Encouraging the development of transferable skills through effective group project work

S. Smith, M. Mannion, C. Hastie

Department of Mechanical, Manufacturing and Software Engineering, Napier University, 10 Colinton Road, Edinburgh, EH10 5DT, UK

Abstract

In industry software engineers rarely work in isolation. The majority of software engineers work in teams which vary in both size and multi-disciplinary emphasis. Group projects can be used throughout an undergraduate course to simulate a working environment and provide students with the transferable skills which will be of value to future employers. Appropriate group working must evolve throughout the course with both increased complexity of technical requirements and also with the devolution of group responsibilities. This paper discusses the issues behind developing students' key transferable skills through the use of group project work and offers a model for software engineering group projects within the educational environment.

1   Introduction

The BEng / BEng (Hons) Software Engineering offered by the Department of Mechanical, Manufacturing and Software Engineering at Napier University develops a student's ability to engineer (specify, design, implement, test and maintain) a software solution to a given problem with finite resources. One of the objectives of the course is to help students appreciate that successful industrial software systems come about only through harnessing the collective talents of a group of people working as a team and that each person in the team has a range of complementary skills. These skills will include technical skills but skills such as initiative, planning, time management, leadership, written communication and oral presentation are also significant. Skills such as these are known as transferable skills. They can be loosely grouped into four categories: communication, working with others, creative problem solving and management and organisation [1].

To achieve our objectives on the course, and to provide students with the opportunity to learn and develop transferable skills, we provide a number of modules in which group working is an essential component and in which a group project is the instrument of assessment. In designing an effective model for encouraging the development of transferable skills in group work, the first stage is to identify those transferable skills which are most readily learned within a group activity. The next stage is to devise a number of group project exercises which range from encouraging the development of an appropriate subset to the complete range of transferable skills. In this paper we present a model in which group project exercises feature in each year of the undergraduate degree course with activities becoming increasingly challenging as the student progresses.

2   Transferable Skills

Transferable skills are generic capabilities which enable people to succeed in a wide range of different tasks and jobs. Their importance in relation to specific technical skills is reflected in a review of graduate recruitment advertisements carried out by the University of Sheffield Personal Skills Unit [2] which found that oral communication, team work, enthusiasm, motivation and leadership ability were common key factors sought by employers.

Transferable skills can be described as the mortar which hold the modules of a degree course together and all modules should incorporate both academic achievement and the development of transferable skills. In [3] twelve transferable skills were identified and these are listed below. This list represents one version of a top-level hierarchy of the vast range of transferable skills.

- initiative
- independence
- teamwork
- management/leadership
- time management
- planning and organising
- written communication
- oral presentation
- finding information
- data analysis
- decision-making
- information technology

Clearly, there are some skills such as management/leadership and team working which can only be fostered through group activity. Others, such as initiative, organisation, information finding, data analysis, decision-making and written communication can be developed both through individual and group projects. Such skills can be sharpened when placed within the group context. For example, within a software engineering project, the clarity with which analysis of requirements is performed and communicated is often improved when other people (designers) are dependent on it.

The driving force for the development of group-related transferable skills is the knowledge that in the software industry the majority of software engineers work in teams whose size varies from two to several hundred members [4]. In the next section we review in more detail how groups work in order to understand how we might build group related transferable skills into group project exercises.

3   Group Work

Most people are aware that when new groups form they take some time before they become effective. [5] highlights the following stages:

i) forming: during this stage the group are finding out about each other and the task allocated to them.

ii) storming: individuals gain more confidence and seek to establish their own level within the group.

iii) norming: this stage heralds the settlement of conflicts and an air of co-operation develops. Where the group is unable to progress to this stage, it may have to be disbanded.

iv) performing: the group finally settles into teamwork which normally exhibits improved problem solving capabilities and the adoption of flexible roles within the group structure.

Within the group individuals can be classified as task oriented, self-oriented or interaction-oriented and it is often the case that the most effective group is comprised of a mixture of personality classes led by a task oriented manager. It might be important to allocate a leader, but a natural leader will often emerge. This natural leader will be the person with most influence over team members.

In some cases the group bonds together so closely that individuals become intensely loyal to each other. While group loyalty can encourage productivity, excessive loyalty can lead to 'groupthink' [6]. Here the group's ability to think critically has been undermined by excessive group loyalty.

The aim of the group project is to establish a realistic project environment within which students can gain experience of working as part of a team to analyse, design and develop software, whilst at the same time learning and developing group related transferable skills. A number of factors affect the success of the project including the size of the group, its leadership, its cohesiveness, the motivation of individuals, the work place environment and the nature of the task [5]. While not all these factors can be controlled by the tutor, an environment conducive to the aims of the project can be created. In this section we provide some general guidelines.

3.1 Choosing groups

Smaller groups (up to four students) are more effective at reducing the amount of group related, as opposed to task related, communication. Larger groups require stronger leadership which is often inappropriate within an academic context. The academic and social experience is often improved by allowing the students to choose their own groups [7]. While it is accepted that software engineers in industry may have very little influence over the construction of their team, effective teams are often constructed on the basis of proven healthy working relationships.

