Using formative group projects with first year students to improve student attendance and promote student cohort cohesion

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Abstract

Formative group projects, utilising enquiry-based learning (EBL), were used to engage first year engineering students more with their courses and their peers in an attempt to improve both student attendance and cohort cohesion. The students were organised into groups by the academics and asked to design and construct a beam from plaster of Paris and their own choice of embedded material for reinforcement. The project enabled the students to acquire certain ‘effective employee’ skills that they would not have been able to attain through a formal lecture. Evaluation of the project demonstrated that the students appreciated both the experience of undertaking a practical student-led project and the importance of developing ‘effective employee’ skills and working in groups to achieve the project aims. The students also appreciated the opportunity to utilise the knowledge they had gained during the early weeks of their undergraduate programmes. Cohort cohesion improved as students from disparate backgrounds worked together in groups during the project and their interaction continued after the project was completed. Attendance and engagement also showed an improvement on the previous academic year.

Keywords: Enquiry-based learning, ‘effective employee’ skills, improving attendance and retention, group projects

Background

The project was aimed at all level 4 (first year) students on the engineering courses delivered by the Department of Engineering at the University of Wolverhampton. The Department of Engineering delivers five engineering degree programmes:

- BEng (Hons)/MEng Automotive Systems Engineering
- BEng (Hons)/MEng Electronics and Communications Engineering
- BSc (Hons)/BEng (Hons)/MEng Engineering Design Management
- BEng (Hons)/MEng Mechanical Engineering
- BEng (Hons)/MEng Mechatronics.

These programmes share a common first year, in that all the level 4 modules are identical. This is one of the justifications behind targeting all of the first year engineering students. Another reason is that the higher education institution (HEI) where the project is based has a policy where attendance is not compulsory and all lecture materials have to be made available to students on the HEI’s virtual learning environment. This appeared to have a detrimental effect on attendance: during the 2009/10 academic year the attendance of the students, and their subsequent performance within some modules, was deemed to be problematic. This indicated that other means were required to maintain attendance and engagement.
The initial idea was to examine the effects of the project on two cohorts. The first cohort would have been comprised of all the level 4 students from the 2010/11 academic year, with the project being undertaken for these students as a method of addressing issues regarding student attendance and cohort cohesion. This cohort comprised 60 students, of whom 57 were male and only 3 female. Table 1 gives a breakdown of students according to origin.

Table 1. Origin of students for academic year 2010/11

<table>
<thead>
<tr>
<th>Origin of students</th>
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The second cohort was comprised of all of the level 4 students from the 2011/12 academic year, with the project being undertaken for these students as a method of tackling issues regarding student attendance and cohort cohesion. This cohort comprised 57 students, of whom 55 were male and only 2 female. Table 2 gives a breakdown of students according to origin.

Table 2. Origin of students for academic year 2011/12

<table>
<thead>
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The approach taken for the project was to utilise formative group projects that were focused on enquiry-based learning (EBL) to provide a solution to a problem set by the project leader. Using formative group projects indicated that there was no summative assessment involved: the outcomes from the projects would not contribute to the students’ grades; however, the students would benefit from undertaking the project in other ways. The intended benefits and outcomes from the group project work, in addition to those of retention and cohesion, are that the students acquired the following ‘effective employee’ skills:

- Team working
- Team leading
- Project planning
- Directing operations
- Practical skills
- Effective decisions in problem solving
- Effective communication.

Other opportunities for which the formative group project should provide are:

- The students to apply knowledge already gained from their degree programmes
- The students to learn aspects of engineering practice that cannot be taught in a formal lecture
- The students to benefit in terms of personal development
- The students to attain a better understanding of the structural design process and the use of materials within that process.

However, due to issues that delayed the development of the project for the first cohort of students, a decision was taken to concentrate on the effects of the project on the second cohort of students. The issues that affected the development of the project for the first cohort of students will be highlighted later on in this case study.

