ISSUES IN ORGANISATION AND MANAGEMENT OF MULTIDISCIPLINARY GROUP DESIGN PROJECTS

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ABSTRACT
In education project teams that reflect organisational concepts considered normal in industrial design teams have a range of benefits for learning and graduate employability. They present a range of issues in terms of management of individual and group expectations. This paper focuses primarily on the issues of expectation and perceived performance as they manifest themselves through self-assessment. It interprets student perception and expectations of their individual and group performance, along with the experiences of their tutors in the management of a capstone group design project in the graduating year on the BSc in Medical Device Innovation at the Dublin Institute of Technology. In summary we found fewer issues in traditional problem areas such as student motivation, initiative, quality of individual work, and more issues related to interpersonal relationships, personal expectations in group-work, group dynamics, group management/decision making and the pacing of the group project against a characteristic time schedule. We also found students had a tendency to assess and score their individual contribution higher than their peers, and their tutors, and to collectively assess their collaborative outputs higher than the sum of their individual contributions. This paper makes the case for transparent assessment of the learning process, the design process and the design product.

Keywords: Multidisciplinary group projects, collaborative learning, biomedical device design

1 INTRODUCTION

Biomedical device design is at the crossover between science, design and engineering; and graduates have the potential to benefit from multidisciplinary group project [1, 2]. Virtual and multidisciplinary teams who work in such environments in industry or design practices may be geographically disparate from each other and may initiate, exist, evolve and devolve over the life of a project. Their effectiveness is often described in the context of progressive phases of 'forming, storming, norming performing and adjourning'[3, 4]. The boundaries of team interaction and knowledge have previously been well defined in the context of multidisciplinary projects. There is a strong belief that this boundary spanning process is a central component of effective team working where the team members have a range of skillsets and are geographically remote [5], and is therefore an essential component of education in University programmes, with clear benefits for graduate employment [6]. In Ireland the need to mimic this method of group working is most frequently embedded in team projects at University level and additionally is driven by many factors including but not limited to:

1. the requirements for accreditation of graduate programmes which places special emphasis on driving multidisciplinary teamwork concepts;
2. the need for an open economy to be able to produce graduates with a high level of teamworking skills and knowledge of international collaboration;
3. the diverse range of companies that now operate in our economy requiring graduates with a range of knowledge and skills transcending traditional boundaries.

In the context of our BSc. in Medical Device Innovation the traditional working boundaries involve engineers, designers, scientists, medical professionals and business professionals. This BSc provides up-skilling to a range of unemployed people with varied educational backgrounds suitable for the transition to biomedical engineering. The programme has students from design, science and engineering, with varied age, experience, and demographic profiles, with 75% mature entry, and thus is different to a typical undergraduate programme.

1.1 Purpose of research

This study is intended to inform practitioners and students using peer- and self- assessment, within collaborative multidisciplinary group projects, of the principle issues encountered. It may also enhance their collaborative experience by promoting engagement and encouraging students to take responsibility for their learning through the recognition, communication and reflection of the issues.

1.2 Theoretical perspectives

It is acknowledged that the question of the interplay between the collaboration processes, the task processes and the outcomes generated by the process at different stages is central to design [7]. Previous research work has identified twelve analytical themes in the study of professional perspectives on collaborative design work [8]. We extracted relevant statements from a literature search, and formed the following initial hypotheses about collaborative groups:

- Collaboration provides access to different perspectives and specialist skills.
- Different expectations lead to different thoughts and actions
- Position in the group's hierarchy influences a person's level of collaboration
- Team size has an effect on group cohesion and performance
- Clashing personalities, egos, and motivations negatively affect group cohesion and performance
- Communication and management is an essential aspect of collaboration.

Collaborative learning can be distinguished from cooperative learning by the degree of interdependence between individual group members working together on tasks. Collaborative learning is therefore a teaching method in which students work together in small groups to perform educational tasks requiring a high degree of interdependence, whereas during cooperative learning, members undertake tasks as part of a heterarchically divided process [9]. Students working in a cooperative learning environment often see any failure to reflect their individual effort in their overall assessment as promoting laziness and irresponsibility in others [10]. There is a central need for assessment to 'foster group learning whilst not inhibiting individual achievement' in the group, while recognising the influence of 'power and control', in the context of teacher-student relationships [11].