There is often a 'black sheep' group which consists of three or four individuals who for one reason or another did not fit into another group. The tutor should pay special attention to this group when fostering teamwork. If any group does not appear to be functioning after the first two meetings it

must be quickly disbanded and individuals allocated to other groups in order
to reduce the impact of the failed group experience on each group member.

3.2 Choosing the task

To ensure an appropriate workload the tutor has the final decision on the
choice of task. Motivation can be increased by giving the students an input
into the definition of the task. The criteria for task selection include that it
should enable students to demonstrate their knowledge and apply their theory
to a practical application with a high degree of confidence, that it can be
completed in the allotted time, and finally that it can be effectively sub-divided
in an equitable way. This will help groups to co-operate and improve
cohesion.

3.3 Allocating responsibilities

The storming and forming stages of group dynamics can be particularly
pronounced in academic situations. Students often feel reluctant to assume
responsibility for a number of reasons including a desire for democracy in all
decisions, lack of empowerment or lack of confidence in their abilities. In
addition, students can make arbitrary divisions of tasks and responsibilities
and place inappropriate burdens on particular team members. This may cause
a lack of motivation on the part of some group members which can affect the
overall dynamics of the group and ultimately the academic achievement. At
this stage the tutor may have to intervene to clearly stipulate the
responsibilities of all group members.

Our experience is that the more successful groups are those in which
responsibilities, such as Design Authority, Quality Manager or Test
Authority, are allocated to individuals and the rest of the group acknowledges
their remit. As students gain more experience of group working on software
engineering tasks they can be given more say as to the roles required and who
should perform them.

3.4 Group meetings

Regular group meetings are essential for the project to succeed. There are
generally two types of meeting: those amongst the group itself and those
between the group and the tutor. An interim review, where peers and
lecturing staff constructively criticise design decisions reached by the group,
can help to avoid 'groupthink'.

Scheduling regular group meetings within timetabling constraints is an
exercise in time management . Current technology can improve and facilitate
the communication process. Computer Supported Co-operative Work
(CSCW) is the term given to harnessing computing equipment and network
technology to enhance the interaction between groups of people. Message
based systems are currently the most widespread and effective co-operative
systems to date [8]. Most institutions have an electronic mail facility which
can be used by students to contact other group members to schedule
meetings, discuss documents and distribute code.

The most important aspect of group meetings is that all group members
should feel accepted and be able to develop a sense of identity within the
group. This generally has a positive impact on their motivation. Group

members must be assured that they can express their point of view and that others will listen. Often, inhibited or aggressive behaviour can be the result of a blocked or inadequate flow of information.

The tutor's role in facilitating this is complex. To foster motivation, they must acknowledge the achievement of milestones and provide feedback and advice. It is important that they remain in an observing role in order to avoid unduly influencing the group. Where personality clashes occur they must intervene and defuse a hostile or antagonistic situation. To facilitate successful group working the tutor should explain aspects of good group behaviour throughout the project and set an example by chairing a regular project progress meeting.

3.5 Assessment

When identifying the group project task, it is essential that students are given clear objectives. Since the product and the process are assessed it is important that clear performance criteria for each phase are given prior to the commencement of the project. The assessment process consists of defining explicit learning goals and criteria that describe a picture of the ability being assessed. By asking each student to carry out some part of each phase a sample of performance is observed and multiple, external judgements of the student's ability across a number of contexts is made. Feedback is an important part of the process and the student's strengths and weaknesses are discussed both during the exercise and on completion of the project[9].

The students are asked to judge the effectiveness of their behaviour and contribution within the group to accurately assess the roles and functions adopted by other members of the group and to evaluate the performance of the group against the stated aims.

4   A model for group project working

The degree course provides at least three opportunities for group project work comprising one group based activity in each of the first three years. This model has evolved over the last five years.

4.1 The first year
The purpose of the eight-week first year project is to enable students to develop the following transferable skills:

- teamwork
- limited planning/organisation
- oral communication
- data analysis (problem solving)
- limited decision making

4.1.1 Choosing the group Group sizes are restricted to up to three students. Students are given an opportunity to decide who they should work with.

4.1.2 Choosing the task The task is allocated to the group by the tutor. Typically this is a small exercise in which the requirements are well defined and the students are asked to produce a design and a working program.

4.1.3 Allocating responsibilities A team leader is appointed as a point of contact but has no additional responsibilities. The task can be divided into equal portions allowing each student experience of design and programming. A project plan is developed and presented to the tutor to provide evidence that the team is operational.

4.1.4 Group meetings The students are encouraged to work on the project during allotted timetable tutorial sessions. The tutor chooses one of these sessions to have a formal weekly progress meeting.

4.1.5 Assessment Students are asked to keep a log detailing the group's progress and their individual contributions. This is then assessed in the light of their final product. The students demonstrate their product to the tutor.

4.2   The second year
The purpose of the eight-week second year project is to build on the organisational and collaboration skills developed in the first year and introduce additional problem solving skills by identifying a more complex and technically challenging task which encourages positive group dynamics. The following transferable skills are developed:

- initiative
- teamwork
- planning/organisation
- time management
- written communication
- data analysis (problem solving)
- decision making

4.2.1 Choosing the group Group sizes are again restricted to up to three students as far as possible. Students can decide who they should work with or can elect to join a pool of students from which the tutor constructs groups.