Rationale

The aim of the project was to engage first year engineering students more with their courses and with their peers in order to improve student attendance and cohort cohesion. This was to be achieved by developing a formative group project that would enhance the experience of participating students with regard to attendance and negating social isolation.

During the 2009/10 academic year the attendance of first year engineering students, and their subsequent performance within some modules, was deemed to be problematic. In addition, there were disparate groups of students within the cohort of that year consisting of international students from Africa, international students from India, British Asian students (predominantly Muslim) from Birmingham and students from EU countries, in addition to white British students. The students were also predominantly male, with only two or three female students in the cohort that year.

The HEI where the project was undertaken currently has a policy where attendance is not compulsory and all lecture materials have to be made available to students on its virtual learning environment. In addition to this policy, students undertaking the first year of any degree programme within the HEI are not subject to examinations. However, due to accreditation of the engineering degree programmes with both the Institution of Engineering and Technology (IET) and
the Institution of Mechanical Engineers (IMechE), this policy changed for engineering students from the 2010/11 academic year onwards so that examinations are a requirement during the first year. Despite this change, the other policies of non-compulsory attendance and electronic availability of all lecture materials remained. Other means were therefore required to maintain attendance and engagement.

Four activities undertaken by the London Engineering Project (LEP) were reviewed in order to determine the best course of action for this project to successfully address the issues of retention and cohort cohesion. Prendergast and Read (2007) investigated the development of a practical tool that could be used to promote best practice during both the development and the enhancement of engineering courses, particularly in relation to the factors that affect their validity. These factors are industry demands, student feedback and the widening participation agenda that was being pursued by the government at that time. The research resulted in the development of the following checklist that could be used for inclusive course design and assist academics in the review and development of teaching methods, the learning environment and curriculum content:

- Place engineering theory within its practical context
- Provide opportunities for problem-based learning
- Discuss engineering practice in society
- Equip students with the full range of skills to become professional engineers
- Support the transition from education to employment
- Develop delivery strategies to include all students
- Develop a positive learning environment and culture that is inclusive of all students
- Offer support and networking opportunities
- Emphasise links between students and lecturers
- Promote co-operative working amongst students
- Use a range of assessment methods
- Develop mechanisms to make use of student feedback.

Read and Worjick (2007) investigated the use of teamwork at MSc level that incorporated generic and transferable skills, such as creativity, innovation, team working, presentation skills and project management, in addition to technical and scientific skills. The project also investigated the incorporation of the five specific learning outcomes specified by Wanous (2006). These outcomes were grouped into:

- Commercial and economic
- Management techniques
- Sustainable development
- Legal framework and health and safety
- Professional and ethical conduct.

Taking into consideration the level of the students for the proposed project, the findings surrounding the incorporation of generic and transferable skills were studied and utilised for this project, especially in the context of the comments from some of the students in this study that they would have liked the sessions on generic skills as early as the second year of their programmes, coupled with a rolling programme of generic support. This is of particular importance, as one of the conclusions drawn from the investigation is that the students saw the benefit of the generic skills and this enabled them to become more engaged in learning. The investigation also considered the widening participation agenda and how under-represented groups could be encouraged to consider engineering.
Read (2007) produced a generic model that allowed engineering curricula to adapt to change, especially in the context of the widening participation agenda and being able to attract and retain students from a diversity of backgrounds. The model presented in this research provided a holistic view of engineering throughout a HEI and demonstrated how a series of interlinked strategies are required to make sure that an interesting and diverse curriculum can be embedded into a HEI without the loss of technical content. The research provided a useful insight into the reasoning behind adapting the curriculum, although the main aim of the current project was how to focus a particular aspect of the curriculum to engage the students, in particular how practical skills, creativity and innovation can be harnessed by an EBL exercise.