When interpreting the effectiveness of collaborative learning it is useful to consider the total context in which the learning takes place, this is the 'learning milieu', and has been defined as: *much more than the physical environment: it embraces the formal requirements, the culture, procedures, practices, and standards of particular institutions and societies, the immediate goals, and expectations of any facilitator, as well as the personal characteristics of individuals who are part of it* [12].

2 RESEARCH METHODS

This constructivist study, based on grounded theory, constitutes qualitative research of the issues in collaborative group learning, and includes a quantitative evaluation of how students and tutors assess group performance as it relates to both process and product. Prior to beginning their final group project, students are introduced to the medical device design process and group collaborative learning in general by undertaking a short accelerated medical device collaborative design project run over eight weeks. The structured design process used in this project, in conjunction with the process and group dynamics assessment criteria, demanded active collaboration by the participants. Following the literature review this study was conducted in the following manner:

Group and individual assignments, performance appraisals by tutors and students, and interview reports were collected from five groups of students. Statements, observations and comments were extracted and collated under the following categories: collaboration, contribution, group interpersonal dynamics, expectations, motivations, perceptions of performance, and assessment/evaluation.

A student questionnaire based on the above categories was developed. It asked closed and open questions on: collaborative activities undertaken, group skills developed, personal expectations, difficulties encountered, conflict management, and freedom of expression and initiative, among others. Students also completed a self-assessment of their individual contribution, and a collective assessment of the group performance under the headings: team process, research, design input, concept generation, detailed design, prototyping, final report and presentation. This provided both a numerical indicator of their perceived contribution and copious comments on their performance/contribution. Each student also rated their own contribution and that of their colleagues by individually distributing one hundred marks, allocated according to perceived contribution, between all members of the group.

All the qualitative data was compared and categorised as pertaining to either: expectation, perception of performance, perceived contribution, or assessment. For the quantitative data: individual and group perceptions of performance were compared with tutor assessment, how individuals rated themselves was compared with how they rated others and were in turn rated by others. All the students participated in the study, with 54% completing the questionnaire, and 90% the rating and evaluation.

3 RESEARCH FINDINGS

3.1 Collaboration - *Personalities, egos, and personal motivations*

The participant's responses highlighted interpersonal differences as a significant barrier to successful collaboration. When these difficulties were compounded by inadequacies in leadership and communication they led to serious problems in the group setting or achieving targets. When this occurred group members often referred to each other as 'delusional', accused members, particularly those attempting to take a leadership role as 'acting as if they personally owned the project'. Participants highlighted the 'lack of contribution by some', and commented on the 'conflict' and 'confusion' of meetings. Participants were 'not willing to listen', people became 'difficult', 'personalities clashed', and 'some could not be led'. This meant that 'no work was done', 'moving forward was a problem', and there was 'difficulty in planning, managing, and communicating'. Groups that fell into this category had a poor correlation between the individual self-assessment of their performance and their performance as assessed by their peers in the group, see Figure 1.

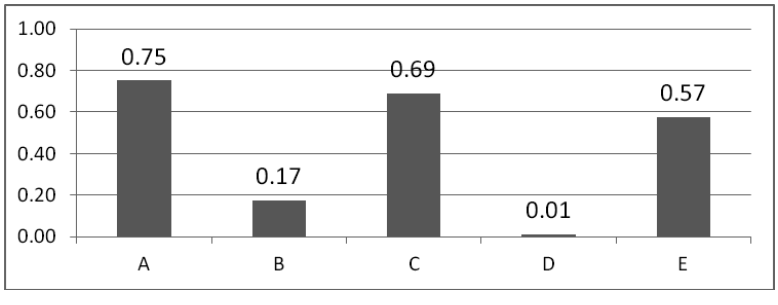

Figure 1. Correlation of group and individual perception of performance

3.2 Differing expectations

Questionnaire: 54% responded, 70% of respondents, i.e. 39% of students, did not think that the group experience matched their expectations, and they expressed their expectations as outlined in Table 1.

