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Experiences with using peer marking in year 1 engineering

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Abstract: This paper gives five different examples of how peer assessment has been introduced into the author's department in the last year. Alongside the description of the activity the paper presents reflections on efficacy linked into what the literature says and summaries of student feedback. There is also some discussion of interesting insights for lecturers considering peer assessment. Finally the paper proposes some plans for the future.

1. INTRODUCTION

Peer marking or peer assessment or peer assisted learning are all activities that are beginning to become popular in higher education. The technique is well established in areas such as the Biosciences [1] and its potential importance within engineering was reflected by a recent HEA event organised by the engineering subject centre [3].

There are many reasons why an academic might choose to introduce some form of peer learning/assessment into their teaching, many of which are neatly summarised in [1] (e.g. student centred, transparent criteria, student empowered, encourages a deep approach to learning, allows students to actively construct learning, encourages discussion between students and tutor, formative feedback, prepares students for lifelong learning, often several assessors, increase students confidence, authentic learning tasks, improved performance). From the author's point of view the most important points are:

- to encourage students to reflect on the quality of their own work.
- to ensure that students engage with the feedback that is provided by returning this rapidly and in a manner they cannot easily ignore.
- to use the opportunity to show ideal solutions and other useful information at a point where students will take notice.

There are of course many other benefits such as: (i) potential reductions in staff loading, something which is especially relevant for large classes; (ii) students receive detailed feedback rather than the few comments that staff time would normally permit; (iii) it is a skill students need to develop for the workplace; (iv) ensures students have more relevant experience, for instance engages more senses and emotion [2], etc…

Given all the positive reasoning above, the author wanted to introduce some peer marking into his own teaching which includes three first year modules and one second year module. In the case of two modules, there are major assignments due in during the week before Christmas and thus it is physically impossible for an individual to mark them before the students leave. Also, in previous years the author has considered the involvement of students in marking process as being an essential part of the assignment and thus for the 2nd year module, each student was expected to attend face-to-face marking to go through their script and discuss weaknesses and

possible improvements; this enabled `feedforward' for the exam and following semester 2 module. However, even with three assistants, this process took five (tedious) afternoons and so it was important to look at more efficient ways of achieving the same goal. Similar statements could also be made about the first year MATLAB module in semester 2; students need significant quantities of focussed comment on their work which is best given in one-to-one dialogue.

So, this paper will look at areas where there was potential to introduce some form of peer marking/assessment and discuss the author's experience in doing so. There is also some reflection on how this fits in with existing literature on the topic and what might be done differently in the future, this being the first year such activities have been introduced. The paper is broken into sections describing the different methodologies adopted for the different modules and the paper is completed with a summary, reflections and conclusions section.

2. MODULES AND ASSIGNMENTS

2.1 Systems modelling

This is a module that the author has spent quite a bit of effort developing [8,9] and he has worked hard to ensure there is a good balance of assignments and content. Student feedback suggests that he has been quite successful in presenting a useful module that most students appreciate. Quotes from Autumn 2007 include: *'The course was fun.and that was helpful considering that this is a very new to most of the students', ' I think the style this course was taught in, is a good way to ease people into Uni life', ' I am so glad to taking that module'. 'It was a good beginning for my engineering life.'*

The module has four assignments (none intended to be very time consuming):

1. A brief essay (approx 1 side) in week 2 to encourage student independence , motivation and self-responsibility. Essentially why is this module important to you backed up by some research? This is followed the next week by a short critique of someone else's essay.
2. In mid term there are two computer aided assessment quizzes (bank of possible questions available in advance for practise) to give students an incentive to learn the key facts and formulae for the module. Unfortunately, there is no substitute for familiarity with some concepts and repetition helps learn these.
3. At the end of term there is a more open ended assignment where students should do some research and then apply the learning from the module to a non-trivial case study of their choice. This should be no more than two sides.

The author perceives that both the first and last assignment have the potential to benefit from some peer assessment; details of how this was done is summarised next:

1. For the essay, students are new to university life and it is useful for them to read other students work both to learn from each other and to judge how their work matches up. It is also important that they begin to reflect on what is a good essay, and what is not. By writing a critique of another students essay they need to be more critical about issues such as flow, construction of an argument, use of references, precision or vagueness, use of examples, etc. Finally, a extra goal (not key to this paper) is to get students into the habit of using the discussions board.
2. The last assignment (two page case study) is handed in just before the vacation as the culmination of the terms learning. Apart from all the usual advantages, a

main reason for using peer marking here is ensure students get good feedback before the vacation. Also, in this case the marking is done in groups of 3, each group marks 3 submissions. This encourages discussion amongst the group and they need to agree what marks to award under a number of specific criteria.

