COLLABORATIVE PEER FEEDBACK

David A. Smith
Faculty of Science, Yale-NUS College
28 College Ave West (RC3), #01-501, Singapore 138533

ABSTRACT

Feedback on assessed work is invaluable to student learning, but there is a limit to the amount of feedback an instructor may provide. Peer feedback increases the volume of feedback possible, but potentially reduces the quality of the feedback. This research proposes a model of collaborative peer feedback designed to increase quality of peer feedback, and describes its implementation in an undergraduate mathematics module. The implementation includes the development of bespoke software to automate administrative tasks.

KEYWORDS

Peer assessment, group, feedback.

1. INTRODUCTION: FEEDBACK & PEER FEEDBACK

Educators seeking to improve their effectiveness are well advised to consider offering more feedback to students. Indeed Hattie (1987) concluded "Feedback is the most important single influence on student achievement" and Black & Wiliam (1998) opined "Feedback has extraordinary large and consistently positive effect on learning compared to other aspects of teaching." Rice et. al. (1994) note that students are also aware of the value of feedback to their learning, "mathematics students want specific, detailed, facilitative feedback". In this context, it seems clear that a great deal more high quality feedback would be beneficial for students. However, providing high quality feedback is a significant drain on instructor time, especially in large classes.

Faced with restrictions on instructor time, a popular substitute for feedback provided by the instructor is feedback provided by other students, so-called "peer feedback".[1] The advantages are many: not only is the task of giving feedback crowd sourced, but those *giving* the feedback also stand to benefit, Dochy et. al. (1999), Ambrose et. al. (2010). By critically engaging with the work of another student, the feedback provider is forced to check data, weigh arguments and appraise evaluations—different skills to finding data, constructing arguments, and evaluating methodologies, but tasks that mutually reinforce. Moreover, if a student has completed an assignment and is then asked to provide feedback to another student on that same assignment, they are forced to engage with the same material at multiple levels, thereby bolstering knowledge acquired and attaining deeper learning outcomes, Somervell (1993).

There are also disadvantages to peer feedback compared to the feedback that an instructor can provide. The most pernicious is the quality of the feedback. It may not be that every student is equally motivated to provide feedback to the best of their ability, which necessarily disadvantages the students receiving weaker feedback. Even the most dedicated student will likely provide lower quality feedback than the instructor, were they unconstrained by time, would be able to provide. The student receiving a peer's feedback is likely aware of this, and may even underestimate the quality of the peer feedback, so may engage with peer feedback less positively than with feedback provided by the instructor.

Anonymity in assessment has many advantages, even when the assessor is the instructor, not least of which is reducing implicit bias. In peer feedback, reducing implicit bias is also helpful, but there is a still more important reason for anonymising peer feedback. If the feedback provider knows the identity of the student whose work they are assessing, it may cause some embarrassment for the assessed student, which makes

[1] Although peer assessment with stakes is a popular model, for example Forbes & Spence (1991), we will not discuss assessment with stakes in the present work.

students more likely to engage in avoidance behaviours, hampering their learning, Friedel et. al. (2002). If a student knows which other student gave them poor quality feedback, they may be less willing to work constructively with that student in future collaborative assignments. Therefore, as far as possible, peer feedback should be double blind.

This research seeks to address some of the shortcomings of traditional peer feedback models that were described above.

2. PEER FEEDBACK IN THE CONTEXT OF LEARNING OBJECTIVES OF THE PROOF MODULE

Proof is a mathematics module pitched to second year students in a highly competitive undergraduate college of the liberal arts and sciences in Singapore. The module serves as a gateway to higher level modules in mathematics, computer science and statistics, providing a survey of foundational university level mathematics and introducing myriad advanced concepts and notation. But the main learning objectives of the module are centered on the writing and critical reading of proofs. Proofs are the means by which mathematicians convince one another of facts (or theorems), so it is as essential that a prospective mathematician, computer scientist or statistician be fluent in proof as it is for a budding historian to be able to write an essay or chemist a lab report. A challenge is that mathematics students have experienced only the palest facsimile of proof at secondary level; most students must learn proof from the basics. Critical reading of an essay is a related but different skill to writing an essay, and the same holds for proof. Students who learn to critically evaluate proofs are able to critically evaluate their own proofs as they write and, eventually, to write better proofs.

