

Peer Assessment: Educationally Effective and Resource Efficient

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Abstract

Peer assessment was included within a Level 4 Human Physiology module at the University of Hertfordshire following a periodic programme review during the academic year 2006-2007. The peer assessment exercise was thought to be beneficial in terms of student learning as it: engaged students explicitly with marking criteria; stimulated dialogue around assessment and feedback and ensured prompt feedback. It was beneficial for staff as it reduced the marking burden and enabled students to receive prompt feedback on their work.

Performance on subsequent laboratory reports supported the argument that peer assessment enhanced student learning and that the skills associated with data analysis and academic writing can be transferred across modules. Comparison of student performance on a laboratory report (tutor assessed) submitted prior to the peer assessment activity, with a later submission of a laboratory report (tutor assessed) which took place after the peer assessment activity, demonstrated a statistically significant improvement in performance on the second assignment ($p < 0.001$). However, a number of possible confounding factors could also have influenced student improvement e.g. improved understanding over time; differing support provision for the two assignments, differing requirements in terms of the nature of the assignments and differing staff members teaching and assessing the assignments.

The introduction of a reflective questionnaire to the peer assessment process, during the 2009-2010 academic year enabled better understanding of the student perceptions of peer assessment. Of those students who responded, 77% indicated that peer assessment was beneficial for their learning. Over 80% indicated that they had benefited from being engaged with the marking criteria prior to writing the report and perhaps most importantly, 83% indicated that they felt better prepared for their next laboratory report as a consequence of the peer assessment activity. The feedback supports the argument that the peer assessment activity did support student learning and was beneficial for future assignments. Peer assessment therefore offers the potential to benefit student learning as well as being a resource efficient assessment method for staff.

Introduction

Within science disciplines, the laboratory report is commonly used as an assignment to assess student understanding of experimental results and scientific writing ability (QAA, 2007). The report usually includes a brief review of the literature within an introduction, a description of experimental design within a methods section, presentation and analysis of results, plus a discussion of the meaning of the results in relation to current understanding

of the subject. As with most Bioscience departments in the UK, the University of Hertfordshire encourages the development of scientific understanding through the writing and assessment of laboratory reports (in addition to other assessment methods throughout the programme).

Context

Within the Biosciences programme at the University of Hertfordshire (UH) all modules at level 4 (entry level Undergraduate) contain an assessment of at least one laboratory report. Reports tend to be approximately 1000-2000 words in length depending on the experiment. Prior to a redesign of the curriculum within a periodic review in 2007, students studied a 15 credit point (cp) module in Human Physiology (Semester A). A significant part of the assessment for the module (20%) was a laboratory report which assessed learning outcomes associated with demonstrating knowledge and understanding of physiological processes and the interpretation of physiological data. All other modules within the programme also used a laboratory report to assess learning outcomes associated with data interpretation and understanding of the subject material.

One of the consequences of the Biosciences programme review was an increase in size and scope of the Human Physiology module from 15cp to 30cp (Semesters A and B). The curriculum review enabled the module team to consider and re-design the teaching materials, activities and assessment methods within the module. To enhance the educational effectiveness of the module the staff team designed a peer assessment activity (20% of the module mark) to replace the tutor marked laboratory report. The peer assessment had an additional benefit in that it reduced the staff marking burden which was important, as the programme and module had experienced an increase in student numbers. The first cohort completed the new Human Physiology module (30cp) (including the peer assessment activity) during the 07/08 academic year.

Rationale for introducing peer assessment

Within the 'old' programme, despite completing a number of laboratory reports throughout an academic year, there was little evidence to indicate that the scientific writing ability of students was improving over time. For example, when comparing student performance on a laboratory report submitted within a Semester A module, with comparable submissions within a Semester B module there was little if any improvement in performance (figure 1). Appreciating that the subject discipline was different (human physiology [Sem A] and biochemistry [Sem B]), the data suggest that student understanding of what was required in a report had not developed, despite receiving written feedback from academic staff and provision of the assessment criteria. Analysis of data using paired t-tests demonstrates no significant difference (ns; $p > 0.05$) in performance between semester A submissions and the semester B submissions.