Table 1.Students expectations of group projects

They expected	They did not expect
work to be allocated equally, hard working groups *people to attend meetings, to hand work in on time* *members to be polite, show respect to one another* *everyone to work away on their own tasks* *groups to be well organised and efficient* *everyone sharing the same goals and standards* *better communications, agreed leadership* *everyone would have a similar level of interest*	*collaboration to be so much hard work* *lazy people doing very little work* *conflict* *everyone having a different perspective* *so much time wasting* *everyone needed to be treated differently and let be themselves*

3.3 Different perspectives and specialist skills

All agreed that experience, particularly experience in relevant technical skills benefited the groups. Gender, age, and culture were reported as having no impact on the collaborative process.

3.4 Hierarchical influences

Issues of leadership, cliques, exclusion, and perceived position in the group hierarchy surfaced in interviews, comments, and questionnaire responses. Often group members recognised the absence of leadership and knew what needed to be done, 'taking control was required', but lacked the skills to take on a leadership the role. One comment was that 'I am not going to let a group go down a path I believe is incorrect or inaccurate'. Other comments included 'it is impossible to lead this team' and 'after six years in industry I know what I am doing and they don't'.

3.5 Group size

There does not appear to be any direct correlation between group size and group cohesion and/or performance for this project. There was no difference in group size between the top and bottom performing groups measured in terms of cohesion, adherence to design process, and quality of final.

3.6 Communication and management

Group management and communication skills are central to efficient collaboration. Groups A, and C made the most positive and realistic comments about how their group functioned. Group E comments showed that they had problems initially but successfully overcame them. Group B had the greatest number of negative comments, and Group D closed ranks and expressed naively that everything was going well and there are no problems. Group D appeared to have an unrealistic impression of their performance and functioning ability. Poorly managed groups had difficulty performing and poor communication appeared to be the most serious impediment to good group management.

3.7 Assessment

Students expected that the group as a whole would perform better than the sum of their individual performances. This is reflected in how students collectively compare their individual input with the group output. This difference is particularly noticeable at stages requiring specialist skills, and is less noticeable at stages where students apply more equally distributed skills, and are therefore more easily able to collaborate. When student, group, and tutors assessment of group performance is compared as in Figure 2, the average of individual students within a group's assessment of their own performance was the nearest to the consensually arrived at assessment by their tutors of their group, and the group's collective assessment of their performance appeared to be exaggerated.

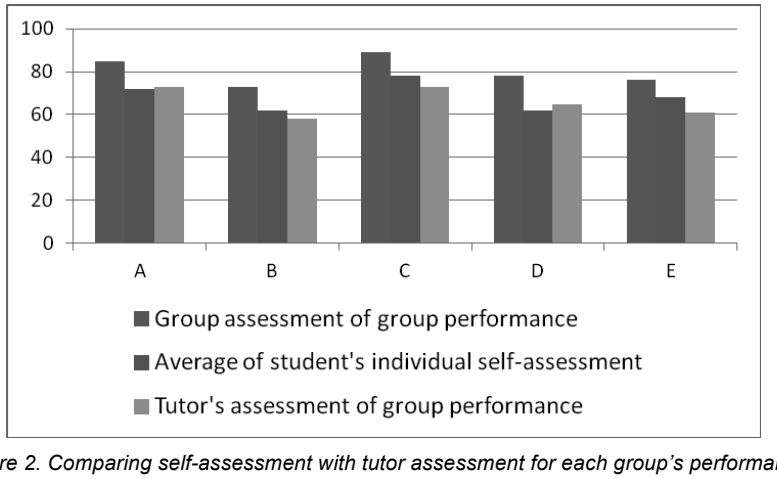

Figure 2. Comparing self-assessment with tutor assessment for each group's performance

4 DISCUSSION OF RESULTS

In a study of self- peer- assessment in an undergraduate social psychology laboratory course it was found that their student sample rated their own contribution more highly than their peers rated them. They postulated that 'these findings suggest that individuals are somewhat distorted in their view of their own contribution to the group project' [13]. The observed low correlation of 0.27 between self and peer assessment of contribution in figure 3, with some individuals rating their contribution

considerably higher than how their peers rate them suggest that this distortion is usually in one direction when evaluating contribution to the group activities. However when individuals assessed their own performance in terms of the design process criteria their average for the group corresponded closely with that of their tutors, while in all cases they collectively expected the group as a whole to perform considerably better.

