

## Towards rational assessment of group projects in engineering higher education

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***Abstract:** Group projects based learning arrangements are common in higher education. Different practices are followed for assessment of individual contributions in group projects. Moreover, several such practices incorporate diverse arrangements for including peer and self assessments along with teacher assessments. An ongoing research by the authors aims at: (a) conducting a benchmarking study on such group project assessment frameworks and (b) thereby recommending rational arrangements for assessment of individual contributions in engineering higher education group projects. The research methods include knowledge-mining from literature reviews and lessons from case-studies in engineering higher education. The discussions in this paper include: (a) a basic overview of some assessment strategies; (b) a key summary from specific case-studies; and (c) a set of recommendations for rational assessment of group projects in engineering higher education.*

### Introduction

Group projects based learning arrangements are common in both undergraduate and postgraduate subjects. Teamwork based group projects can enhance students' knowledge and learning outcomes (Burdett, 2003; Fellenz, 2006). Some such educational benefits of group projects include transferrable skills development and peer-assisted learning values especially, talent building in various useful aspects such as communication, leadership, team-working, negotiation, decision-making and problem solving (Boud, Cohen and Sampson, 1999; Mellor, 2009). A plethora of previous research analysed different assessment arrangements in the higher education (e.g. Goldfinch and Raside, 1990; Somervell, 1993; Dochy, Segers and Sluijsmans, 1999; Lejk and Wyvill, 2001a; Johnston and Miles, 2004) and yet assessing individual contributions in group work remains problematic in many cases (Parsons, 2004). For example, related studies such as Barfield (2002) and Fellenz (2006) highlighted that shortcomings in group project assessment and feedback could affect student performance in group projects as well as their satisfaction levels.

Drawing threads from such observations, the authors recently initiated a research that mainly aims at a benchmarking exercise to explore current and good practices so as to develop systematic arrangements for improved group work assessments, which include developing clustered rubric models and rational frameworks for intra-group and inter-group peer assessment as well as self assessments. The research methods in this ongoing research are: knowledge-mining from literature reviews, surveying students and staff, focus group studies and lessons from case-studies in engineering higher education. The discussions in this paper include: (a) a basic comparison of some assessment strategies; (b) a key summary from specific case-studies; and (c) a set of recommendations for rational assessment of group projects in engineering higher education.

## A basic overview of group project assessment strategies

In general, the assessment of individual contributions in higher education group projects shall beneficially adopt hybrid multi assessment arrangements including self and peer assessments in addition to conventional teacher assessments (Goldfinch, 1994; Stefani, 1998; Sluijsmans, Dochy and Moerkerke, 1999). The difficulties of integrating self and peer assessment scores originate from various reasons such as lack of common standards and systematic approaches, poor reliability of peer/self assessments (Cheng and Warren, 2000; Lejk and Wyvill, 2001b), controversial deviations from teacher assessments (Sharp, 2006). Basically, self assessment arrangements aims to enable students themselves assess their own work (Dochy, Segers, and Sluijsmans, 1999). Potentially, self assessment can encourage personal responsibility, individual accountability, and self realization values (e.g. Hanrahan and Isaacs, 2001). Moreover, in ideal scenarios, use of self assessment in education could enhance learning and teaching experiences (Anderson and Freiberg, 1995), for example, the students could be their own agents of learning, thereby improving learning outcomes including related future gains (Hahn, Mentz and Meyer, 2009). However, probable pitfalls for incorporating self assessments in final marks/ grades include: overrating or underrating bias, lack of knowledge, poor accountability or responsibility. For example, personality traits including esteem led bias might affect the reliability of self assessment component (Lejk and Wyvill, 2001b; Sharp, 2006). Similarly, earlier case-studies by Magin (2001) revealed specific criticisms for including the peer assessment scores as integral part of marking in group projects and the key concerns include: collusion, commitment, understanding, trust, reciprocity effects and different bias issues. For example, poor preference for including peer assessments might be due to concerns such as lack of fairness, injustice and unreliability in relation to assessment standards (Mellor, 2009). The individual contributions in group project works can be assessed based on either holistic peer assessments or category based peer assessments. In case of holistic peer assessments, a single peer assessment for individual contributions is given by each group member, whereas in the category based peer assessments, the individual contributions are assessed by several representative categories for the group project works (Lejk and Wyvill, 2001a and 2002). Systematic frameworks/ tools can facilitate to reliably incorporate peer assessment of individual contributions in group works – e.g. SPARK – Self and Peer Assessment Resource Kit (Freeman and McKenzie, 2002), GPEP – Group work Peer-Evaluation Protocol (Fellenz, 2006), TeCTra – Team Contribution Tracking system (Raban and Litchfield, 2006). Table 1 provides a basic outline of different strategies for assessing individual contributions in group works.