With such a novel concept as proof, the potential drawbacks of peer assessment are magnified. Students submitting assignments are not used to writing precisely, and students providing feedback are not used to unpicking imprecise writing to offer constructive feedback. The likelihood of a student providing valuable feedback is low, especially towards the beginning of the module, even assuming they are motivated and not under time pressure. Nevertheless, the potential advantages of peer feedback are also amplified. Plenty of feedback is of great value in a module dealing with a novel means of communication. And even peer feedback that suggests the provider misunderstood the argument of the assessed work can be of value: it shows that the argument was expressed with insufficient clarity for a member of the target audience to follow. Critical reading of proof is itself a learning objective of the module, and other students' work is a good source of proofs of varying quality.

Handwritten mathematical notation includes many symbols that are not present on a standard computer keyboard, and two dimensional arrangements of symbols which are not easily reproduced using standard word processing software. For this reason, mathematicians use the LaTeX markup language in place of MS Word etc. Using LaTeX to typeset mathematics is another learning objective of the proof module. Students are expected to typeset all their submissions for assessment. Learning computer languages is typically undertaken by students in relative isolation, with only online resources to help, so students from a single cohort typically learn disparate techniques, many of which could benefit all students. As students are often reluctant to use virtual learning environment (VLE) message boards, peer feedback could be an efficient means for exchanging LaTeX tips.

3. PROPOSED COLLABORATIVE FEEDBACK MODEL

This research proposes the following model of peer feedback, designed to address some of the issues raised above.

To improve the quality of feedback provided, the process of giving peer feedback is conducted collaboratively by a randomly assigned group of 3-4 students (the feedback group) during class time, with some oversight by the instructor. Students in the same feedback group will often have varying mis/interpretations of the work on which they are to give feedback (submitted work). It is insisted that the feedback group arrive at a consensus on each feedback note before recording it. In order to enforce this rule, each feedback group is provided with only one pen, which must be shared, with a different student acting as scribe for each submitted work. With only one pen available, students are prevented from working individually

on separate submitted works. Requiring a dialogue before feedback is recorded not only equalizes the quality of peer feedback generated, but also greatly *raises* the quality. Groups of students can achieve higher quality results on an assignment, and peer feedback is no different. The peer feedback exercise is run in class time in order to encourage students to view the exercise as a valuable learning activity rather than an administrative duty that may be shirked.

As the instructor oversees multiple feedback groups simultaneously, the instructor has limited time to actively participate in the provision of feedback with any one feedback group. Therefore, the instructor's role is primarily in managing time and ensuring that the feedback groups are operating collaboratively. As expert advice is valuable for the feedback groups, the instructor provides model solutions and advice for the feedback groups to study before the submitted work is made available. A list of common errors may be helpful to the feedback group in providing the best feedback possible, but it was deemed to risk causing embarrassment to a student, therefore avoided; the proper time for a student to engage with feedback on their own submission is when they receive full personalised feedback, not immediately before they give feedback to others.

In advance of the class, students submit their work through the VLE as a raw (computer code) LaTeX document. The instructor pseudononymises the submissions, compiles to pdf, and decides on the distribution of submitted work to feedback groups. To avoid potential student embarrassment, the instructor ensures that at no time will any student be providing feedback on their own submitted work. Care is also necessary to ensure that each feedback group will be assigned a similar amount of submitted work. After the class, the instructor scans the peer feedback, matches pseudonyms to the students' submitted work, and distributes the feedback via the VLE. The pseudonyms are changed each time the exercise is conducted, so that students do not even know their own pseudonym until they receive the feedback, and at no time to do they know the pseudonyms of others. Therefore, the student experience of pseudonymisation is the same as if it were anonymisation.

After the feedback has been distributed, students are required to assimilate the feedback they received by submitting a paragraph of reflection through the VLE. This is designed to enforce some engagement with the peer feedback, closing the learning cycle. Students are encouraged to be critical of the feedback if appropriate, but to bear in mind that the purpose of a proof is to communicate an argument to a peer—if this was unsuccessful then the responsibility is unlikely to lie wholly with the reader.