Read et al. (2007) piloted a solution to the issues arising from the widening participation agenda by establishing weblabs on a system originally developed for allowing remote access to real experimental equipment. Weblabs were demonstrated to provide both general support to the student population and specific support for the students coming into engineering via widening participation. It could be seen that the use of weblabs allowed students to access ReLOAD at times that suited their personal circumstances and allowed for further attempts where they had initially been unsuccessful, giving less academic students the chance to improve grades. Whilst the findings provided considerable insight into the various approaches for engaging disparate student groups, it was decided to utilise a hands-on project to promote student cohesion. (The weblabs provided remote access from home or for distance learning students, whereas the aim of this project was to bring students physically together to undertake a group-based EBL exercise, an objective upon which the weblabs were not strictly focused.)

The approach

The project utilised a formative group project as a means to develop a strategy for engaging first-year engineering students both with their lectures, in terms of attendance, and their peers, in terms of cohort cohesion. The group project utilised EBL. Some guidance and information was provided by academic staff at the start of the project with regard to specific knowledge that the students required in order to undertake it. After that initial guidance and information was presented, the students were left to determine the solution to the challenge set by the project.

The challenge set by the formative group project was to produce a scaled-down concrete beam constructed using plaster of Paris and various methods of reinforcement, such as embedding fibre or metal wire in the plaster of Paris. Two constraints were set by the project leader with regard to the beams: maximum bending stress and maximum weight of beam. The students were expected to determine and justify within the constraints the mix ratio of plaster of Paris to reinforcement, the type of reinforcement material and the cross section of the beam. They were also required to make their own wooden shuttering/forming.

The student groups (mainly of four, although the occasional group contained five) were pre-determined by the project leader to ensure a mix of home and overseas students, as well as a mix from disparate backgrounds. The students were then required to agree responsibilities in their own teams and keep minutes and meeting records of decisions made (i.e. who was responsible for what action). The keeping of minutes and meeting records as a tool for group self-management proved to be partially successful; some groups were meticulous in keeping proper minutes and records, whereas others produced minimal notes as evidence that meetings had taken place.

The beams produced by the teams were to be tested to destruction against a ‘control beam’ of plain plaster of Paris. The team which built the beam with the best strength-to-weight ratio would win the challenge.

It was hoped that the group project would be undertaken in conjunction with a local engineering employer to raise the profile of the project. Although no such employer was identified, this was no impediment to the execution of the group project.
A formal evaluation sheet was developed for the students to complete at the end of the group project to ascertain their views of how they thought the project had worked and what skills they thought they had developed during its course.

The initial intention was to run the project twice. The first run was to be undertaken during Semester 2 of the 2010/11 year, as a means of addressing issues surrounding attendance and cohesion. The second run was to be undertaken during Semester 1 of the 2011/12 year, as a means of preventing issues surrounding attendance and cohesion.

Assessment

A problem occurred that delayed the development of the project early in Semester 2 of the 2010/11 academic year. The majority of the level 4 students of the 2010/11 cohort failed the examinations in the modules that were delivered and assessed in Semester 1 and needed to undertake re-sits for these units. The first activity was therefore delayed until after Easter 2011, during the period leading up to the re-sit examinations (as a means of addressing the retention/cohesion problem).

Out of an expected cohort of 50 students, unfortunately only 15 attended the remedial sessions. The majority of overseas students had opted to return home before the re-sit period and thus were not present for the challenge. Out of the 15, three students were unable to take part due to other commitments. This left the project leader with just 12 students who were divided into two groups of six.

Also, despite guidance from the project leader and other staff with regard to the expectations of the challenge, neither of the two groups produced minutes detailing discussions related to the challenge, nor did either group construct the required beams for testing. 'Due to the lack of engagement, there would have been no realistic benchmark against which to set evaluation. It was therefore deemed pointless to issue evaluation sheets for the challenge. Reasons for this failure could be due to the challenge clashing with the re-sit period; the students were focused more on passing their exams rather than attempting a challenge.

Initial observations suggest that the use of the activity to address a problem after it has occurred has not been very successful. It was therefore hoped that the use of the activity at the start of an academic year (the second iteration), in order to prevent a problem occurring by engaging students when they are 'fresh', would have a more positive outcome.