**Table 1 A snapshot of adjustment strategies for group work assessments**

<b>Strategy</b>	<b>Brief description</b>	<b>Reference</b>
Additive adjustment for individual contributions	<ul style="list-style-type: none"> <li>▪ The base marks of group projects are adjusted by relevant additive/ subtractive adjustment components for individual contributions, i.e. <math>I_x = G_x \pm a_x</math>, in which <math>I_x</math> is additively adjusted marks of individual 'x' in a particular group, <math>a_x</math> is that individual's additive or subtractive marks, and <math>G_x</math> is the base mark for the particular group in which individual 'x' participated in group project works.</li> <li>▪ The additive adjustment might includes self and/ or peer assessments.</li> <li>▪ In some practices, certain limit is set for the additive component including self and/ or peer assessments (e.g. 10 marks).</li> </ul>	Conway, Kember, Sivan, and Wu 1993; Parsons 2004
Multiplicative adjustment for individual contributions	<ul style="list-style-type: none"> <li>▪ Suitable multiplicative weighting factors are used to adjust group project base marks for accommodating individual contributions, i.e. <math>I_x = G_x \times w_x</math>, in which <math>I_x</math> is multiplicatively adjusted marks of an individual 'x' in a particular group, <math>w_x</math> is that individual's multiplicative weighting factor, and <math>G_x</math> is the base mark for that group in which 'x' participated in the group project works.</li> <li>▪ Normally, <math>w_x</math> will be the normalized average of intra-group peer (and self) ratings – e.g. in Cheng and Warren (2000) case study, the ratio between 'individual effort rating' and 'average effort rating for group' is used to derive the multiplicative adjustment value of '<math>w_x</math>'.</li> <li>▪ Without limiting constructs, this strategy would heavily impact individual marks.</li> </ul>	Conway, Kember, Sivan, and Wu, 1993; Cheng and Warren, 2000

**Table 1 A snapshot of adjustment strategies for group work assessments (continued)**

<b>Strategy</b>	<b>Brief description</b>	<b>Reference</b>
Consensus based negotiated adjustment	<ul style="list-style-type: none"> <li>▪ In consensus based negotiated adjustment arrangement, the assessment marks for individual contributions of group members is decided by negotiation and consensus based agreement.</li> </ul>	Goldfinch and Raeside, 1990; Lejk, Wyvill, and Farrow, 1996
Fixed sum limited adjustment	<ul style="list-style-type: none"> <li>▪ Fixed sum limited adjustment methods include (a) zero sum system, (b) 60 sum system and (c) flexi sum method.</li> <li>▪ For example, in the zero sum system, a null balancing of the increases and decreases for individual contribution adjustment marks is followed such that the total of increase adjustments is equal to gross sum of decrease adjustments.</li> </ul>	Parsons, 2004
Regressive adjustment	<ul style="list-style-type: none"> <li>▪ If the difference between 'final individual grade' and 'group grade' is significantly different (i.e. a deviation more than or less than a pre-defined cut-off limit), special regressive adjustment formulas are used for final fine-tuning</li> </ul>	Fellenz, 2006

## Key summary from two case-studies

### Case study 1

The first author's Hong Kong based case-study is regarding the group project assessment arrangement in one postgraduate subject (which is a common choice for the postgraduate students specialising in *Construction Project Management* or *Real Estate Project Management* at the *City University of Hong Kong*). The same arrangement was repeated over two consecutive cohorts. The arrangement for group work assessment was mainly specific category-based (i.e. with different components), which included: (a) teacher assessment of product (i.e. report and presentation) and observation of the process (e.g. team-working), (b) inter-group peer assessment of product (which is restricted to presentation and certain aspects of report), (c) intra-group peer assessment of process (assessment of individual contributions from other team members of his/her group, i.e. in terms of specified categories such as data collection, analysis, and report writing), (d) self-assessment of individual's contributions (i.e. both product and process).

