Implementing Innovative Ideas in Structural Engineering and Project Management
Edited by Saha, S., Zhang, Y., Yazdani, S., and Singh, A.

ISBN: 978-0-9960437-1-7

IMPROVING GRADUATES' ATTRIBUTES THROUGH LABORATORY TEAMWORK

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In today's changing global environment engineering graduates are expected to have both technical and soft skills. Accordingly, La Trobe University has incorporated the soft skills of communication, teamwork, interpersonal skills and leadership into its Civil Engineering course. This paper describes the contribution of teamwork to the development of soft skills during laboratory classes in a number of subjects taught at the second, third and fourth years of study. The assessment for the practical component was designed to enhance teamwork and measure the students' contribution during the laboratory/field sessions. The practical classes and teamwork requirements improved the students' technical knowledge, and students became more aware of their own strengths and weaknesses. It also enhanced students' communication skills and promoted the development of interpersonal skills and a responsible attitude.

Keywords: Communication skills, Group work, Oral communication skills, Practical sessions, Soft skills, Written communication skills.

1 INTRODUCTION

Engineering graduates are required to be adaptable and self-motivating team players, (Cukierman and Palmiery 2014), and many higher education curricula include teamwork to enhance graduates' attributes (Davidson *et al.* 2014). Deep learning occurs when meaning is negotiated in a social context (Frank and Barzilai 2004, Hellström *et al.* 2009). Teamwork encourages discussions, critical thought and reflection and leads to deeper learning (Powell 2004). Furthermore, teamwork instils cooperation, encourages respect and enhances communication and people management skills (Powell 2004, Hellström *et al.* 2009).

The Civil Engineering course at the Bendigo campus of La Trobe University has a long history. The course consists of thirty-two subjects, with four in each of the eight semesters. The curriculum was changed in 2000 to incorporate new trends and requirements in engineering education (Kilpatrick *et al.* 2006, Kilpatrick *et al.* 2007). Demonstration models and practical sessions were enhanced and many subjects include a significant component (10-70%) of practical sessions. This paper discusses the general approach to teamwork in three subjects, namely Materials in Engineering and Science (MES), Geotechnology A (GTA) and Geotechnology B (GTB), and presents the outcomes of this approach over a ten-year period in one subject (GTA).

2 APPROACH TO TEAMWORK

Group work is common practice during laboratory and field classes. This is due to the complexity of the practical sessions, which requires more than one student to carry out a given task. However, other factors also lead to a teamwork approach, such as time constraints and limited laboratory space, especially when there are many students in a subject. Two approaches to group membership were previously used. In one approach, students were randomly placed in groups that would complete a given task (the same for all groups) and the task would be completed simultaneously by all groups (GTA). Alternatively, each group would be required to perform a different task in a given practical session (MES, GTB). In this case, the tasks were performed in sequential order.

In some cases, a group contained more students than necessary to perform a given task. Some students were actively involved in the task, whereas other students were passive and did not contribute much to the task. Hence, some students did not gain many hands-on skills from the task. The arbitrary assignment of students into groups can cause imbalances due to the different academic levels of students, with a detrimental effect on learning (Frank and Barzilai 2004, Gibbings and Brodie 2008). Groups with lower academic and practical skills required more time to complete a task.

In 2004, the teaching methods and assessment schemes for MES, GTA and GTB were revised to eliminate these shortcomings. The new approach was developed to encourage teamwork and mentoring during both the practical classes and technical report writing stage. Information on group membership, team responsibilities, assessment requirements, including due dates and marking distributions, was given to students at the start of the semester.

The academic performance of students was considered as a reasonable criterion to achieve more balanced teams. This encourages peer-assisted learning and improves teamwork (Frank and Barzilai 2004, Hellstöm *et al*. 2009). Furthermore, to encourage further development of communication and interpersonal skills, the team composition was changed from one practical session to another. Although this approach may require more work from the subject coordinator, the outcomes are worth the additional work.

3 ASSESSEMNT OF TEAMWORK

The assessment in the subjects relies heavily on the final examination, which contributes 60% (MES) to 70% (GTA, GTB) to the final mark. The remaining 30% (GTA, GTB) to 40% (MES) is made up from numerical assessments and technical reports on laboratory work.

