Peer and self-assessment in engineering students' group work

Venkata P. Kommula, Jacek Uziak & M. Tunde Oladiran

University of Botswana
Gaborone, Botswana

ABSTRACT: The current practice in engineering education increasingly entails team work and group projects. The ability to work effectively in teams is considered by many to be an essential skill required of today's engineers; some claim that such ability is one of the most desired qualities of a graduate engineer. Group projects are frequently used to improve and develop students' team skills. Other reasons for using team projects include better simulation of industrial conditions, improvement of interpersonal and leadership skills, and communication enhancement. Assessing individual students in a group or team activity is a challenge. The results from the preliminary study of a peer-assessment instrument for awarding marks to individual members for a group project are presented in this article. The tool employs both quantitative and qualitative methods to assess the role and contribution of individual team members. The results indicate that the instrument provides an accurate measure of the student's participation in teams. The results also can be used as a model to extend project-based group work to other courses in the programme.

INTRODUCTION

The use of group-based project work (GBPW) is becoming increasingly popular in higher education, for sound pedagogical reasons. Group learning achieves deeper learning and students retain information longer, and are also more likely to attain higher grades. Using GBPW can enable students to develop personal transferable skills of teamwork, communication, presentation, problem-solving, delegation and organisation. They also acquire better understanding of the environment in which they would be working as professionals, because group work better simulates industrial conditions [1]. Although the concept of team-orientated, project-based learning has been generally validated, the assessment in such conditions is considered to be subjective, not usually repeatable and generally questioned. The common criticism of group work by both teachers and students is related to a situation when the same assessment or grade is given to all group members irrespective of the contribution or efforts individual members of the group have made [2].

However, this drawback can be overcome by using a tool which provides for the assessment of students' individual contributions. Assessment is normally used for at least one of the following reasons: to improve, to inform and to approve the curriculum. These reasons contribute to making the assessment a decisive motivating factor in the learning process. Ramsden maintains that *from our students' point of view, assessment always defines the actual curriculum* [3]. Assessment in most engineering courses is usually summative in nature, i.e. the assessment is carried out periodically during the teaching period [3]. For example, quizzes, tests or exams provide information about students' understanding of knowledge and ability to carry out essential course learning outcomes. It also provides for individuals receiving formal credit for their activity, in the form of a grade. The process is often feared by students since there is always a possibility of error and loss of deserved grade [4].

There are two main problems with group work, namely, the existence of so called free-riders in the team and the work submitted being a collection of individual contributions rather than a consolidated team effort [5]. The solution to both problems would be to intentionally and actively involve students in assessing their own, and their peers' contribution to group work, by using some form of peer and self-assessment tools. Such an approach has been advocated by a number of researchers [6][7]. Self- and peer assessment are particularly useful methods to award marks because it is difficult for the lecturer to know which individual contribution has been made by students outside the normal class time. Students are in a unique and privileged position to assess individual contribution by group members to the agreed milestones and the final work product. Also, non-conventional assessment can empower the students in that they become actively involved in the learning and teaching strategy [8]. Both peer assessment and self-assessment provide an opportunity to learn critical evaluation skills. Although this approach is also criticised for not being reliable, it is arguably the only pragmatic method of assessing group members. The reliability can be improved by using multiple ratings [9]. It has been suggested that students should be involved in the assessment process of the group work at an early stage, i.e. in the

development of the assessment criteria and the decisions on proof of the contribution. Students would then own the process, support it and be realistic in assessing themselves and others.

However, there are also several studies in which the criteria are set by the assessor, with no input from the students [6][10]. There are mainly two categories of peer-assessment methods within group project work: holistic and category-based. In holistic type each student awards only one grade to each of the other group members, which summarises overall contribution to the group effort. In the category-based method, which was used in this study, students assess each other in a number of categories and these scores are incorporated as a percentage contribution for each group member.

Self-assessment of work performed by individuals has a longer history than equivalent peer assessment. It has been reported [11] that more experienced or senior students tend to be more accurate and reliable in their self-assessment (and, incidentally, in peer assessment) than less experienced or junior students. Interestingly, students studying scientific-type courses tend to be more accurate than those from the arts or humanities. Also, good students tend to under-rate themselves and weaker students tend to over-rate themselves in comparison to lecturers' assessments [11]. There are also reports on using students' self- and peer assessment to adjust summative teamwork marks into individual summative marks for team members. Contributions are rated by all students in a team [6][10].

METHODOLOGY

The structure of the questionnaire used in the current study was patterned after sample instruments collected from a variety of sources including engineering education, communication, engineering practice and teacher education [12-15]. The goal was to generate a concise, easy-to-complete instrument that would inform team efforts to target deficiencies that impact on teamwork abilities. The questionnaire was also used as a self- and peer assessment instrument. Students were asked to respond to the questions using five-point Likert scales from (1) strongly disagree to (5) strongly agree. The questionnaire consisted of 5 categories with 35 items. There were also open-ended questions about the assessment in general. All students were asked to complete the questionnaire individually and confidentially.