Despite the maturity of postgraduate students, they were instructed that their aggregate values of self and peer assessments should not deviate by more than a certain range from teacher assessments (e.g. 15%). An interim mock-up trial with moderations was included in both case-study cohorts, which mainly covered mid-semester report and presentation. The mid-semester assessment marks were not counted in final grading as such trials were mainly for benchmarking, training and orientation purposes. Overall observations from this case-study revealed enhanced group project works from improved individual contributions and satisfied students.

Key lessons from this case-study are: (1) in observations of both cohorts, major deviations were noticed in self assessment scores, i.e. even after training/ moderation and mid-semester mock-up trials, hence checking controls were required; (2) the intra-group peer assessments were more consistent (i.e. after the mock-up training) and match with teacher assessments; (3) in the inter-group peer assessments, only one group had some problematic scores, which were fixed subsequently by teacher intervention based negotiated consensus; (4) thus, even in such mature postgraduate cohorts and rational rubrics based assessments, peer/ self assessment of individual marks in group projects should not (preferably) alter the teacher assessments by more than a transparent preset limit – e.g. 10% from teacher assessment of individual contributions in such teamwork based group performance (e.g. as per Sharp, 2006).

## Case study 2

Another case-study of assessing individual contributions is from the UK based experience by the second author, specifically in assessment of undergraduate engineering students' second year design projects. In these projects, second year Mechanical Engineering undergraduate students were required to design an electrically folding caravan bed. The cohort was divided up in groups of four or five students, each on a random basis to simulate working with clients and colleagues. The group devised three concept proposals over one semester, out of which one was selected by the teachers and external (company) representatives, for full design. The full detailed design was concluded in the next semester. The first semester group working was just for preparatory purpose (i.e. pass/ fail "hurdle") and no marks were given. The second semester marks were given on the basis of a set of pre-defined detailed assessment criteria such as simplicity, ease of manufacture, cost, innovation, and recyclability.

In this, a moderated hybrid arrangement of consensus based negotiated agreement with multiplicative adjustment method is adopted. A 'zero sum system' is considered. In this arrangement, the teacher initially assesses the group projects and allocates some base marks for every group. Each group divides the project into several comparable sub-tasks. The group members choose their input to subtasks based on their individual strengths and weaknesses. Through group meetings and log of work performed, the group decides the multiplicative factors for each member through consensus. Accordingly, the group members will decide on intra-group peer assessment of individual contributions. For example, if teacher score for a group is 60 and all 4 members of Group 'X' uniformly decided their contributions are equal, corresponding contribution adjustment for each member is zero (i.e. in zero sum system, the adjustment will be zero) and the individual marks will be same (i.e. 60). Similarly, if teacher assessment for another Group 'Y' is 80 and all 4 members of this group consensually decided that individual contributions are -5%, 0%, +5%, and 0% respectively, corresponding adjusted individual marks are 76, 80, 84, 80.

This group project assessment design was successfully repeated in several engineering undergraduate cohorts of *Sheffield University* and *Newcastle Upon Tyne University* over a decade and the feedback and student satisfaction levels were consistently high, requiring teacher intervention only in some cases. Main lessons from this case study are: (1) clear-cut guidelines for overall assessment; (2) additionally, evidence in the form of log books, minutes of meetings and attendance at meetings avoided misconceptions about individual work and peer assessment of awarded grades – which was the key to the success of this scheme.

