Assessing the Softer Skills Learning Outcomes in Group Projects

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ASSESSING THE "SOFTER SKILLS" LEARNING OUTCOMES IN GROUP PROJECTS

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Abstract: The Product Design and Development and Mechanical Engineering degree programmes in the School of Mechanical and Aerospace Engineering at Queen's University Belfast (QUB) include major group Design Build and Test (DBT) projects in their 3rd and 4th years of study. These are advanced team projects which combine the technical and commercial elements typically found in industry. The students start with the identification of a problem and then develop a product through concept, product design specification, detailed design, prototyping and testing stages to finally produce plans for manufacture and commercial launch.
These yearlong projects seek to develop the students' skills and abilities across all phases of a product lifestyle and as such have a wide range of learning outcomes. Many of the learning outcomes are capable of being assessed through traditional means, such as written reports, but other "softer skills" such as time management and team working skills are less easily assessed in this way. Academic staff acting as supervisors of such projects cannot be with the students all of the time, particularly since they are often required to simultaneously supervise multiple projects as well as carry out research and perform other teaching and administrative roles. The potential to observe the operation of project groups over a long period of time and hence assess these "softer skills" is therefore reduced.
This paper will detail some of the methods used at Queen's to assist in the assessment of "softer skills" learning outcomes and evaluate their effectiveness in terms of time efficiency, accuracy and reliability

Keywords; personal and professional skills, "softer skills", group projects, assessment

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1. INTRODUCTION

The type of major group Design, Build and Test (DBT) projects carried out by 3rd Year Product Design and Development (PDD) and 4th year Mechanical Engineering undergraduate students at Queen's University Belfast is of a similar nature to the "capstone" projects carried out at many universities around the world. These generally seek to provide an authentic learning experience for students by including many elements which the students will face in professional practice, post graduation. The learning outcomes are broad and usually set at a high level of cognitive ability. In terms of taxonomy such as that described by Bloom (1956) the objective is to test the highest level of intellectual ability which involves evaluation and synthesis of a problem through to a viable solution. As well as applying technical knowledge and understanding the students are

expected to develop a range of personal and professional skills, often referred to as "softer skills". These may include how to plan and manage tasks in a timely manner, how to work effectively as a leader or member of a team, how to communicate effectively with team members and faculty supervisors and how to resolve conflicts.

The requirement for these professional skills in addition to technical knowledge is recognised by a growing number of accreditation bodies such as the Institution of Mechanical Engineers (IMechE) who in the UK base their assessment on the Engineering Council's UK-SPEC (Engineering Council, 2010) document. This specifies a standard for professional engineering competence including 2 sections (C and D) which relate specifically to "technical and commercial leadership" and "effective interpersonal skills". Similarly the international CDIO initiative, of which the QUB School of Mechanical and Aerospace Engineering (SMAE) is a leading member, has identified this requirement. A series of stakeholder surveys undertaken by a number of the collaborating universities highlighted that these personal and professional skills are highly valued by employers and recognised by alumni as being every bit as important as technical knowledge in professional practice. Consequently the Syllabus developed by CDIO contains sections which deal with these requirements namely; Section 2 on Personal and Professional Skills and Attributes and Section 3 on Interpersonal Skills: Teamwork and Communication (Crawley et al, 2007).

CDIO Standard 5 specifically states that degree programmes should have an introductory course that incorporates DBT experiences followed by at least one further DBT exercise of a more advanced and demanding nature, usually the capstone project. This rationale has been extended on the PDD programme to include an additional half module (5 ECTS points) group project in first year and a full module (10 ECTS points) with 3 group DBT exercises in 2nd year. This has been done to allow a staged development of the required skills and attributes.

The psychologist Csikszentmihalyi (1990) describes flow as a state of consciousness in which people are more engaged with and get greater satisfaction from the activities in which they are involved. In an educational context this relates to deep learning rather than surface learning and assists the individual in their ability to progress through the stages of cognitive development. Csikszentmihalyi also contends that this state can be controlled by ordering the information that enters the consciousness. Often referred to as the "+1 principle", this requires setting tasks of appropriate level, challenging but achievable and related to prior knowledge and skill levels. Often described as being between boredom, where no new learning occurs, and panic where survival strategies rather than deep learning dominate.

In the case of the DBT projects Bloom's taxonomy of learning domains (Bloom, 1956) is used to guide the setting of learning outcomes for each year with appropriate progression (Hermon et al, 2009). Hence the students are able to build on their previous experiences of shorter group projects in the earlier years before being asked to tackle the capstone DBT project. This approach is aligned with the constructivism theory work of Vygotsky (1980) and the experiential learning cycle model of Kolb (1984) and means that graduating students are better prepared for professional practice by the repeated opportunities to improve their personal and professional skills in the context of their application to multiple DBT projects.