Students expected their group to perform well at some stages of the project. This is evident in the higher collectively arrived at mark for design and prototyping compared to marks for writing and presentation skills, and may reflect the impact of higher achievers in the group raising the overall performance. Because students, particularly the weaker ones, tended to overestimate their own contribution, and performance, there was no correlation between marks awarded by their tutors and their own collective assessment of the group. Other possible factors previously identified as affecting these group characteristics are prior experience of design processes and prior work experiences, which were traits of some of the students in each group and could have led to variation in response type [14].

Groups that collaborated well often performed well and achieved more than the sum of their parts. Strong leaders could manage or dominate depending on the level of the collaboration in the group. The consideration of the understanding of the emotional undercurrents beneath all group interactions as essential has led to the belief that "behaviour is determined as much by passions, anxieties and convictions as it is by reason". Without respectful communications passions dominate [15].

The issues we found, such as interpersonal relationships, personal and group expectations, and group management/decision making, correspond to those found in the literature in terms of task, group and support [16, 17]. We also found students had a tendency to assess and score their contribution higher on an individual basis, than their project supervisors, and to assess their own performance higher than their peers assessed them. We believe from review of our discussions with the students that this is most likely due to the effect previously learned practices had on their clarity of understanding and depth of knowledge of the very rigorous design process in the medical device environment.

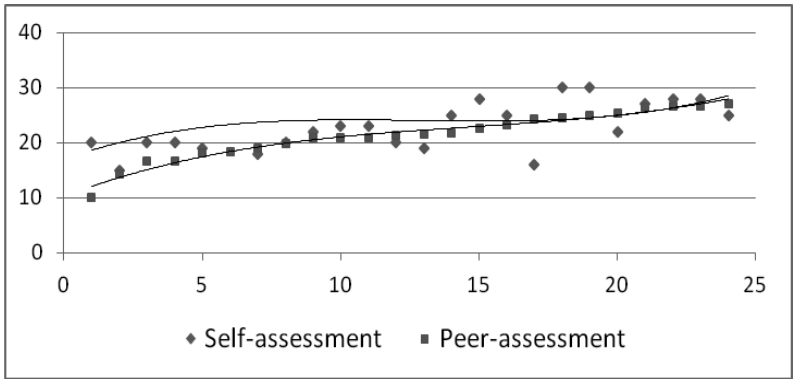

Figure 3. Self-assessment compared to peer-assessment of contribution for 24 students

5 CONCLUSIONS AND RECOMENDATIONS

Research advocates shifting 'the emphasis away from learning outcomes towards learning processes' when conducting peer assessment in order to reward the student's contribution to the process of peer learning within the group [11]. If students are poor at evaluating their own performance or overestimate the importance of their contribution to group activities it is often because they inadequately understand the processes and criteria involved in learning and assessment. By focusing too much on the product or learning outcomes, tutors can encourage their students to take a non-reflective approach to learning. The process of how the student arrived at an assessable outcome is invisible to student and tutor unless the process itself is assessed.

Group learning is 'messy', students need time for reflection and 'non-thinking time' for ideas to evolve and grow. Structured assessment processes, clear guidelines, and prompt feedback can remove emotion insecurities, assessment anxiety, and help to establish fair practices that enhance group cohesion. Developing a shared interpretation of the design problem and the design process along with an appreciation of the difficulties to be encountered are essential to successful collaborative work.

Collaborative design is most successful when there is a shared passion for the practice of design, coupled with realistic expectations and performance evaluation, along with comfortableness with group activities and learning new skills. Students need to learn how to realistically evaluate both their contribution and their task performance against an agreed set of appropriate criteria. Tutors must intervene to correct and moderate unrealistic expectations or distorted self-evaluation where necessary. An important task for a tutor in collaborative learning is to help the group to formulate a coherent picture of the topic and sometimes redirect the focus of discussion, while encouraging and supporting contributions from the group. The roles a tutor must play to accomplish this task include observer, leader/instructor, neutral chair, facilitator, counsellor, and commentator. The skills needed to carry out these roles include asking, testing, clarifying/elaborating questions, and communications, including techniques for bringing in and shutting out contributors, and for turning questions back on the group. Group learning is probably best summarised as 'learning to be' rather than 'learning about' [15].

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