Eighteen final-year students took part in the self- and peer assessment exercise, of whom 17 and 1 were respectively from mechanical and electrical engineering undergraduate programmes. The group project work was undertaken in a course entitled Production and Operations Management (POM) which, like many courses in the mechanical engineering programme, did not normally use peer and self-assessment method. The group project was an assessed piece of assignment within the POM course and contributed 40% towards the continuous assessment of the course. At the beginning of the course, the students formed themselves into groups of three to carry out a group project, which had the following three assessable components or milestones:

- A seminar group presentation at the beginning of the project;
- An oral presentation at the end of the project;
- A written report.

Each of the above components was carried out as a collaborative group activity.

The group mark was a combination of the lecturer's mark and that of the remainder of the class, i.e. the presenting group did not award marks to its own group. Each class member was asked to rate each group project presentation, other than their own using the following qualities or criteria:

- Informativeness;
- Achievement of group tasks;
- Members' contribution to the project.

Presentation mark was weighted with 25% for peer mark and 75% for lecturer's assessment. Mathematically, the individual seminar mark, p_i, was calculated from:

$$p_i = 0.25\frac{\sum_1^{n-1} a_i}{n-1} + 0.75 b_j \quad (1)$$

where: a_i=seminar assessment mark by each member of class for the presenter (the presenter did not score himself/herself), b_j= supervisor mark for individual seminar presentation, and n = total number of students.

Similarly, the individual final oral presentation mark, q_i, is:

$$q_i = 0.25\frac{\sum_1^{n-1} c_i}{n-1} + 0.75 d_j \quad (2)$$

where: c_i= oral assessment mark by each member of class for the presenter (the presenter did not score himself/herself), d_j= supervisor mark for oral presentation.

The final presentation mark was a simple average of the results from equations 1 and 2 above. Only the lecturer assessed the written report.

Total mark was calculated by using weightings of 30% and 70% for final presentation and written report respectively, that is:

$$f_i = 0.3\,\frac{p_i + q_i}{2} + 0.7 s_j \qquad (3)$$

where: f_i= individual final project mark, and s_j= written report mark from the supervisor.

RESULTS AND DISCUSSIONS

Students were asked to rate themselves and their peers according to the categories in the questionnaire. The responses from items within a particular category have been combined and the results are discussed in this section. Students were asked questions about group tasks including sharing the work, willingness to consider other ideas, valuation of diverse opinions, engagement in discussion during the processes, delivery of work on time, communicating ideas clearly and working with the team to resolve conflicts. In that respect, 33% of the students (i.e. 6 out of 18 students) rated themselves higher than their group members (see Figure 1). The evaluation implies that the group members had contact with other team mates frequently and sharing of ideas might have improved making work more effective. This also suggests that, for at least some students, the formative evaluation did help to reinforce the need to work co-operatively and the assessment promoted high-quality learning.

In the qualitative response for overall contribution to the project, with respect to members' ability to perform effectively in the team, and how effective the team has been at working together, 44% (i.e. 8 students) rated themselves higher than others; 56% of the students (i.e. 10 students) rated themselves lower than the group members. The results seem objective as they are not lop-sided. The results also indicate that the students fully understand the assessment process and were able to evaluate their contributions more clearly. The results are shown in Figure 2.

To assess each team member's performance, members were asked to distribute 100 marks to the three members in the group, i.e. including self. Marks awarded by each student were different from marks awarded by other students in the class, which confirms independence of assessment and also improves reliability of results. In that instrument 50% (i.e. 9 students) awarded 40 marks or more to themselves; 11% (i.e. 2 students) awarded themselves fewer than 33 marks and only one student awarded equal marks to everyone in the team. The results are depicted in Figure 3.

The component marks (i.e. seminar, oral and written) and the final marks are compared in Figure 4. It was observed that students awarded high marks to their peers during the seminar and oral presentations. However, both the seminar and oral presentation marks shown in Figure 4 were calculated using equations (1) and (2) respectively, i.e. the individual mark was a combination of the supervisor assessment and peer assessment, with 75% and 25% weighting. The written report component was completely assessed by the supervisor. Using these three components the final project mark was calculated by using equation (3). The final mark is juxtaposed in Figure 4. It can be observed that for most students the final mark is almost equal to the supervisor written report assessment.