1.1 Capstone Project Learning Outcomes

Stage 3 PDD and Stage 4 Mechanical Engineering students undertake a major (capstone) group project which accounts for 1/3 or 1/4 of their academic programme in the respective years. The learning outcomes are similar in both cases and can be summarised as follows:

To provide students with experience of working within a team on a realistic major project developing a product from the identification of a problem / customer need through concept development, product design specification, detailed design, prototyping and testing and finally to a plan for manufacture.
After successfully completing the project students are expected to be able to:

1. Apply knowledge and understanding of a specialist subject and related elements of professional product design practice.
2. Collate information, analyse and solve a technical problem.
3. Design or develop a system, component or process and recognise opportunities for improvements in a design.
4. Utilise appropriate laboratory equipment, computer software and instrumentation, in order to accomplish the objectives of a project.
5. Communicate effectively the results of a project in oral presentations and written reports.
6. Design and plan a project and manage the time involved to complete all tasks to the respective deadlines.
7. Work and learn independently and as a member of a project team.
8. Work and communicate effectively as a member of a project team.

The teams of typically between 4 and 6 students produce a number of deliverables during the 24 weeks of the project such as technical reports, working prototypes and oral presentations. These provide content which can be graded in relation to the product rather than the process and the collective output of the team rather than the individual. As such they can be used effectively in the assessment of learning outcomes 1 to 5 but not for items 6 to 8 which relate to the personal and professional skills and attributes.
Biggs (1999) states the importance of appropriate teaching and learning activities being provided and that assessment methods are aligned with these. The remainder of this paper will detail how these learning outcomes (6 to 8) are assessed in the 3rd year group projects on the PDD degree.

2. ASSESSMENT

It should be noted that while conflict resolution is a desirable skill it is not included in the learning outcomes. We have chosen to avoid conflict where possible rather than engineer artificial scenarios. It is assumed that in any project there will be sufficient disagreement within the group that some experience of dealing with conflict will be gained. With this in mind the groups are constructed by the module coordinator with the objective of being balanced and harmonious.

2.1 Building "Super Groups" and Avoiding Dysfunctional Groups

In order that all students work in an environment which is conducive to learning some effort has been put into the formation of the groups for the capstone project. By the end of 2nd year the students will have worked on 7 DBT projects of between 3 and 12 weeks duration. In all these cases the groups will have been constructed by the tutor with the objective of creating teams of balanced ability and learning style preferences. At the end of 2nd year the students (typically 30 in a PDD cohort) should have worked with all members of their year on at least 1 project. At this

stage they are asked to confidentially rank all the students in their cohort in terms of their preference as a partner for the capstone project in stage 3. The top students in terms of previous academic performance are seeded into the various groups and they get to work with their first preference choice, or highest preference not currently assigned to another group. The 2nd student in each group then gets their highest preference still available and so on. In general the students have tended to produce a preference rank which correlates reasonably well with the performance ranking but significantly there are a few notable exceptions each year. Some very able students are not seen by their peers as being desirable partners for group work while others of lesser ability are considered highly desirable as team members. These individuals are the ones whose data points lie furthest from the best fit line of the graph in figure 1. The general correlation between performance and preference suggests that students are very aware of each other's ability and close friendships seldom override a desire to have an effective project partner.
With reference to Figure 1, the student who ranks 9th in performance and 1st in preference is clearly viewed as a good team player while the student ranked 5th in performance and only 15th in preference likely has less well developed personal and interpersonal skills and is therefore less preferable as a teammate.