For the second iteration, a three-hour slot was timetabled one morning every week over a period of ten weeks for the level 4 students of the 2011/12 cohort to undertake the group project. The slot was timetabled on a day when the cohort had no official lectures; however, the students were informed of the importance of attending the group project sessions in terms of engineering practice skills, personal development and an understanding of the mechanical design process. The sessions were administered by two academics who provided initial information sessions relating to the group project and subsequently monitored student attendance and workshop activity in conjunction with the workshop technicians. Attendance of the project sessions was monitored as part of the project.

In the final week the groups presented their findings to the two academics who then asked the group members questions to determine whether the workload had been spread equally or whether one or two members were ‘carrying’ the others. At the end of each presentation the group members were asked to complete an evaluation form to feed back to the academics how the students had perceived the project and whether they had benefited from undertaking it.

Evaluation

The purpose of the evaluation of the project was to determine whether the students had gained any ‘effective employee’ skills (such as effective communication and working in teams) from undertaking it, as well as ascertaining whether the students benefited from undertaking the project in terms of personal development. Another objective was whether the experience of the project
encouraged the students to engage further with their learning on their courses (resulting in improved assessment results and improved retention). Whether or not there was an improvement in cohort cohesion due to groups being pre-determined by the lecturers was also investigated. Although there are no official results available at this point (as the examination boards for modules have not yet taken place), it is possible to consider the performance of students within key modules as an indication of improved results and improved retention.

The evaluation was undertaken using an anonymous written survey issued to the students at the end of the presentations. The students were asked 18 questions in total.

Out of the 57 students in the second cohort, 53 initially engaged with the project in the beginning. By the time the presentations came around at the end of the project, 48 students had continued. Of those 48 who completed the project, 44 completed the evaluation survey. Thus, in terms of the total cohort, 76% completed the evaluation survey; in terms of those students who initially started the project, 83% completed the evaluation survey; and in terms of those students who completed the project through to the presentation stage, 92% completed the evaluation survey. Of the 44 students who completed the evaluation survey, 19 were international and 25 were domestic. Key findings from the survey are reported below.

91% of the students either agreed or partly agreed that they were sufficiently prepared to get the most out of the project. Several attributed this to the initial information sessions provided by the academics at the start of the project: “We did not know where to start but went through it with the lecturer and felt really prepared and went for it.”

Only 4.5% of the students partly disagreed that the preparation was sufficient and attributed this to the fact that the topic covered in the project had not yet been studied on their courses: “It wasn’t actually part of the work being done in class.” This hinted at the students’ misunderstanding of what EBL is essentially about (i.e. investigating the project for themselves with minimal guidance from the academics). Encouragingly, 64% of the students were prepared to act as mentors for students undertaking a similar project in subsequent years.

Regarding the question of ‘effective employee’ skills evidenced from the project:

- 95% of students highlighted team working
- 36% highlighted team leading
- 59% highlighted project planning
- 23% highlighted directing operations
- 34% highlighted health and safety awareness
- 66% highlighted practical hands-on skills
- 52% highlighted effective decisions in problem solving
- 70% highlighted effective communication.

Whilst 20% of the students found the project challenges easy and 23% found them difficult, 52% of the students found the project balanced, neither being too easy or too difficult: “I didn’t truly struggle but neither did I fly through it.”

Some of those students who found the project difficult attributed this to not having undertaken a group project before: “It was quite difficult for me because I never [sic] got involved with this kind of work.”

86% of students agreed or partly agreed that the project gave them the opportunity to apply knowledge from their degree programmes. This can be justified, as the students were studying a level 4 materials module at the same time as they were working on the group project. 89% of the students agreed or partly agreed there were opportunities to learn aspects of engineering practice that could not be picked up from a lecture. This result can be related to the ‘effective employee’ skills evidenced by the project:
- “Team-working, effective communication, project planning, practical hands-on approach, practical hands-on skills.”
- “It was very hands-on and a lot of it was our own decisions instead of something being taught to us.”
- “Lectures seldom have hands-on components and rely on perfect, theoretical working, when real life is not so accurate.”