In both cases, the academic acts as a moderator, but in slower time, going through the students marking and commenting on whether he agrees with the feedback students have given each other and, where necessary, adding supplementary detail. In general his experience is that he rarely changes marks much, although there are some exceptions. However a key point is that he need only comment at length where he disagrees or thinks an important point has been missed; this is much quicker.

Critically in the author's view, students are clearly animated and emotionally involved during the marking session and for good or bad, they clearly take notice of the feedback or, in some cases, paucity of feedback they receive. The deadline is immediately before the marking session and several students, having worked hard, want to feel their work had been treated with respect. Students are given an opportunity to comment on their mark and feedback before handing to staff for moderation later.

2.2 Mathematics for engineers

The second module where peer marking has been attempted is in the first year, first semester mathematics module. This module has some new concepts but largely is reinforcing concepts you hope most students have studied previously. Perhaps in common with many institutions, this is the module that tends to have most failures in year 1, year after year. A separate project within the department is tackling this issue, but that project connects with the peer marking discussed here.

As part of the review of mathematics teaching, the department decided to integrate the delivery more closely with the engineering modules [10] and also to introduce regular assignments; basically the aim is to give students a motivation for keeping up with the work. Originally these assignments were intended to be CAA based (from HELM) but for reasons beyond the author's control, the requisite software is not yet fully functional. Perhaps this was serendipity because, as a stop gap, regular in-class tests were introduced.

In class tests are like mini-exams and if anything are harder due to the tight time limit of 40 minutes giving little slack for errors. Despite this, students seem to appreciate their value and have not complained, as yet. We give three in-class tests per semester, based on about the previous 3-4 weeks' lecture material. Naturally, students benefit most where these are marked rapidly with detailed feedback.

In the first year, scripts were brought back to a lecture so that students could look over them and ascertain where they made mistakes and where the scored marks. Ideal solutions were also posted on the VLE immediately after the test. However, most students did not seem to avail themselves of this opportunity to learn. The author also felt that, despite frequent offers of marking during tutorials, students were not using this and thus not developing their question answering skills. Thus there was a need for a mechanism to encourage students to engage with not just, what mark did I get but, what is the marking scheme, why is that the marking scheme, how do I need to answer questions to get the most out of a given marking scheme?

So, from this year, the author used peer marking of the in-class tests [6,7], within class to achieve several ends:

1. Immediate feedback. The module has a double lecture so the test was in lecture one and the marking takes place in lecture two. (This compares to a turn around time of several weeks for the test delivered by another colleague.)
2. Students see the questions being solved by staff, alongside the marking scheme and thus see how marks are awarded, what working is needed and how this should be presented, what information is not needed, how much detail is needed, etc. Hopefully, being coincident with the test itself so that emotions are engaged, students will be more receptive to this.
3. Students see each other's work and, hopefully, understand how easily you can score very low marks even where the student perhaps knew what they should do!
4. Students must sign the cover sheet to say they are happy with their mark and feedback before leaving the session.

The marking only takes about 20 minutes and the rest of the lecture is used for the staff member to moderate scripts where students felt they had been unfairly marked – unsurprisingly:

- students are less able to judge the quality of an answer that does not follow the model route.
- students queue up to protest vehemently that they deserve more marks, even though the marking scheme does not allow that.

The author's hope is that this opportunity for moderation reassures students uneasy about being marked by a colleague. About 50% of the appeals are granted (usually only partially), but 50% are also turned down and this also is good feedback to an aggrieved student who then is better convinced that their work does have severe and specific weaknesses.

2.3 Peer marking of MATLAB assignments

In the current regulations (soon to be altered) many students do a full 10 credits of MATLAB in year 1 because this is a tool used in the majority of modules from year 2 on and also is a key tool in industry. The module aims are divided between programming objectives (learning to do loops, conditionals, functions, etc.) and using the capability of MATLAB to solve very complex or computationally demanding problems (image processing, non-linear optimisation, numerical methods, etc.). The module also includes some professional skills such as report reporting, effective commenting of code, formatting of code, etc. Once again a perhaps surprising observation is how poorly some students present their work and how little knowledge they actually have of word processors such as word. Consequently, the author has tried to include three face to face marking sessions with each student throughout the semester, but even this is very little, especially given the last session is in the last week and has little immediate feedforward benefit (the module has no exam).