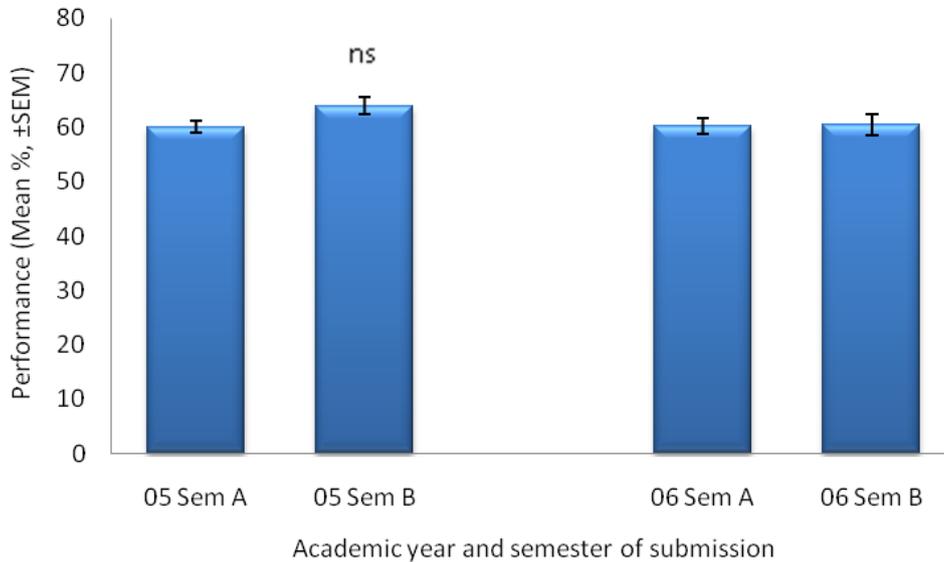


Figure 1: Mean student performance on laboratory reports submitted in Semester A and Semester B. (Data expressed as mean percentage \pm standard error of the mean (SEM) as shown within the error bars).

Peer assessment is a method that actively engages students in the marking process (Falchivok, 2004) and provides insight into what is expected within an assignment. It actively engages students with the assessment criteria and helps clarify good performance (Rust *et al.*, 2005). Expressing criteria which are understandable to students can be challenging and students may interpret criteria in different ways, possibly dependent on their social and cultural background (Bloxham *et al.* 2004) as well as their previous experience within the discipline. Distributing and/or explaining criteria to students may not be sufficient for student understanding (Rust *et al.*, 2005) yet active engagement with assessment criteria has been shown to help students interpret the criteria and understand how they will be assessed by tutors (Elwood and Klenowski, 2002).

Peer assessment encourages dialogue around learning amongst students and promotes interaction between staff and students (Gibbs and Simpson, 2004; Nicol and Macfarlane-Dick, 2005) as well as preparing students for lifelong learning, in that it provides opportunities for students to give constructive feedback to peers (Orsmond, 2004). In addition to the benefits that peer assessment brings to student learning and personal development, peer assessment can also reduce marking burdens for academic staff members, thus providing an effective yet efficient assessment method.

It was hoped that peer assessment would aid student understanding of the requirements of a scientific report, improve experimental data analysis and also reduce staff marking burdens, enabling feedback to be returned to students much quicker than was previously possible through tutor marking.

Aims of the study

The aim of the study was to determine if peer assessment was beneficial to student learning through consideration of student performance on subsequent laboratory reports and their own self reflection.

Method; Peer assessment process

Since the academic year 2007-2008, students on the human physiology module (level 4) at UH have taken part in peer assessment of their laboratory reports. Each year between 130-200 students registered on the module. The peer assessment activity formed part of the summative assessment for the module and contributed to 20% of the module grade.

All students took part in a laboratory class lasting up to four hours, during which the experimental data was recorded and discussed. After all students had completed the laboratory class they attended a one hour workshop designed to provide insight and guidance on the peer marking activity (figure 2).

Aims of the preparatory workshop:

- To provide the rationale for peer marking
- To discuss the benefits of peer assessment
- To describe the peer marking process
- To provide guidance on laboratory report writing
- To consider the specific marking criteria for the report
- To gather student perceptions regarding peer assessment and discuss any student concerns regarding the activity.