95% of the students agreed or partly agreed that the project benefited them in terms of personal development. Of those students who left a comment, the importance of team working was stressed:
- “I usually dislike working in a team, but now realise most tasks undertaken by an engineer must be done in groups.”
- “Now I got how to [sic] work in a group and how to work with new people that I don’t know before.”
- “I desperately needed teamwork experience.”

95% of the students also agreed or partly agreed that the project provided them with a better understanding of the mechanical design process. As the engineering programmes share a common level 4, this can be seen as an important factor in terms of retention and progression at the end of the academic year:
- “Designing from beginning to testing.”
- “It has introduced me to some basic design processes.”
- “Better understanding of mechanical design process as a team.”

Regarding the rating of the overall learning experience, 41% thought that the experience was excellent and 45% thought it was very good. 11% found the experience satisfactory, whilst 2% (or one student) found it poor. Regarding improvements to the project learning experience, 66% either agreed or partly agreed that some improvements could be made, in particular with access to the workshop for making the beams. This was a particular difficulty highlighted by some of the student groups which needs to be taken into consideration for future iterations of the beam project:
- “The university is ill-equipped to handle 60 people wanting time in the lab.”
- “More lab time (if available) may help.”
- “Probably spending more time in lab.”
- “Yes because some of the lab assistants were not in on some days.”

Some difficulties experienced by the students during the course of the project were also noted on the evaluation. Many of the difficulties concerned the calculations involved in the design of the beam:
- “Calculations.”
- “Making the calculations for the expected design.”
- “The most difficult part was to calculate the dimensions, so the beam wouldn’t get heavier than 400g.”

Another issue that several of the students found difficult was communication within their groups:
- “Communication between the team members.”
- “Communication between the members of the group.”

However, when asked what they thought was their most significant experience during the project, most of the students stressed the significance of team-work:
• “Group work: getting to know more about working together for one outcome.”
• “Team-work.”
• “The fact of working in a team again, especially working in the workshop with the most experienced technicians on the campus.”
• “Working with new people and writing the whole design process.”
• “The most significant experience for me was that I had to work in a group and with different types of people.”

These comments are borne out at the end of the project when, as a consequence of working together in hand-picked teams, barriers between disparate groups of students appear to have broken down and the cohort of students seems to be more confident in socialising and speaking with each other, both within the environment of a group project or lecture and outside during breaks and after hours.

Another consequence of the project is that attendance and engagement with the degree programmes appears to have improved. More students tend to remain for the full session within modules and are keener to engage with the tutorial material. It is hoped that this will result in improved student retention and improved performance, although at this point there are no official results for modules studied in the first semester of the 2011/12 academic year as the marks have not yet passed through examination boards. However, performance has improved greatly between the previous and current academic years for the two modules on which the students are examined in the first semester, and indications are that retention for these modules will also greatly improve.

Discussion

The general overview deduced from the evaluation was that the students found the beam project to be a valuable experience as it provided them with an opportunity to work in groups at an early stage of their time at university. This is of particular importance as the students face summative group project work in the second, third and fourth years of their engineering courses. The project also enabled the students to gain ‘effective employee’ skills by undertaking the project work with minimal guidance from the academics (whose main role was to maintain an oversight of the process after providing the initial ground rules and information required to undertake the project).

From an academic viewpoint, the project has highlighted the potential of using EBL within modules as a means of summative assessment and learning. The academics have identified the role of the group project in helping international students develop confidence through peer support. This is important in the sense that, for many international students, this is their first introduction to independent learning in a university environment where they are expected to take responsibility for their own study. Also from an academic viewpoint, the students now have a greater appreciation of the mechanical design process. It is hoped that this appreciation enables them to undertake their engineering studies with both a positive insight into how the design process works and an understanding of how the learning from the modules they study feeds into this process.

The first key point to highlight was the engagement of the students with the project. It has already been stated that, out of the 57 students in the second cohort, 53 initially engaged with the project in the beginning. The five students who did not engage were either repeating the academic year due to failure in the previous year or had not attended any classes during the semester and had effectively withdrawn from the courses.