In order to try and introduce more of an interation, so students could improve, last year he phased the first two assignments. The first phase, which carried a few marks to improve motivation, was based on peer marking in groups. Students, in groups of three, spent ten minutes each on another students work, testing the code and discussing it face to face with them. Two weeks later, the students had to submit a very similar assignment but for staff marking. In the case of these assignments, the deadline is always set immediately prior to the marking lecture so that the feedback is as rapid as possible and students have the topic fresh in their mind.

2.4 Peer marking of year 2 laboratory assignments

This is a very large module, typically 100-150 students and for reasons of content delivery, the laboratory assignment cannot be taken until week 11 of semester at the earliest, week 12 being the last week before the Christmas vacation. Also, due to number limitations of the laboratories and timetable clashes (many different programmes take this module), 4 or 5 alternative slots needed to be provided so some sessions end up being in week 12.

The particular assignment is designed to get students using a topic they have been studying; by being active they are more likely to develop understanding. Also, the computer speeds up the mathematical computation, which is a major hindrance with this topic otherwise, and thus frees students to focus on the concepts [11,12]. To ensure maximum learning benefit, students work is marked face to face so they can be advised on where their arguments are incorrect or incomplete and this will help both with the exam and later studies. Historically, student feedback on the laboratory has been very positive, e.g.: *'I think this laboratory has been very effective'. ' The laboratory sessions help to reinforce the material covered in lectures in a more personal way, because you can fiddle around with the functions and parameters and get a visual response as to what effect the alterations are having, which often helps clarify the theory.'*

However, the biggest problem has been that marking each student takes 10-15 minutes so that even with 3 demonstrators and marking in small groups and a marking timetable, there have been huge queues and a big battle to get everyone marked before the end of term. Consequently, having started thinking about peer marking, the author thought it was worth attempting that with this particular assignment [6,7]. Students were advised to this affect only in week 9, yet the vast majority were very positive about the prospect and requirement to attend a double lecture on Wednesday of week 12. In future we will give more advanced notice but did mark scripts of those genuinely unable to attend.

3. STUDENT FEEDBACK AND STAFF REFLECTIONS

It is fair to say that the majority of students understand why peer assessment is useful, once they are presented with the arguments. Where asked to agree or disagree with standard arguments [3] (e.g. you'll have to, early in a job, it teaches you about critical appraisal, it gives experience in critical appraisal, if you can assess others you can assess and improve your own work – independent scientist/worker, you get complete feedback on what you should have done, you can compare your work and standards with others, you understand the work better, …), the majority agreed. Consequently the student feedback collected by the author suggests that the majority acknowledge it is a worthwhile exercise. Nevertheless, as experienced by other people, there is always a sizeable minority who feel short changed if their work is not marked by an academic and feel that somehow their learning is affected by this.

3.1 Student feedback on peer marking of systems modelling

In the second peer marking exercise for systems modelling there was also a hard time constraint (lecture hour) which meant that students did not have as long as they would like to give thorough feedback, although one could argue this is a useful lesson in realism and time management that they will need. This comment was reiterated by several students. Another issue that became very clear was that

students were more inconsistent than the literature suggests in assigning marks even though a fairly precise marking schedule was provided. For instance, students find it hard to understand what is the difference between a 7 and a 9 for some criteria, both of course being first class marks; does a 7 mean you have lost 3 marks out of ten or not done enough to earn them? Many students commented that they 'ONLY' got 8 out of 10 and therefore perceived they must have made some mistake as opposed to viewing this as, 'you could have done more'. This is one aspect that needs careful improvement for the future.