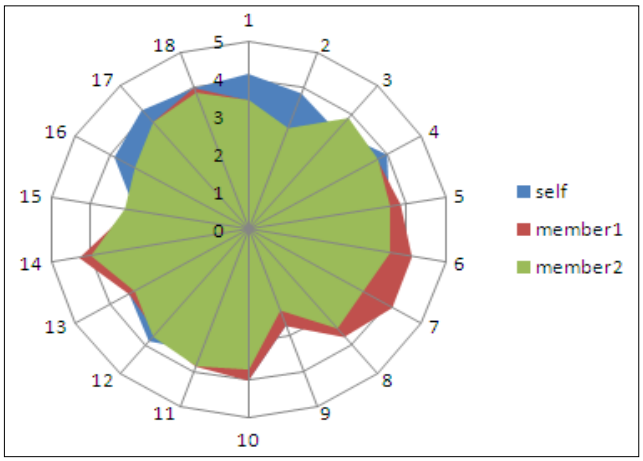

Figure 1: Response to group tasks.

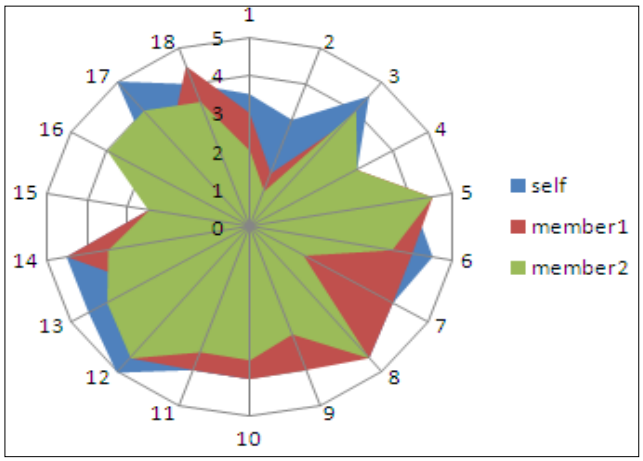

Figure 2: Overall contributions of group members.

At the end of the group project, each member was awarded a final project mark which was determined by a combination of marks given by both the teacher/supervisor (70%) and the rest of the class (30%). Figure 5 shows the comparison of

the individual final project mark in the course and the overall mark obtained in the course. The results show that one student with a good project mark has failed (i.e. less than 50%) the course and 4 students (i.e. 22% of the students) got almost the same marks in the project and the final mark for the course.

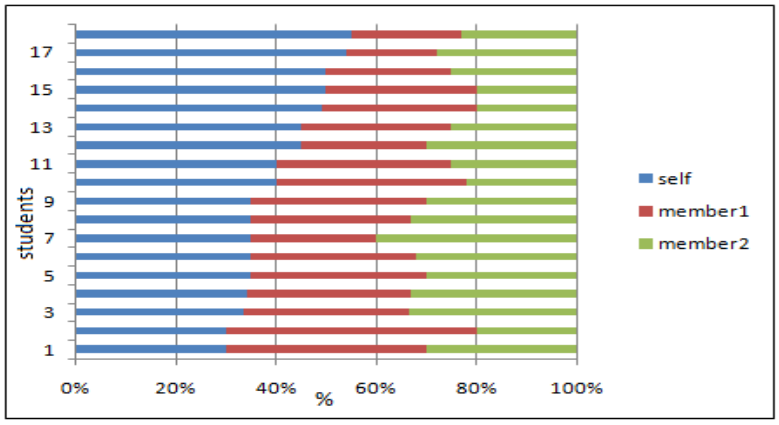

Figure 3: Assessment of each team member's performance distributed over 100%.

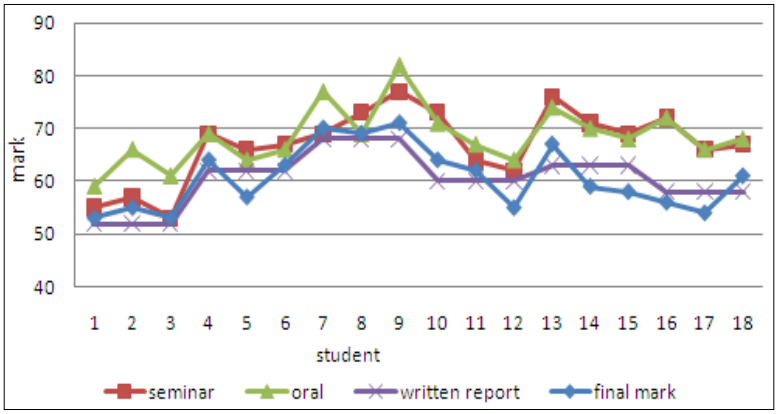

Figure 4: Comparison of components of the individual project mark.