It has also been stated that by the time of the presentations at the end of the project, 48 students had continued with it. Thus only five students out of a cohort of 53 had not engaged with the project. Out of these students, two were British Asian, two were white British and one was of Arabic/Persian origin; this student was also repeating the academic year due to failure in the previous year. Their attendance did not inhibit the performance of the other students since groups were re-organised during the course of the project, where necessary, to account for their absence.
The use of EBL proved effective as the students were able to demonstrate, through their own initiative, different solutions to the problem set at the start of the project. After the initial information sessions provided by the academics, the student groups delivered beams of various shapes and compositions, some of which conformed to the constraints set by the project, others did not.

There are some aspects that would be approached differently during future iterations of this project. The main point would be to ensure that the groups were timetabled into the workshop at an earlier stage of the project. One of the main issues to arise was that some groups did not have adequate time (or any time, in one or two cases) in the workshop to construct and test their beams. An option in future may be to give the students a deadline for detailing their calculations, possibly mid-way through the tenure of the project. This would then allow the latter half of the project run to be used for workshop activities for all groups to have the opportunity to undertake. Due to space constraints, a rota would need to be established that would guarantee equal access to the workshop.

One student suggested allowing the students to choose their own groups: “I think it’s more appropriate to let students choose their own groups. So they can comfortably ask questions if they are not sure about something.” However, this does not recognise the fact that in the engineering industry engineers do not usually get to choose their teams, instead being allocated to a team by a manager. One of the main successes of the project has been how students who did not know each other at the start had worked together to produce a beam that met the initial constraints and developed ‘effective employee’ skills as part of that process, in addition to the academic learning that has taken place. The effects of this have been noticeable: in previous years the disparate groups of students have not mixed together, but since the end of the project it has been noted that students from the disparate groups are mixing together and engaging with each other, both within and outside of lectures. Whether this is as a result of the group project is open to interpretation; however, based on the cohorts of previous years, the students in this cohort are more confident after the project about approaching, talking to and assisting each other.

Summary

In summary, the aim of the project (to engage first year engineering students more with their courses and their peers in order to improve student attendance and cohort cohesion) seems to have been successful. Attendance has improved during the 2011/12 academic year in comparison with the previous academic year and students from different backgrounds are more readily engaging with each other rather than remaining with their own peer groups. By making use of a formative group project that would enhance the experience of first year students, the students have been able to acquire certain ‘effective employee’ skills that they would not have been able to attain through a formal lecture. The students have also been exposed to working in pre-selected groups, a situation that is likely to occur in the engineering industry where project teams are assembled by a manager. It will be determined at a later stage whether the experience from the project has encouraged the students to engage further with their learning on their courses and resulted in improved assessment results and retention.

Further development

It is intended to disseminate the results from this project through the National HE STEM Programme Conference to be held at the University of Birmingham in September 2012. It is also proposed either to engage an employer in the assessment process for future iterations of the project (assuming the same project challenge is used) or to ask an employer to suggest a different project challenge for the students to undertake that encompasses the development of the same set of ‘effective employee’ skills.
Several regional HEIs will be asked to run the project the following year to gauge the validity of the findings of the initial project run at Wolverhampton. The level 4 students who have undertaken this project have already expressed interest in undertaking a similar formative group project during their level 5 studies in the following academic year. The academics will now be seeking a suitable project for the students to undertake at level 5. One possible suggestion is to undertake an investigation into the de-lamination of turbine blades due to vibration.

As stated previously, 64% of the level 4 students also volunteered to act as mentors when the project runs again for next year’s level 4 intake. A possible strategy here is to allocate two mentors to each group to aid the students in their calculations and designs, enabling the academics to take a step back and the project to become more student-centric.

The academics will also investigate where and how EBL can be embedded into specific existing modules as summative assessment opportunities. Where identified, the changes towards EBL as summative assessment would have to be approved by the university’s quality assurance systems.

References


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