Until 2004, students were required to submit the numerical assessments and the repots as individual work. The contributions of the components to the final mark in MES were shared equally between the two types of assessment. For GTA and GTB, the contributions were 20% from the reports and 10% from the numerical assessments. The marking allocations for the reports for all subjects were 5% for introduction/objectives of the laboratory session, 15% for the description of the test procedure, equipment and materials, 25% for the presentation of test data, 35% for the discussion and critical analysis of the results and 20% for the conclusions.

By 2004, this system proved to have numerous shortcomings, such as excessive workload for both students and staff and no assessment of teamwork contributions, resulting in negative effects on student learning. In addition, the system did not provide appropriate incentives for the types of behavior that were considered desirable, such as collaborative learning and mentoring.

The revised assessment scheme involves both individual and team assessment, and includes a mix of summative and formative assessments. The assessments are used as an incentive to encourage desirable behavior, such as mentoring. The new marking system also places more emphasis on the development of a student's skills to ensure an increased level of competence. However, the overall contribution of the various assessment components did not change. The revised approach was only applied to the practical sessions.

Individual participation was assessed in the report. To encourage mentoring within a team, the teamwork assessment was extended from the development of the practical sessions to the preparation and writing of the report. In this way, the mark completely reflects the team's performance. Furthermore, a student's contribution to report writing needs to be motivated and rewarded by allocating a mark to it. To ensure that each student contributed to the report, the team was required to submit a written statement, signed by each member of the team, indicating the individual contributions to the report. This approach also encourages self-assessment.

The marking system used for the practical sessions was revised to include the student's contribution to both the test development and the report, and its composition is presented in Table 1 (2004-2005). Report writing is a repetitive task, which applies the same principles to different laboratory classes. Hence, this approach consolidates and extends the skills in this area. Students are rewarded for learning new skills and the marking allocations for the later reports had a slightly different distribution as given in Table 1 (2006-2007).

Despite the 20% allocated to individual contributions, it was found that this was not a sufficient incentive for some students. Hence, the assessment of individual contributions was revised again in 2008 by using a multiplier applied to the final report mark (see Table 1, Post 2008). This approach proved more effective and it is still used for the subject. In addition, more emphasis is placed on the presentation of results, critical analysis, discussion and conclusions in later years of study.

4 RESULTS AND DISCUSSION

The new method of forming teams ensures balanced teams in terms of both academic and practical skills. This fosters mentoring within the team, better teamwork and competition between teams, especially when working on the same task. Moreover, intra-team communication and interpersonal skills are further developed during the practical sessions and report writing. Exchanging information between groups, mainly when groups perform different tasks during the same practical session and when all students are asked to report on the collected data, further contributes to efficient oral and written communications and enhances the leadership skills learned in previous subjects. The introduction of a group report eases the workload for both students and

staff. The revised assessment scheme encourages teamwork during the practical sessions and report writing. Rewarding individual contributions to teamwork ensures that every member of the team contributes to the completion of the task and enhances teamwork skills. The use of previously-learnt skills is also encouraged by the new marking system. This also contributes to the further development of written communication skills and promotes and enhances responsible attitudes and interpersonal skills.

Table1. The revised weighting of the technical report mark.

Report section	**Report Marking Breakdown**			
	2004-2005	**2006-2007**	**Post 2008**	
			2nd and 3rd year	**4th year**
Introduction/statement of laboratory aims including engineering applications of tests	5%	5%	10%	10%
Description of materials/equipment/procedure	10%	10%	10%	
Presentation of the test results	20%	15%	20%	25%
Discussion/critical analysis of the results	25%	20%	30%	35%
Conclusions	20%	15%	20%	20%
Report writing skills	-	15%	10%	10
Individual contribution to the practical session	10%	10%	-	-
Individual contribution to the report writing	10%	10%	-	-
Contribution to the laboratory work/report writing multiplier	-	-	0, 0.25, 0.5, 0.75, 1	

Overall, the revised scheme places emphasis on the improvement of skills and learning new skills, rather than just achieving a minimum level of competence. This results in improved learning and further development of a student's soft skills.

The new strategy for teamwork in GTA was implemented in 2004. The results to date demonstrate a considerable improvement in student performance. This is demonstrated by comments from students taken from Quality Assurance (QA) surveys and the first author's observations and student discussions when teaching the same cohort in a different subject.