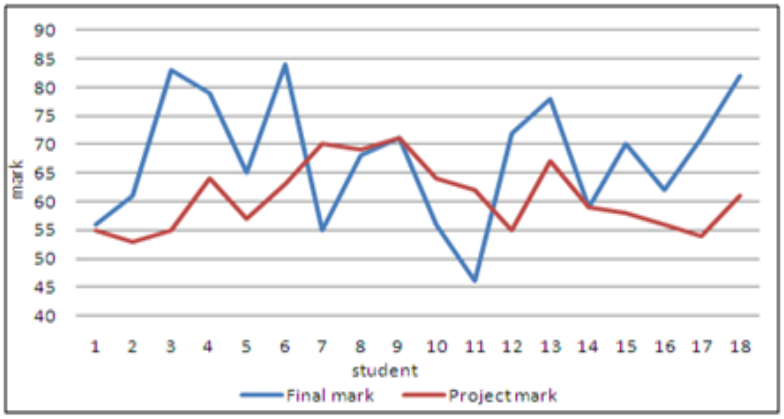

Figure 5: Comparison of final mark in the course and group project mark.

The students generally were satisfied with the assessment method because they participated in the group project assessment. This type of assessment can enhance high-quality learning because students participated in various tasks and learning outcomes of the groups.

CONCLUSIONS

Assessment of students' performance in engineering courses is usually based on the summative method. The formative type of assessment has several advantages, including students' participation as assessors. A self- and peer assessment instructional tool was designed and used in a group project, which contributed 40% of the continuous assessment to the overall mark in a mechanical engineering course. Each group achieved the targets of the project to the overall satisfaction of the lecturer, as shown by the high pass rate in the course. The mark obtained in the group project is considered a true reflection of the individual student performance in the course. The questionnaire was used as the instrument for collecting the students' opinions and this peer assessment provided an accurate measure of the students'

participation in teams. As the evaluation was reliable and students were satisfied to have participated in the process, group-based project work can be extended to other courses in the programme. In particular, the final-year degree project, which for several years has been run on an individual basis, may now be considered for a changeover to group work.

REFERENCES

1. Cheng, W. and Warren, M., Making a difference: using peers to assess individual students' contribution to a group project. *Teaching in Higher Educ.*, 5, **2**, 243-255 (2000).
2. Kørnøv, L., Johannsen, H.H.W. and Moesby E., Experiences with integrating individuality in Project-Oriented and Problem-Based Learning POPBL. *Inter. J. of Engng. Educ.*, 23, **5**, 947-953 (2007).
3. Ramsden, P., *Learning to Teach in Higher Education*. London: Routledge (2003).
4. Biggs, J., *Teaching for Quality Learning at University*. Bakingham: The Society for Research into Higher Education and Oxford University Press (2003).
5. Fink, L.D., *Beyond Small Groups: Harnessing he Extraordinary Power of Learning Teams*. In: Michaelsen, L.K., Knight, A.B. and Fink, L.D. (Eds), Team-Based Learning: A Transformative Use of Small Groups. Westport: Praeger Publishers, 3–26 (2004).
6. Conway, R. and Kember, D., Peer assessment of an individual's contribution to a group project. *Assessment & Evaluation in Higher Educ.*, 18, **1**, 45–57 (1993).
7. Goldfinch, J.M. and Raeside, R., Development of a peer assessment technique for obtaining individual marks on a group project. *Assessment & Evaluation in Higher Educ.*, 15, **3**, 210–225 (1990).
8. Leach, L., Neutze, G. and Zepke, N., Assessment and empowerment: some critical questions. *Assessment & Evaluation in Higher Educ.*, 26, **4**, 293–305 (2001).
9. Falchikov, N. and Magin, D., Detecting gender bias in peer marking of students' group process work, *Assessment & Evaluation in Higher Educ.*, 22, **4**, 385– 396 (1997).
10. Goldfinch, J., Further developments in peer assessment of group project. *Assessment & Evaluation in Higher Educ.*, 19, **1**, 29–36 (1994).
11. Lejk, M. and Wyvill, M., The effect of the inclusion of self-assessment with peer assessment of contributions to a group project: a quantitative study of secret and agreed assessments. *Assessment & Evaluation in Higher Educ.*, 26, **6**, 551–561 (2001).
12. Freeman, M., Hutchinson, D., Treleaven, L. and Sykes, C., Iterative learning: self and peer assessment of group work. *Proc. 23rd Annual Conf. of Australasian Society for Computers in Tertiary Educ.*, Sydney, Australia, 257–266 (2006).
13. Johnson, V., The design of survey questionnaires to identify the critical education and support processes most in need of improvement. Presentation at the Rose Hulman Best Assessment Practices in Engineering Education: A Working Symposium, Terra Haute, Indiana (1997).
14. Kaufman, D.B., Felder, R.M. and Fuller, H., Accounting for individual effort in cooperative learning teams. *J. of Engng*, 89, **2**, 133–140 (2000).
15. Vilson, V.L, Questionnaire and survey development: principles of good practice. Presentation at the Rose Hulman Best Assessment Practices in Engineering Education: A Working Symposium, Terra Haute, Indiana (1997).