Figure 2: Aims of the workshop that students undertook prior to the peer marking activity

The students then submitted two copies of their report; an online submission, to be used for staff moderation purposes, and a paper copy for distribution during the marking session. The peer assessment marking activity took place one week after submission of the report and was conducted over a two hour period. Each student was randomly given another student's report (tutors ensured that no students received their own report) and the tutor guided the students through each section of the report according to detailed marking criteria. Two/three additional tutors were available to answer any queries during the marking session. Each section (abstract, introduction, methods, result, discussion, references) was marked in turn and the students provided annotated feedback as well as allocating marks for each section. Reports were then returned to the original author to review the mark and the comments. The results were recorded by the tutor.

Moderation of scripts was carried out per UH academic quality processes, ensuring that any assignments deemed to have failed (<40%) were moderated by a member of staff plus at least the square root of the remaining number of scripts. Students who wished to challenge their grade could also request additional moderation.



Figure 3: *Peer assessment activity; order of events.*

Analysis of results

Student performance data from the peer assessments activities in the academic years 2007-2008, 2008-2009 and 2009-2010 were considered in relation to student performance data from the 2004-05, 2005-06 and 2006-07 student cohorts. (For ease of reading; 2004-2005=05, 2005-2006=06, 2006-2007=07, 2007-2008=08, 2008-2009= 09, 2009-2010=10). The students from the 05, 06 and 07 cohorts undertook a similar practical exercise and submitted a laboratory report as part of a Semester A 15 credit point (cp) Human Physiology module but these assignments were tutor marked.

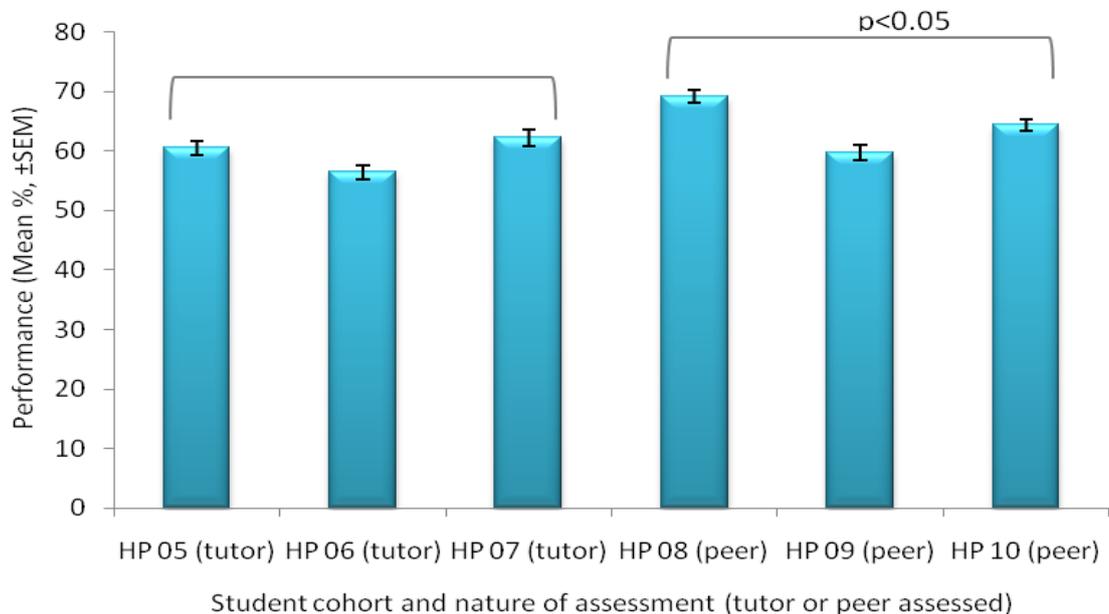


Figure 4 *Student performance on human physiology laboratory reports which were either tutor marked or marked by a peer.*

When grouping the data from 05-07 (tutor marked) ($n = 421$), and comparing it with data grouped from 08-10 (peer marked) ($n = 459$), using an independent t-test there was a significant

difference ($p < 0.05$) in the performance. The data suggests that performance on the laboratory report was higher when peer assessed compared to tutor assessed.