Consequently, the author does not have enough confidence in the students marking to leave the scripts unmoderated, and did this as fast as possible after the session. Typical student comments on the experience are given next:

- *Peer marking worked well ➔ instant feedback,*
- *Fairly marked. Allowed me to see how others think and I doing and where I can improve.*
- *I do find this of value, others have done the work and know the process and can reflect on how you have done. It also allows me to reflect on others and how well I have done myself. So this is a very helpful process. But, it does need moderating.*
- *Peer marking is fine as long as the marks are reviewed by the lecturer.*
- *I think my grades are fair. I knew I had good quality but didn't know my peers would be impressed by it.*
- *I found peer marking helpful. I am able to view my work through other peoples eyes.*
- *It is helpful but I don't like it. Agree with statements*
- *Agree with statements. I don't mind peer marking and quick feedback is useful and makes clear what others think of strengths and weaknesses.*
- *A good idea because you get to read other peoples work which is helpful when reflecting on your own work.*
- *Comparing to he scripts I have marked, my work lacked complexity.*
- *I liked working in groups as we could discuss differences in opinion. The table helps me to pinpoint areas in which I need improvement. Details is not great due to time restriction.*
- *I think that peer marking is useful because it allows you to see how you can improve your work. It can be uncomfortable to make other peoples work but can be useful.*

3.2 Peer marking of in-class tests in mathematics

From staff point of view the most interesting observation is students perceptions of what constitutes a good answer is often a long way from reality and they often do not want to accept this. Having the work marked by a peer to a strict scheme, exposes their weaknesses in a very clear way with which they engage immediately. Although more students were positive than negative about peer marking, the majority is not significant and the author suspects this is more to do with dissatisfaction with the marking scheme. In the old scheme of having the opportunity to check their script a few weeks later after marking, the number of appeals was minimal and many had little interest in going through their scripts.

I liked the peer marking	OK	I disliked the peer marking
8	22	20
Peer marking was helpful to understand how to answer questions		It was not helpful
30		15
Peer marking is an effective way of giving feedback on student work		It is ineffective
29		16
Peer marking encouraged me to reflect on my own work		made no difference
27		18

- Several commented that they would appreciate more if did not contribute to module mark (Of course I could retort that we repeatedly stated that this was on offer all term in tutorials but, probably because there was not credit associated, students did not make use of it).
- Several liked method of going over solution, but wanted scripts marked later by staff.
- A lot of protests about strictness of marking scheme and students demanding they deserved more marks. Unwilling to accept their answer was unclear and protested issues such as, "*but the lecturer should know what I intended*".

3.3 Peer marking of MATLAB assignments

Within the MATLAB module, a key aim is to get students to solve real and perhaps numerically challenging engineering problems with software. Assignments require them both to produce the code and to write a brief report which presents the code and solutions. Each assignment had three phases: (i) solve and present solutions to about 3 problems (week x); (ii) in-class test to solve for the numerical answers to the same problems in 40 minutes on unseen systems (week x+1) and (iii) same as (i) but with slightly more complexity (week x+2). The middle assignment was partially there as a test for plagiarism in (i,iii) but also a test of engineering proficiency/speed.

Peer assessment was used for (i) and the intent was that this acted as feed forward into (iii) which was assessed by academic staff and carried most marks. A secondary objective was to encourage students to evaluate the quality of their own progress by having to go through the work of 2-3 colleagues. Clearly opportunities for peer learning/teaching are manifold.

In the first year of running (2006-07) student reflections on the process were not collected but the author's observations were that students were very actively engaged in the process and certainly making suggestions to each other about what they could improve or where their code did not fully meet the specifications. However, having moderated a few he felt the accuracy of marking of the qualititative aspects was poor. His view is that this is most probably because students did not have clear enough guidance on how to mark this aspect and this is partially because he wanted the first assignment to be open-ended: '*show me what you think is a good report and then lets talk about it'*. In future, he will give more detailed template answers to guide the process.

3.4 Peer marking of control laboratories

As mentioned earlier, this peer marking was introduced a relatively short notice. Reflections on the process suggest that although on balance most students were happy, there were some key failings and more careful preparation of some aspects is needed. In fact, the pilot demonstrated many of the issues that are discussed in the literature.

First the student comments are summarised: *'Smaller groups might work better, Went through discussions answers too quickly, Interesting way of marking, worked reasonably well, Marking too fast, Students not experienced enough to mark properly, I feel the process is good, Happy with the marking, seems to be fair, The process was pretty good (although so would marking one to one with a demonstrator), The marks reflect the generosity of the marker more than the content, I don't like peer marking!, I think this is bad way to mark, There are too many people so it is hard to ask questions, My marker made several mistakes and omitted to mark some points, Was good but lecturer went too fast, Need less people and more marking sessions, Great stuff, nice honest marking, Marking lecture hard to follow. Everything is OK, Good way of marking, Can see where you get marks from, Went through answers a little bit quick, Perhaps organise a marking session for each system, Next time do this in smaller groups and hand out a mark scheme to work from. Part of the problem was that students had worked on different systems so it would be better to run a separate session for each system.'*