4. IMPLEMENTATION OF THE MODEL

The model was originally implemented in the *Proof* module in semester 1 of academic year 2016-2017. Measured by anonymous student evaluations of the module, it was found that students were generally enthusiastic about the learning activities, and saw the exercise as valuable. Measured by the students' submissions of reflective assignments, it appeared that the students rated the feedback as valuable. We hypothesise that this was due to the students having seen their peers providing the feedback, and the careful work that went into it; knowing that their own feedback groups gave high quality feedback, students extrapolated to the feedback groups providing feedback to them.

The greatest issues with the implementation were (1) the administrative burden on the instructor and (2) the risk that some students may not receive important feedback because all students in the feedback group suffer the same misconception as the student whose work was assessed.

Administrative tasks such as sorting are well suited to automation. Prototype software was developed to implement this, greatly reducing problem (1). Indeed, the tasks of randomly assigning students to feedback groups respecting diversity, pseudonymising and compiling to pdf the submitted work, and assigning submitted work to feedback groups was all successfully automated. It remains to automate the process of matching students' pseudonyms to submitted work and uploading the feedback to the VLE. Software is currently being developed to address this using barcodes.

To address (2), the following modification was made to the model for future semesters. After the peer assessment is complete, the instructor asks students to share with the class the errors that they encountered most often in the submitted work. By noting this feedback on the board, the instructor provides generic feedback that may benefit all students. An incidental benefit is reinforcing the message to students that theirs is not the only submitted work with errors, in advance of receiving their personalised feedback. The instructor also gains an, albeit limited, measure of the most common areas for improvement. It was found that the generic feedback exercise obviated each student receiving feedback from multiple feedback groups. Therefore the

modified model is more efficient with class time. The generic feedback was also a particularly good time to address learning objectives related to LaTeX. It may be that the context of a specific assignment, where all students had to solve very similar typesetting problems lent itself to productive class discussions on typesetting.

5. CONCLUSION

Peer feedback as naively constructed can have significant drawbacks alongside its undeniable benefits to student experience and learning. The proposed model for collaborative peer feedback was successful in avoiding many of the most significant drawbacks of peer feedback. Increased automation will further improve the faculty experience of the model, without affecting the student experience. Although the model was implemented in a module relying on students submitting LaTeX source files, there is no significant impediment to implementing the fully automated model in another context. Indeed, provided all work is submitted through an LMS, there should be no impediment to automating the pseudonymisation.

ACKNOWLEDGEMENT

The author is grateful to the Yale-NUS College Centre for Teaching and Learning for the Teaching Innovation Grant which supported this research, and to Robin Zheng and Nancy Gleason for comments valuable in the preparation of this report.

REFERENCES

Ambrose et. al. (2010) *How learning works*, Jossey-Bass, San Francisco CA

Black, P. and Wiliam, D. (1998) *Assessment and classroom learning* Assessment in Education, **5** (1), 7-74

Dochy, F. et. al. (1999) *The use of self-, peer and co-assessment in higher education: A reviw* Studies in Higher Education, **24** (3), 331-350

Forbes, D.A. & Spence J. (1991) *An experiment in assessment for a large group*, 97–101 in Innovative teaching in Engineering, Ellis Horwood

Friedel, J. et. al. (2002) *"Stop embarrassing me!" Relations Among Student Perceptions of Teachers, Classroom Goals, and Maladaptive Behaviors* Presented at the annual meeting of the American Educational Research Association April 2002, New Orleans, LA

Hattie, J.A. (1987) *Identifying the salient facets of a model of student learning: a synthesis of meta-analyses* International Journal of Educational Research, **11** 187-212

Rice, M. et. al. (1994) *Improving student feedback in distance education: a research report* in Evans, T. & Murphy, D. (Eds.) Research in distance education 3: Revised papers from the third research in Distance Education Conference. Geelong, Victoria: Deakin University Press.

Somervell, H. (1993) *Issues in Assessment, Enterprise and Higher Education: the case for self-peer and collaborative assessment* Assessment & Evaluation in Higher Education, **18** (3) 221-233