Consideration of student improvement when peer assessed compared with tutor assessed

The improvement in student performance may have been due to improved understanding of what is required within the report based on the pre assessment workshop and the engagement with the assessment criteria; however it could also be argued that the students were more generous with their marking than tutors and that peer assessment led to over-marking of reports. Staff moderation of scripts did not support this argument, a finding which corresponds with results from other studies that have investigated the validity of peer assessment (e.g. Davies, 2006; Falchikov and Goldfinch, 2000; Ferguson *et al.*, 2007; Hughes, 2005; Lui and Tsai, 2005; Pope, 2005; Topping, 1998; Zevenbergen, 2001). It was hoped that the students improved performance was due to enhanced understanding of what was required within a laboratory report through early engagement with the assessment criteria, although this clearly cannot be unequivocally determined from the above analysis.

Improvement on future laboratory report submissions

To further investigate how peer assessment may be benefiting student learning, performance on subsequent assignments was considered (i.e. those that took place after the peer assessment activity). It was hypothesised that if students had benefitted from the peer assessment through engagement with assessment criteria and better understanding of the requirements of scientific writing, then their performance would improve on subsequent assignments.

To determine if peer marking has benefits on the writing of subsequent laboratory reports, student performance on another module (which the same students studied) was considered. Since the programme review, all level 4 students study the 30 credit point module 'Introduction to Biochemistry, Microbiology and Pharmacology' (IBMAP) as well as the Human Physiology (HP) module. Within the IBMAP module, students submitted two independent laboratory reports, one in Semester A (IBMAPi) and the second in Semester B (IBMAPii). The first laboratory report was written, submitted, marked and feedback provided in semester A (prior to the peer assessment exercise taking place in the Human Physiology module). The second report within the IBMAP module was submitted after the peer marking activity (figure 5).

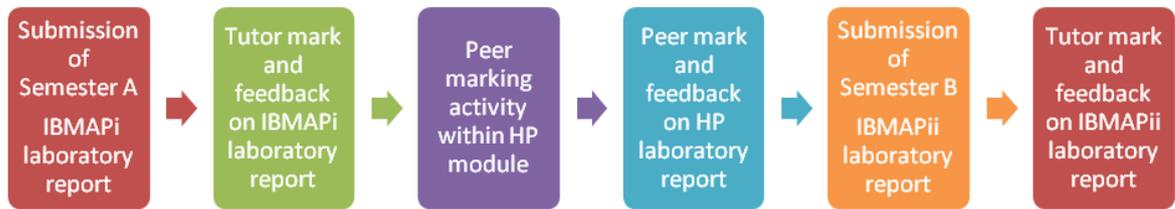


Figure 5: Student submission timeline

Student performance on the three laboratory reports can be seen in figure 6.