From the academics perspective, a few issues need to be handled better. The author went through the answers to each part of the laboratory using the data projector and gave a precise marking scheme for students to apply. Where the answers were the same for every student, this went reasonably well. However, there were five different sets of numerical answers depending on which system students had worked on, and delivering these answers via the data projector did not work well as students needed patience for the systems not relevant to their marking. Also, there was a relatively large number of numerical pieces of data and plots, and thus presenting these on the board was too slow. Moreover, the author noticed that at this point of the marking, the noise levels were far too loud and thus students could not hear him; this was necessary for them to mark. The noise was partially due to the large group size (circa 130).

The literature suggests that sometimes it is worth handing out hard copy of some of the solutions so students can use these to check the scripts – in this case that would certainly have improved the situation enormously when checking values and figures. There were issues linked to the use of different systems and group size and some thought needs to be given to improving the organisation to reduce noise levels at key points. The author feels that as a pilot this was very useful and felt that the majority of students were happy. Hence, with a few minor modifications, this will work very effectively in the future.

3.5 Lecturer's reflections

Irrespective of the issues mentioned next, the author's perception is that the majority of students appreciated the peer marking experience and found it useful, albeit a sizeable minority still wanted him to moderate every script later. The most important factor is careful preparation and organising the marking sessions appropriately to the assignment being marked and the group size.

Many observations that the author could make duplicate those available in [1, 5, 6, 7] and wider literature. Marking criteria do need to be clear; students find it hard to judge between say a 6/10 and 8/10; students have a resistance to change – they are not used to this; it is the teachers job; perhaps use for formative rather than summative assessment; for lecture based marking, criteria must be unambiguous (simple) and precise (e.g. quantitative) – not suitable for all tasks; silence is important to hear tutor; rapid feedback does allow effective formative feedback; students must understand the reasons for using peer assessment and there must be clear ground rules; even when they understand the reasons there may still be resistance.

Some student remarks demonstrate a clear narrow mindedness in what constitutes learning and education and, for instance, perceived that their role is only to submit work. In fact, many students do not want to be convinced where it takes them outside their comfort zone so it is necessary to accept there will be some negative feedback. As an academic it is our role to educate and lead and accept that this does mean we are not always popular.

Two of the exercises could have gone better, that is the class based marking of laboratory work and class based marking of MATLAB assignments. In the latter case he felt students were not always critical enough and, in retrospect, perhaps not mature enough to give quality feedback on some of the factors to be marked, that is where these were qualitative (paragraph answers) rather than quantitative (is the numerical answer correct?). He intends to improve this next year by going through the qualitative aspects on the board with the whole group before leaving them to deal with the numerical and right/wrong/badly done aspects. With the control laboratories the key problem was the large number of figures and data that needed to be checked and this could be handled better by handing out hard copy rather than going through it on the data projector.

4. CONCLUSIONS

Peer marking has been used on four different modules and for five very different types of assignment: essays, case studies, laboratories, reports and in-class tests. The author feels that in each case peer marking has been well received by the majority and has definitely achieved a key aim of ensuring feed forward via active student engagement and reflection on what constitutes good/bad or right/wrong work. His experience, perhaps unsurprisingly, replicates much of what is already reported in the literature and this gives confidence that, even where a few students are negative, one can continue with the practise and work harder to *educate* them. Perhaps a minor frustration is that with some assignments, even though the peer marking achieves several useful aims worthy in themselves, it is still necessary for the lecturer to moderate all the scripts later and thus there is no time saving.

Useful insights include:

- where in-class marking is used, it is essential to have a large block of spare time at the end of the session to give students unhappy with their marks an opportunity for immediate moderation.
- using in-class marking makes students face up to the realities of marking schemes, how scripts are marked and how their presentation is often very inadequate; this factor caused easily the most complaints but, hopefully, will also have a feed forward effect into how students subsequently tackle their exams.

- the author has looked more broadly than engineering to pick up ideas of how to engage and assess students (e.g. use of discussion board for peer assessment), but always be prepared to modify what is in the literature to suit your own needs.

For the future the author intends to continue using peer marking at key points in several modules and reiterate that constant reflection and also cognisance of the literature are invaluable to efficacy.

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