## Discussions

In addition to teacher/ tutor assessments, useful arrangements for assessing individual contributions in group projects include: (a) inter-group peer assessment of group performance, (b) intra-group self assessment of group performance, and (c) intra-group peer assessment of individual contributions. Presented case studies show that the following arrangement worked well: (i) in 'case study 1', all three arrangements, i.e. (a), (b) and (c) were useful – despite an issue of (b); (ii) in 'case study 2', only (c) was used was found successful.

Basically, the group project marks should reflect two key assessment parts such as (a) team performance component and (b) assessment of individual contributions. The frameworks for assessment should be preset i.e. well before commencement of group projects and the rational arrangements shall include details such as criteria, instructions/ guidelines, formulas and rubrics. Also, developing user-friendly software and tools will be useful e.g. as in: Freeman and McKenzie (2002), Raban and Litchfield (2006), and Fellenz (2006).

For effective outcomes, the group size should be kept between 3 and 5 (e.g. Burdett, 2003 recommended a nominal 'restrictive' limit of 5). In 'case study 2', a particular group in one cohort unusually included 7 students and there were certain issues such as two radical leaders and some functional problems. Midway through the semester, this problematic group was divided up and then both worked well. The group work assessment arrangements should be simple, comprehensive and consistent. Instead of static repetitions of a particular arrangement, using various new assessment

forms could encourage responsible and reflective learning communities – e.g. Dochy, Segers and Sluijsmans (1999). Some such reasonable modifications would effectively discourage collusions and dishonest cartels. However, such variations should be audited by concerned teachers and adequately debriefed to the respective students, e.g. Johnston and Miles (2004) recommended a ‘contribution index’ based verifying method.

Furthermore, suitable feedback and moderation/ facilitation arrangements should be available so as to minimize the problems such as conflicts, disagreements and disputes (Fellenz, 2006; Gibbs, 2010), for example, relevant safeguards are necessary for improved reliability of self and peer assessments in group projects. In *case study 1*, the teacher facilitated interventions were useful for some issues in self and peer assessments. While adequate transparency is required for assessment methods (including criteria, rating guidelines), confidentiality is crucial especially in intra-group peer assessments (Lejk and Wyvill, 2001b; Mellor 2009). Bias and variability in peer and self assessments should be carefully identified and relevant teacher interventions and feedback arrangements should be established for improved assessment validity and satisfaction (e.g. Smith and Jones, 2008; Mellor, 2009).

## Conclusions

Assessment of individual contributions from group work based coursework is a complicated challenge. Without suitable frameworks and systematic good practices, the assessment of individual contributions from group projects is deemed as a challenging task for the teaching community in engineering higher education. Focused literature review and previous case studies by the authors highlighted some successful arrangements for assessing individual contributions in group works. Thus, the principal aims of this ongoing research are: (a) enhancing dynamic participations in group work with improved understanding of useful contributions; (b) encouraging competitive innovations from students in group works, and (c) beneficial standardized arrangements targeting consistency, timesaving and improved transparency.

## References

- Anderson, J.B. and Freiberg, H.J. (1995). Using self-assessment as a reflective tool to enhance the student teaching experience. *Teacher Education Quarterly*, 22, 77-91.
- Barfield, L.R. (2003). Students’ perceptions of and satisfaction with group grades and the group experience in the college classroom. *Assessment & Evaluation in Higher Education*, 28, 355-370.
- Boud, D., Cohen, R. and Sampson, J. (1999). Peer learning and assessment. *Assessment & Evaluation in Higher Education*, 24(4), 413-426.
- Burdett, J. (2003). Making groups work: University student’s perceptions. *International Education Journal*, 4(3), 177-191.
- Cheng, W. and Warren, M. (2000). Making a difference: using peers to assess individual students’ contributions to group project. *Teaching in Higher Education*, 5(2), 243-255.
- Conway, R., Kember, D., Sivan, A. and Wu, M. (1993). Peer assessment of an individual’s contribution to a group project. *Assessment & Evaluation in Higher Education*, 18(1), 45-56.
- Dochy, F., Segers, M. and Sluijsmans, D. (1999). The use of self-, peer and co-assessment in higher education: A review. *Studies in Higher Education*, 24(3), 331 – 350.
- Fellenz, M.R. (2006). Toward fairness in assessing student groupwork: A protocol for peer evaluation of individual contributions. *Journal of Management Education*, 30 (4), 570-591.
- Freeman, M. and McKenzie, J. (2002). SPARK, a confidential web-based template for self and peer assessment of student teamwork: benefits of evaluating across different subjects. *British Journal of Educational Technology*, 33 (5), 551–569.
- Gibbs, G. (2010). *Using assessment to support student learning*. Leeds Met Press: Leeds, UK.
- Goldfinch, J. and Raeside, R. (1990). Development of a peer assessment technique for obtaining individual marks on a group project. *Assessment & Evaluation in Higher Education*, 15(3), 210-231.