One of the aims of the new scheme was to improve teamwork. Figure 1 presents a comparison of the mark for the laboratory component in the subject. The comparison is done over a ten-year period, three years before the change and seven years after the change. It is clear that the 2003 group had significant problems in managing the workload for the laboratory component, leading to lower marks. The implementation of the revised teamwork scheme continuously eased the difficulties that some students had. A considerable improvement was also observed in the final grades of the two cohorts prior to the change and after the change. In addition, the QA surveys prior to and after the change showed that students welcomed the new assessment scheme. The comments in the QA survey showed that students became more aware of their own strengths and weaknesses while working in teams.

The first author is also involved with teaching of the second subject of the Geotechnology discipline, which makes it easy to observe the progress of a cohort. The

change to the assessment scheme implemented in GTA enhanced the competence and communication skills of students, and produced a better performance in GTB.

Although the results so far show significant improvements in student learning, few aspects need to be improved and this requires further investigation.

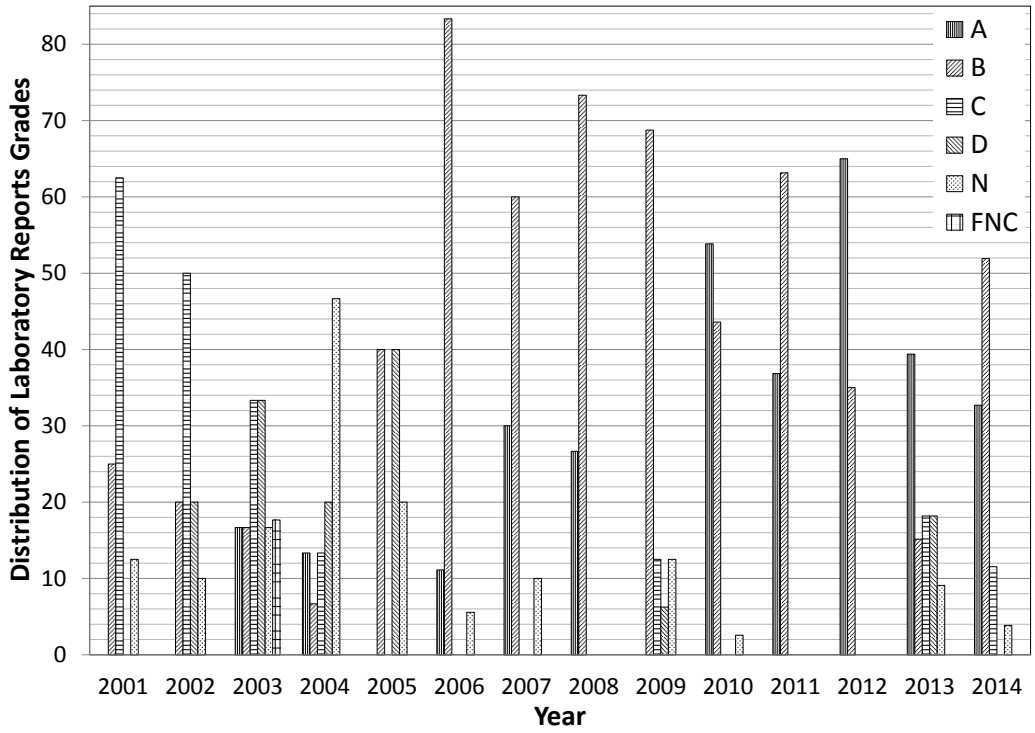

Figure 1. Grade distribution for the laboratory component in Geotechnology A (A, B, C and D are passing grades, N is a failure grade, whereas FNC is a failure to complete the task).

5 CONCLUSIONS

The revised approach to teamwork and assessment in Geotechnology A encourages teamwork and provides a mechanism for assessing individual contributions to teamwork. It also enhances communication between teams and promotes the development of interpersonal skills. Teamwork contributes to a higher level of learning through peer mentoring within a group. The new system encourages and rewards the practice of the acquired skills, especially communication skills. Overall, it was shown that the current teamwork and assessment strategies in Geotechnology A result in deeper and higher-quality learning.

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