, you could do it separately'.

Plagiarism

During the first running of the project it was realised that some students were not fully aware of the issue of plagiarism, with substantial chunks of submissions clearly pasted in from web pages. This also caused problems for groups, with students realising that plagiarism by one of their members could jeopardise them all.

Formative evaluation and feedback

While there were numerous opportunities for formative evaluation in the course of the project, many comments related to the desire for more examples and formative evaluation activities in the online tutorials. In some cases it was felt that more self-tests in similar format to the quizzes would be beneficial, while in others, practice exam questions were specifically requested. This highlights the issue of whether the formative evaluations would truly enhance learning, or simply coach for exams, as the exam mark still comprises the largest assessment component.

Student workload

The work involved for students in preparing the project submissions was perceived to be onerous, although unequal sharing of the group load contributed to this perception. Student withdrawals affected the group size, and that affected the workload for the remaining students, as well as making facilitation difficult. The problem definition proved to be problematic for some students, with some groups with simple items choosing to look at only one component, while others with quite complex items looked at two or three components. Some students suggested that the weighting given to the group project should be greater. This should encourage better group participation, and promote deeper involvement in the collaborative activity.

IMPROVEMENTS AND SUBSEQUENT IMPLEMENTATION (2007)

Student engagement and motivation

In the first implementation a substantial minority of students was very negative about the group work experience, and felt that it was not useful or engaging. For subsequent implementations, the purpose of group work, and of the peer review activity, was clearly articulated at the start of the course. Feedback indicated that there was now more appreciation of the benefits of group work, even when it was challenging. Adjusting the workload for the project (see below) also addressed the issue of motivation to some extent, and subsequent evaluations showed that students were generally more satisfied with the group project. In 2007, 69% of students agreed with the statement 'The group learning activities made me more involved', 15% greater than 2004 (Q5, Figure 1).

There were ongoing problems reported by a small number of groups relating to non-participants. A check on early non-participation in discussion, with absent group members being told by the teacher that they would be unenrolled if they did not respond, was effective in arousing some stragglers. Some groups, however, seem to need more support for group facilitation processes; more explicit group facilitation guidelines have now been provided. The relatively small weighting given to the project continued to be an issue; the weighting has now been increased (see *Formative evaluation and feedback* below).

From 2005 the group composition was based on laboratory groups, rather than randomly selected, to assist students in identifying non-participants. This improved the group formation process, but students still requested a face-to-face group orientation session, which has now been introduced, to improve the ability of groups to organise themselves.

Self-directed learning

Students agreeing that the course had helped them in this area fell from 84% in 2004 to 76% in 2007 (Q6, Figure 1). This could be due to the reduced project workload and increase in support reducing the learning challenges for students. This raises the question of whether workload adjustments or additional scaffolding to support less able students, reduces the challenge, and therefore the learning outcomes for others.

Development of generic skills

In spite of this reported perception of a reduced capacity for organising their own learning, students reported substantial improvement in all generic skill development areas. The percentage of students who agreed with the statement 'The course helped me to work effectively in a team' improved from 58% in 2004 to 73% in 2006, while other indicators of generic skill development also increased: 'The course helped me in decision making and problem solving' (66% to 79%), 'the course helped me to conduct online research' (72% to 82%), 'The course helped me to communicate with correct terminology' (80% to 85%) (see Q7, 8, 9 &10, Figure 1). Additional scaffolding of group facilitation processes may have contributed to these reported improvements,

Efficiency for teachers managing the course

Adjusting the number of assignment submissions (see *Student workload* below) has improved

marking efficiency; this could be further improved with the introduction of a computer-based Calibrated Peer Review process, which is under consideration. Changes to group formation has helped to reduce interventions required in that area, and providing better group facilitation processes should further improve efficiency in group management. Additionally, a Frequently Asked Questions page, based on postings on the Help forum, has now been included in the online support.

Collaboration v cooperation

Group facilitation processes should be designed to require students to take a collaborative approach to the project tasks, rather than dividing them and working separately. It could be argued that meeting online in an asynchronous environment encouraged a vertical rather than horizontal division of roles [16], and that explicit instructions for group facilitation (e.g recommending a rotation of roles) could mitigate that tendency.

Plagiarism

In 2005 a plagiarism activity was introduced to complement the existing online group forming exercise. This involved students in the group posting their own definition of plagiarism and the group then posting a consensus definition. Web links giving definitions of plagiarism were provided to assist students with this activity. This, together with the specified word limit for submissions, largely reduced evidence of plagiarism.

Formative evaluation and feedback

To reduce the demand for 'exam coaching' and increase student involvement in the problem-based work, an adjustment to the relative weightings of group project and exam was implemented (from 20/60 to 30/50). Facilitation guides now encourage students to reflect on the group learning process. Additional self-test items have also been incorporated in the online tutorials as well as in the online course support material.

Student grades

Increasing the number of marks for the group project has also appeared to increase the average grades, which had not substantially changed on the introduction of the project. Averages improved from 62.5% in 2004–6 to 67.4% in 2007, with a commensurate reduction in the percentage of failures, which fell from 10.3% over 2004–2006 to 6.8% in 2007. The constraint on performance of high-achieving students was also redressed. Not all of the grade improvement was focused on the project, with performance improving also in the mid-term and final exam, while there was no significant change in lab and tutorial grades.

The increase in average grades was also accompanied by a general grade shift which restored the number of students in the distinction range (75–84%) to its former level. Moreover, the number of students achieving high distinction (85% plus) increased significantly with an attendant decrease in the number in the pass range (50–64%).

Student workload

To reduce student workload for subsequent implementations, the number of submissions for the group project was reduced and a strict word limit imposed for all submissions. It was found that one part of the project (selection of manufacturing route) overlapped with a project that the students were undertaking in a concurrent companion course, so this part of the project was deleted.

To ensure equivalent workload for each topic, the three separate components of the item (e.g golf club head, shaft and handle) that each group must examine were specified. To provide as broad as possible a learning experience, the components specified were chosen to require quite different course material to be evaluated in each case.

Group number was increased to five to allow for some attrition, and an arrangement for penalising non-participants by removing them from the grading of individual submissions has been effective in giving the group more control over grading for individual members. Improved facilitation processes now address the issue of load-sharing by encouraging a collaborative rather than co-operative approach.

CONCLUSIONS

Introduction of a collaborative, problem-based project appears to have improved student engagement and helped to develop generic skills. Initially, no significant effect on overall grades was observed, the project serving mainly to lift lower-performers. However, in later implementations, where the weighting for the group project was increased with a commensurate decrease in the exam weighting, a significant increase in the average grade was observed.

The implementation of online tutorials to enhance flexibility was successfully achieved, and they have been consistently rated by students as one of the most popular and effective aspects of the course. The number of students taking the course annually has more than doubled since 2004 and the course is now run twice yearly. The increased numbers are very encouraging for a non-compulsory (elective) course, particularly since student feedback indicates that the course is quite demanding.

Some negative impact on teacher workload was experienced, with time spent in facilitating and marking the group work not compensated by the reduction in lecture hours. There is still work to be done, notably in supporting group formation and facilitation, and promoting the horizontal division of project tasks, to help more students enjoy a positive group-work experience. Alignment of assessment, and the weighting of group activities

remains an issue—as long as assessments are largely based on demonstration of low-level mastery of specific knowledge and skills (such as in examinations), what the students do, and therefore what they learn, will be driven by that.

The course developers are satisfied that the aims have been achieved, and the online project is already being used as a model for other courses.

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