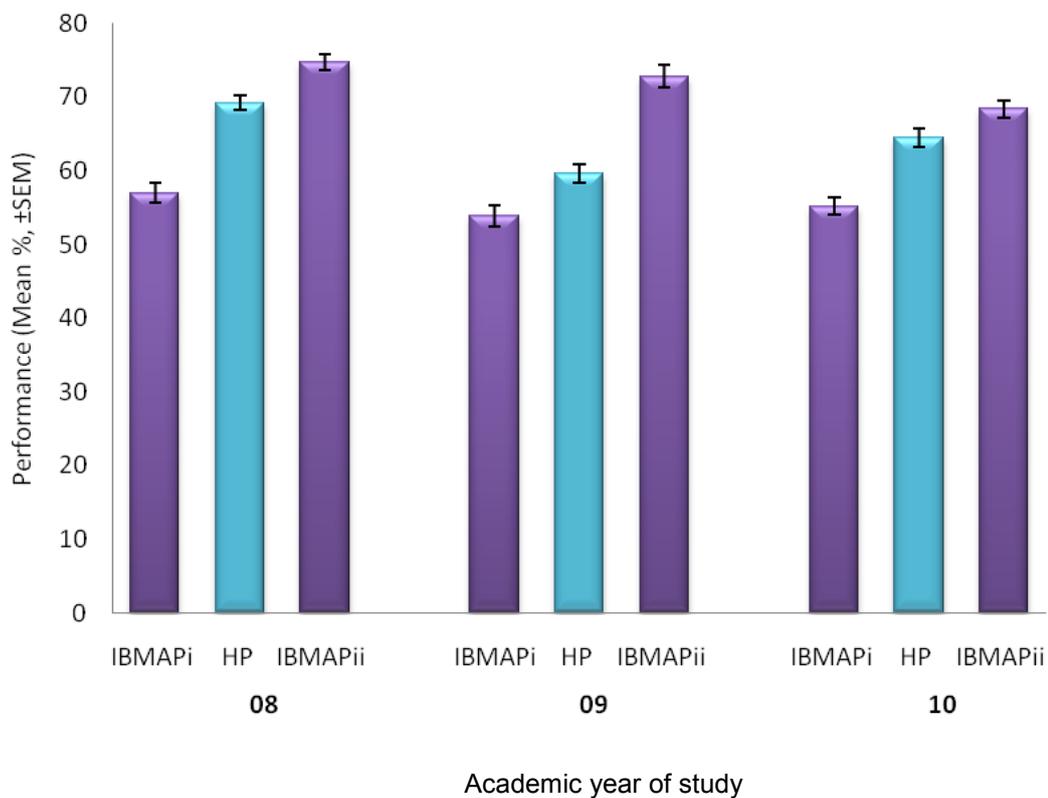


Figure 6: Mean student performance on the sequential laboratory reports submitted by level 4 students.

To determine if student performance significantly improved within the IBSMAP module since the inclusion of peer assessment within the HP module, data were analysed using paired t-tests ($***=p<0.001$). (For 08 $n=127$; 09 $n=124$; 10 $n=167$).

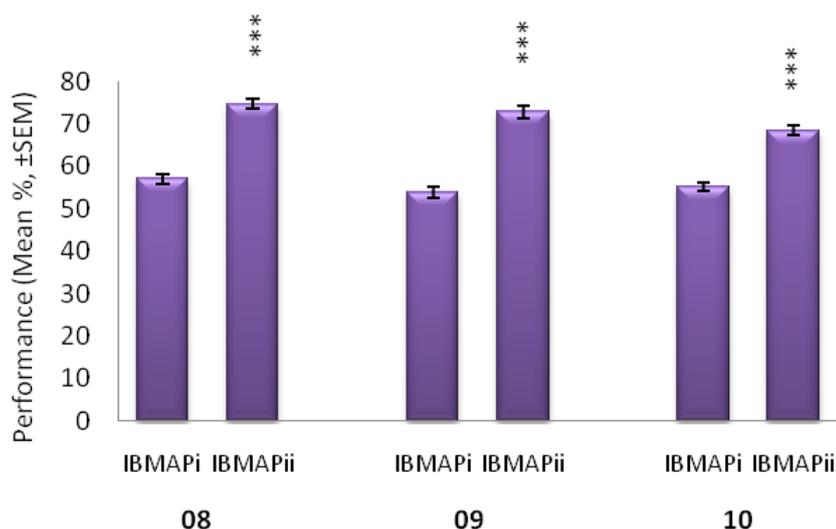


Figure 7: Mean student performance on the laboratory reports submitted by level 4 students within the IBMAP module (before and after completion of peer assessment of a laboratory report within the Human Physiology module).

As can be seen in figure 7 above, student performance on the second laboratory report (Semester B) was significantly improved ($p < 0.001$) compared with the submission of the first laboratory report (Semester A) within the IBMAP module over each of the three academic years considered.

Discussion of peer assessment

Benefit to future assignments

It was hypothesised that if students had benefitted from the peer assessment activity through engagement with assessment criteria and better understanding of what was required within a laboratory report, performance on subsequent assignments would be improved. When considering student performance on the IBMAP assignments, students performed significantly better on the second laboratory report (submitted in semester B) compared with the submission of their first laboratory report (submitted in semester A). The second submission took place after the students had taken part in the peer assessment activity within the HP module. It could therefore be argued that the peer assessment activity had indeed benefitted student learning and that students better understood what was required of them within this type of assignment and understood what tutors were looking for when marking this type of work.

Clearly however, this statement cannot be made unequivocally as other potential causative factors which may have led to improved performance on the second assignment must be taken into account. For example, it could be argued that over the time period of

study student understanding would have improved as could their ability to analyse and report scientific data. This argument isn't supported by early data however (figure 1), but unfortunately a direct comparison between 'pre peer assessment performance' and 'post peer assessment performance' within the ICMAP module cannot be made as this module did not exist prior to the periodic review.

Other confounding factors must also be considered; the two assignments, although within the same module and assessing at the same level, were reports on different experiments and may have had slightly different demands in terms of data analysis and subject understanding. The pre submission support for both submissions may have differed (e.g. data analysis workshops, scientific writing guidance) and there were different staff members running the experiments and marking the reports which may have influenced student understanding. It would therefore be premature to conclude that peer assessment alone resulted in the improved performance on the subsequent laboratory report.