E Palaneeswaran and A Kapoor, Towards rational assessment of group projects in engineering higher education.

- Goldfinch, J. (1994). Further development in peer assessment of group projects. *Assessment & Evaluation in Higher Education*, 19(1), 29-35.
- Hahn, J.H., Mentz, E., Meyer, L. (2009). Assessment Strategies for Pair Programming. *Journal of Information Technology Education*, 8, 273-284.
- Hanrahan, S.J. and Isaacs, G. (2001). Assessing self- and peer-assessment: the students' views. *Higher Education Research & Development*, 20(1), 53-70.
- Johnston, L. and Miles, L. (2004). Assessing contributions to group assignments. *Assessment & Evaluation in Higher Education*, 29(6), 751-768.
- Lejk, M., Wyvill, M. and Farrow, S. (1996). A survey of methods of deriving individual grades from group assessments. *Assessment & Evaluation in Higher Education*, 21(3), 267-280.
- Lejk, M. and Wyvill, M. (2001a). Peer assessment of contributions to a group project: a comparison of holistic and category-based approaches. *Assessment & Evaluation in Higher Education*, 26(1), 61-72.
- Lejk, M. and Wyvill, M. (2001b). 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 Education*, 26(6), 551-561.
- Lejk, M. and Wyvill, M. (2002). Peer assessment of contributions to a group project: student attitudes to holistic and category-based approaches. *Assessment & Evaluation in Higher Education*, 27(6), 569-577.
- Magin, D. (2001). Reciprocity as a source of bias in multiple peer assessment of group work. *Studies in Higher Education*, 26(1), 53 – 63.
- Mellor, A. (2009). *Group Work assessment: benefits, problems and implications for good practice*, Red Guides Paper 53. Northumbria University, UK.
- Parsons, D. (2004). Justice in the classroom: Peer assessment of contributions in group projects. In S. Mann & T. Clear (Eds.), *Proceedings of the 17th Annual Conferences of the National Advisory Committee on Computing Qualifications*, (pp. 144-151). Christchurch, New Zealand.
- Raban, R. and Litchfield, A. (2006). Supporting peer assessment of individual contributions in groupwork, *Proceedings of the 23rd annual ascillite conference: Who's learning? Whose technology? The University of Sydney*, (pp. 685-694). Sydney, Australia.
- Sharp, S. (2006). Deriving individual student marks from a tutor's assessment of group work. *Assessment & Evaluation in Higher Education*, 31(3), 329 – 343.
- Sluijsmans, D., Dochy, F., and Moerkerke, G. (1999). Creating a learning environment by using self-, peer- and co-assessment. *Learning Environments Research*, 1, 293-319.
- Smith, A. and Jones, J. (2008). Students reflections on a collaborative project, *Proceedings of European Conference on Education Research – ECER 2008*, (18 pages). Gothenburg, Sweden.
- Somervell, H. (1993). Issues in assessment, enterprise and higher education: the case for self-, peer and collaborative assessment. *Assessment & Evaluation in Higher Education*, 18, 221-233.
- Stefani, L.A.J. (1998). Assessment in partnership with learners. *Assessment & Evaluation in Higher Education*, 23(4), 339-350.
- Zhang, B., Johnston, L. and Kilic, G. B. (2008). Assessing the reliability of self- and peer rating in student group work. *Assessment & Evaluation in Higher Education*, 33(3), 329 – 340.

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