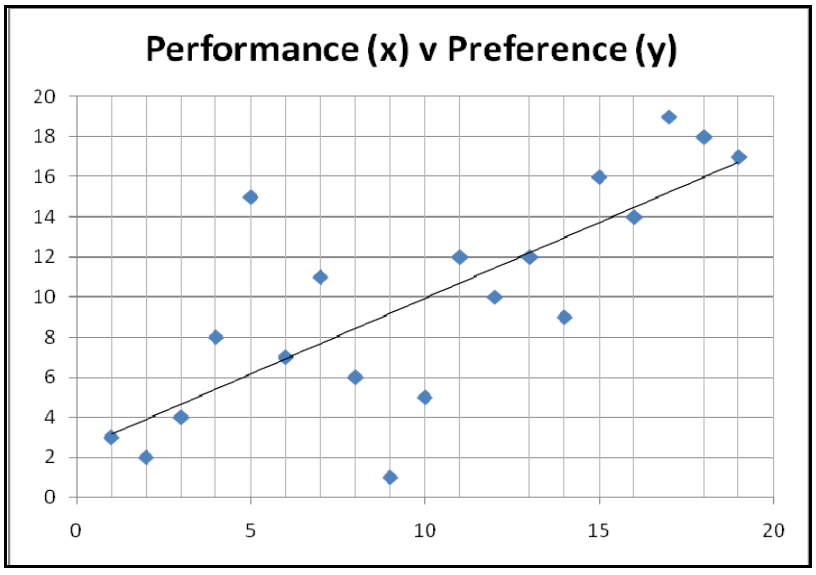

Figure 1 – 0910 Stage 2 PDD performance versus peer preference rankings

This information can then be used in discussions with individuals as part of a Personal Development Planning (PDP) process either with the module coordinator, project supervisor or personal tutor. The same data also indicates which students individuals absolutely do not want to work with as they will rank them last in their preferences. Hence individuals who are likely to fail to work effectively together can be kept apart. What is significant here is that this data tends to indicate something of the group dynamic within the cohort which is not easily observed by the academic staff. The students spend longer working with each other on these projects than it is possible for the faculty members to spend with each student and they are constantly making decisions and judgements about their peers in relation to how effective they are in their roles. The idea that the students form accurate assessments of their peers that can be useful in helping

faculty assess personal and professional skills has also been used in other areas of the assessment of these DBT projects.

2.2 Peer Assessment

Peer Assessment spreadsheets are used in all group projects in all years of study and are a mandatory requirement. The confidential peer assessment works on a zero mean basis with each student scoring themselves and all other members of the group in each of fifteen categories, which are aligned with the deliverables and learning outcomes of the particular project. Each row must add to zero and justifying comments must be entered for any rows with a non-zero value in any cell. These comments provide useful evidence to support the supervisor's observations of the group and the structured format ensures that each student comments on the same aspects of the project which enables direct comparison across the group ensuring accuracy and consistency. Guideline statements are provided describing the range of values between -2 and +2 which students can enter in each cell. 5 of the 15 categories typically relate specifically to personal and professional skills, e.g.:

- Effectively takes charge of tasks assigned
- Is fair and even in the treatment of other group members
- Produces work on time
- Willing to take on tasks
- Communicates clearly with other members of the team

In the capstone project students are required to complete a peer assessment at the end of the first semester, which is half way through the project. At the start of the second semester all students have an individual interview with their project supervisor(s) which includes a discussion of the collated peer assessments for each group. Student's comments remain confidential but a summary of the scores is fed back to each student as the basis of a discussion of their own performance and to provide a focus for areas which could be improved. This practice has proved particularly beneficial to the students and has been warmly received by them as positive and constructive feedback. The timing of the feedback provides the student with an opportunity to take corrective action and for the supervisors to focus the attention of their observations over the 2nd semester on areas identified by the other students as being relatively weak. The students then complete a similar peer assessment at the end of the project which provides an opportunity to assess any improvement as observed by the other student members of the group. It is important that the benefit of the peer assessment is sold to the students from the start of the project so that honest and valuable information is gathered for the interim feedback interviews. The use of the same format of peer assessment in previous years has built a familiarity with the format which ensures high quality data is provided.

2.3 Online Collaboration

Since 2008 online collaboration has been facilitated by setting up private forums using Google Groups. This free web based utility is a refinement of Usenet discussion groups which have been in use for many years. The module coordinator creates a new group and restricts membership by invitation only to the students and supervisors of the project. This provides the students with a shared space to upload files and a discussion forum to share information about relevant resources, reports and journal articles as well as somewhere to coordinate the scheduling of tasks. The students are sent an email when new content is added and the supervisors can read and