Enhancement of peer assessment process

Although it was felt by tutors that the peer assessment activity was beneficial, and the data suggested benefits, there was little evaluation of the student perception of the process. There were also concerns over the administrative burden for staff, caused by high numbers of student requesting moderation. During the first two years of peer assessment a number of students (approximately 20%) complained to the tutor, immediately after the marking session, that their mark was too low and that they wanted the staff member to remark their work. The higher moderation requirements increased the staff burden and nullified some of the time gains which the peer assessment activity had bought (figure 8).

Challenges associated with the peer assessment process:

- High moderation requirement for the teaching team
- Even after the moderation, a number of students still questioned their marks
→further increase in workload of the module team
- Evident lack of self reflection (developing self reflection was one of the intended benefits of the peer assessment)

Figure 8: *Challenges within the peer assessment process*

During the 2009-2010 academic year, the peer assessment activity was enhanced within the HP module and a web-based data gatherer was introduced to make the peer assessment process more effective and efficient. Through the data gatherer, students

were encouraged to review their peer assessment feedback; to reflect on the experience of marking another student's work and to identify what they needed to do to improve future laboratory reports. They were also able to request remarking if they could indicate, against the marking criteria, where they felt they had been unfairly marked (either too high or too low).

Introduction of a reflective questionnaire

Following the marking activity, students were requested to reflect on their learning experience by answering a web-based questionnaire containing 27 questions. A web-based data collection facility (data-gatherer) had been re-purposed to specifically support this activity (Russell, 2006). Five percent of the marks associated with the laboratory report were allocated to the reflection and feedback activity.

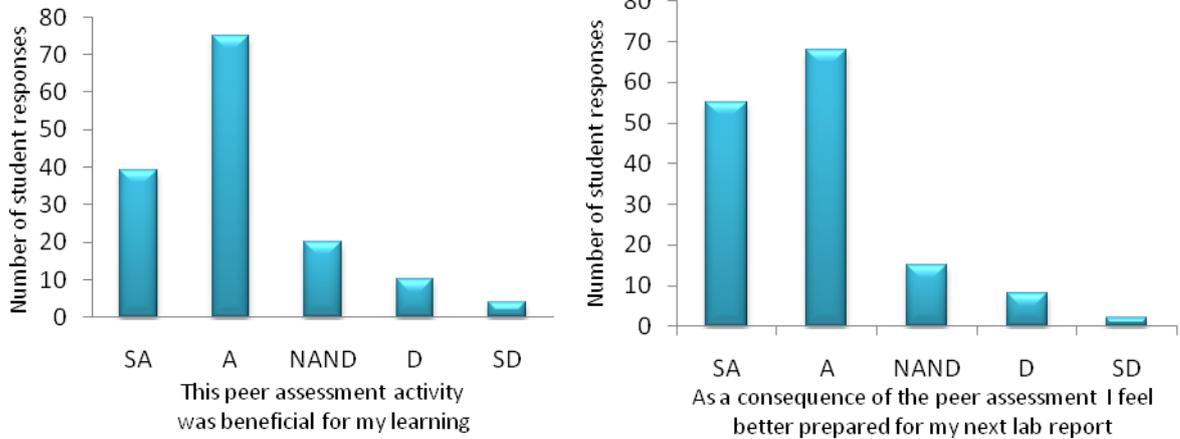
The questionnaire contained eight questions which could be answered on a likert scale (SA= Strongly Agree, A= Agree, NAND = Neither Agree Nor Disagree, D = Disagree, SD = Strongly Disagree), two questions had radio buttons providing a choice of one out of five options (e.g. "which section of the report did you find most challenging?" options: abstract, introduction, methods results, discussion, references) and seventeen free text questions enabling students to provide qualitative comments. Through the questionnaire, students were also asked to identify if they thought they had been over- or under-marked during the peer assessment activity. If they indicated that they had been mis-marked and wished to request moderation of their script, they had to specifically justify where they thought the mismarking had occurred, against the assessment criteria. It was hoped that this would limit the immediate requests for moderation which had been experienced in the previous two years.

The questionnaire was open to students three days after the marking activity and the return of their assignments. The students had up to one week to complete the questionnaire.