4.2.2 Choosing the task The task is allocated by the tutor. This is a more extensive activity than the first year project and the requirements are provided only in outline format. The students are actioned to produce a detailed analysis followed by a design and a working program. However the method of analysis and design are pre-determined.

4.2.3 Allocating responsibilities A team leader is appointed by the tutor but has no additional responsibilities other than as a point of contact. Each group is asked to allocate the roles of Analysis Authority, Design Authority and Quality Engineer. The task can be divided into equal partitions allowing each student to experience each phase of the software development process. A project plan is developed and agreed with the tutor. Progress is then measured against the plan. While the plan is updated throughout the

project, the original plan is retained and students can reflect on their original timescales when the project has been completed.

4.2.4 Group meetings The students are encouraged to work on the project during allotted timetable tutorial sessions but are expected to work on the project outside these hours. The tutor chooses one of these sessions to have a formal weekly progress meeting.

4.2.5 Assessment The assessment is based on a demonstration of the product by the group and the project documentation. The regular group meetings provide the tutor with the opportunity to monitor the work and the contribution of each group member. The students are asked to reflect on the group experience and submit a review with the project documentation.

4.3   The third year

The purpose of the fifteen-week third year project is to undertake a substantial piece of work and demonstrate the ability to work in teams in an environment in which many of the constraints imposed to encourage success can be relaxed to offer the student the opportunity for further personal development. All the transferable skills listed in section two are developed.

4.3.1 Choosing the group Group sizes are restricted to four as far as possible. Students are given an opportunity to decide who they should work with.

4.3.2 Choosing the task The students are expected to demonstrate the full range of software development lifecyle activities. Unlike the other two projects, the task and methods are determined by the group and approved by the supervisor. Often the difficulty for the tutor is reigning in some of the ideas. A full requirements analysis may be followed by a partial design and implementation.

4.3.3 Allocating responsibilities The group is asked to nominate a Project Manager. The Project Manager will act as the point of contact and will have responsibility for monitoring progress and co-ordinating the group. The group is also asked to identify specific roles which they feel will be important in managing the group. Each member of the group is expected to do at least 20% of each phase of the software development lifecycle. The group must provide a detailed project plan which must include a Gantt chart.

4.3.4 Group meetings The students are encouraged to work on the project outside the allotted timetabled hours. Progress meetings with the tutor take place after each milestone and at least every fortnight. As each group will have a different plan, electronic mail is very important in co-ordinating different meetings.

Peer review is introduced by scheduling at least one formal review and thereafter a number of walkthroughs whereby the students are encouraged to think critically and analytically about a peer's contribution to the project. This encourages students to reason about their work in a non-threatening situation.

4.3.5 Assessment The students present their work by a demonstration of their product and a poster display to both their peers and their tutor. This presentation includes an opportunity for detailed questions to be raised whereby the group can provide evidence of the extent of their knowledge with respect to the problem domain and can justify their design decisions.

5   Conclusion

Group project work offers students a positive vehicle for the development of their key transferable skills. It is important that students have an appropriate framework for the development of these skills which enhances their academic experience but which provides adequate protection against potentially catastrophic group dynamics which may be a damaging experience, jeopardising both their confidence and their academic success. We have presented a three year model for group project working which evolves and relaxes the constraints under which the group must work.

Our model is still evolving. Further improvements can be made to the methods of assessment. At present this is still primarily in the domain of the tutor. We believe self assessment and peer assessment can play a greater part and we are looking at ways to develop peer review and reflective assessment.

6   References

1. McLeod, L. Incorporating Transferable Skills in Modules and Courses, Napier Enterprise Centre, *Napier University Publication,* 1993
2. Green,S. Analysis of Personal Transferable Skills requested by employers in Graduate Recruitment Adverstisements in June 1989.   Sheffield: *University of Sheffield,* 1990
3. Moore, I., Exley, K. (ed). *Alternative Approaches to Teaching Engineering*, UK Universities and Colleges Staff Development Agency, Level Six, University House, Sheffield, S10 2TN, 1994
4. Sommerville, I. *Software Engineering* ; 4th ed. Addison Wesley, 1992
5. Cole, G. *Management Theory and Practice* ; DP Publications, 1993
6. Janis, I. *Victims of Groupthink*; Harcourt Brace Jovanovich, 1972
7. Chapman, N., Fox, M., Keravnou, E., Lee, M., Levene, M, Long, D., Rounce, P., Offen, R., Samet, P. & Winder, R. "Slick Systems' and 'Happy Hackers': experience with group projects at UCL", *Software Engineering Journal,* 1993, 8(3), 132-137.
8. Grudin, J. Groupware and Social Dynamics: Eight Challenges for Developers, *Communications of the ACM*, 1994, 37(1), 92-105
9. Gibbs, G., Habeshaw, S. & Habeshaw T. *53 Interesting Ways to Assess Your Students*, Technical and Educational Services Ltd, 1988