contribute to the discussion threads as well as provide instant feedback by rating each post on a 1 to 5 star basis. The resource can be accessed anytime and from anywhere with internet access and complements the required face to face project review meetings which the students organise and run with their supervisors. The students are made aware from the outset that their contribution is graded on a weekly basis as a measure of their level of engagement in the project and of their level of professional practice. By signing up to receive digest emails the supervisors conveniently receive a transcript of all activity in the group which can be kept as a record.
Quality as well as quantity of contribution is both measured with guidelines provided on the scoring metric used by the supervisors. The highest marks are reserved for contributions which clearly demonstrate a responsibility for moving the project forward. Posts stating only the detail of work done by an individual of their assigned tasks receive a pass level grade. 3rd year students are expected to make at least 4 contributions to the online forum per week.
Fundamentally this facility enables the supervisors to obtain a view of how the group is operating. It can be used to ascertain who in the group is driving things forward, who can effectively communicate what they are doing and who can produce a concise summary of relevant technical information. The fact that it is ongoing for the full duration of the project removes the risk of being inaccurate by attempting to assess such skills as a snapshot during face to face meetings. It has however been noted that some students are more comfortable in either the online or the face to face meeting situation and that this virtual environment is not seen as replacing the formal design review meeting. Indeed it is desirable to include both as this provides additional opportunities for students to express themselves in a medium which is preferable to them. At the end of the project the supervisor provides a grade and a short report on each student based on a combination of their online and face to face interactions. It is noted that different skill sets are required in the virtual and real worlds and that quite often students need guidance in the appropriate use of both media. Again the interim interview provides an opportunity to discuss with each student their relative competence in these different skill sets.

2.4 Leadership

Not all students volunteer to take a leadership role in these projects. To provide each student with an experience of what it is like to lead the group they are forced to rotate the role at regular periods during the first 12 weeks. The leader acts as chair of the review meetings and is responsible for the agenda and minutes as well as assigning tasks and deadlines. The supervisor attends the meetings and rates all students' professional conduct. In the second half of the project the groups elect their leader every 4 weeks by secret ballot in which they rank all members. This again uses the students' direct experience to provide additional input into the supervisor's assessment of the leadership qualities of those who have been in charge. The mandatory requirement to act as leader for at least part of the project, while contrived, has received favourable comment in the module review, particularly from those students who would never volunteer to lead.

2.5 Reflective Critique

In order to assess if students have developed the required skills and not just become aware of what is required in theory they are asked to write an individual reflective critique at the end of the project. This includes a section asking them to reflect on any skills and attributes they have developed during the course of the project which relate directly to the process of team working; specifically the 5 categories in the collaboration section of the peer assessment spreadsheet.

3. EFFICIENCY, ACCURACY & RELIABILITY

3.1 Efficiency

Assessing personal and professional skills requires observation and interaction with students over a period of time. While the cohort size described is relatively small (average of 30) it does still require a considerable amount of time to operate the regime described above. The interim feedback interviews of around 20 minutes are seen as particularly important and have been run with 2 supervisors present at each interview to date. This has been done to develop a consistency of delivery but the intention is that these can be done on a one to one basis in future. If however the staff involved in supervision changes in the future the recommendation would be that any "new" staff member partner with an experienced supervisor for at least one year before operating alone.

The amount of information and discussion threads generated on Google Groups can be overwhelming, particularly at the start of the project when the groups are searching to find a customer need on which to theme their project. While this has proved a very valuable resource for all supervisors it is sensible that only 1 faculty member grade the posts, which requires more time and rigour. To facilitate this a precise marking rubric is essential to ensure consistency across groups.

3.2 Accuracy

In order to encourage the students to provide accurate information to guide the supervisor's assessments it is important to be seen to be fair and accurate in your marking. At the interim interviews students are given an indication of what grade they are heading for in the project and the reasons for their grade. At this point 30% of the marks will have been assigned so there is still much to be gained by the student responding to the feedback and guidance provided. To date this has had a very positive effect on a number of students who have managed to improve their overall grade significantly following this intervention. It is therefore suggested that the grades obtained are more accurate than a model which has only summative assessment and no interim feedback.

3.3 Reliability

In stage 4 of the PDD programme there exists an optional 12 week work placement project (30 ECTS points) which requires a major project to be undertaken. This provides an opportunity for employers to provide feedback on the level of personal and professional skills displayed by the placement students. To date only 4 students have completed such placements (with a further 7 due to complete in June 2010) and so statistics gathered are as yet insignificant. The intention is to continue a longitudinal study which asks the placement employers to grade and comment on the relevant skills. To date the responses have been very favourable but it is anticipated that there will be scope for further refinement and improvement. This real life measurement is seen as having an important input into what is within the university environment only a simulation.

4. CONCLUSIONS

The development of personal and professional skills can be facilitated by providing numerous group DBT project experiences throughout all years of an undergraduate engineering programme, with staged progression defined by appropriate learning outcomes.

Students can provide valuable information which can be used as supporting evidence in the assessment of these skills through appropriate use of peer assessment and peer ranking.

Online tools such as Google Groups can be used to gather relevant input and data regarding the quality and quantity of contributions made by individuals when not in direct contact with project supervisors.

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