Quantitative findings

Over eighty percent of the students (82%) took the opportunity to reflect on their learning through completion of the online questionnaire (148 students out of a total of 181). The vast majority of the students engaged very well in answering all 27 questions, and provided detailed free text comments. As such, all but three students gained the full five marks allocated for feedback and reflection.

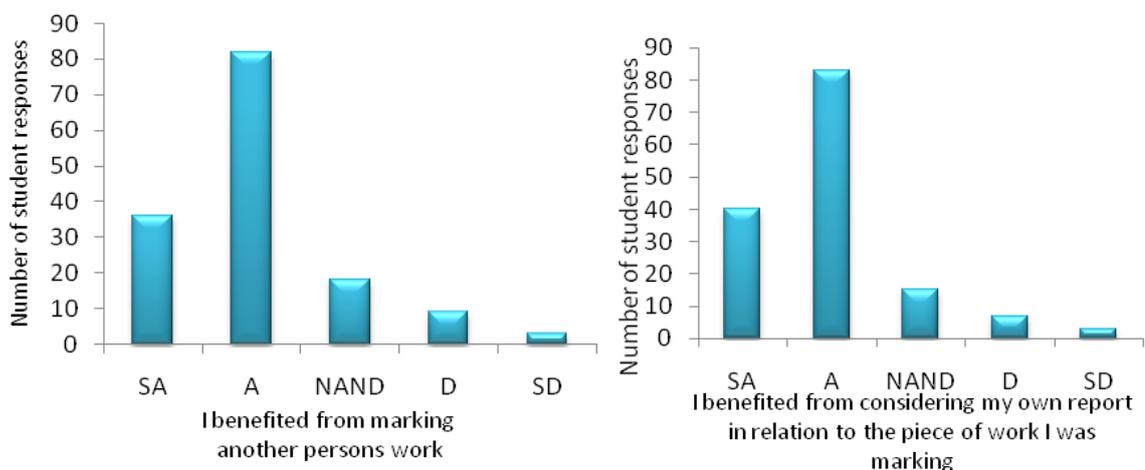
The first part of the questionnaire used closed questions relating to reflection on the report and the peer assessment process. A selection of results is provided.



Figures 9 and 10: *Student responses to the indicated statements. (SA= Strongly Agree, A= Agree, NAND = Neither Agree Nor Disagree, D = Disagree, SD = Strongly Disagree)*

Figures 9 and 10 indicate that the majority of students who answered the questionnaire explicitly expressed that peer assessment was beneficial for their learning (77%) and that as a consequence of the activity they feel better prepared for their next laboratory report (83%).

80% of students also reported that the process of marking someone else's work was beneficial, particularly in terms of considering their own work in relation to someone else's (83%) (figures 11 and 12).



Figures 11 and 12: *Student responses to the indicated statements.*

Students also indicated the benefits of being engaged with the marking criteria prior to writing the report with over 83% either 'strongly agreeing' or 'agreeing' (figure 13).

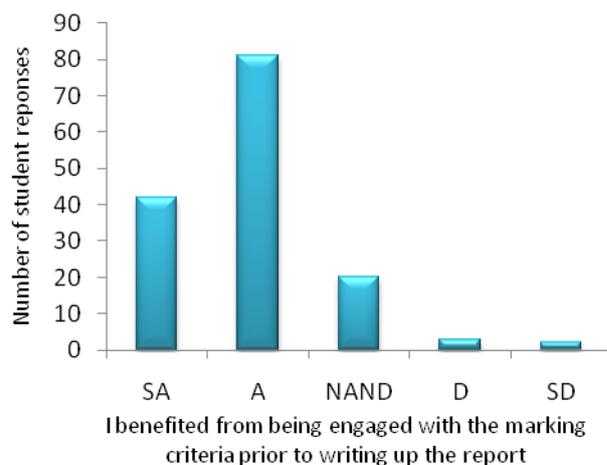


Figure 13: Student responses to the indicated statement.

Qualitative findings

Students provided free text comments in response to the question; “What other comments do you have regarding the peer assessment process?” There were some extremely positive responses such as;

“The marking criteria was a great help and provided a guideline for future lab reports”

“I felt that the marking scheme and even reading other peoples work made me reflect upon what I was good at and what I could work on/add to in my report and future reports”

“Good indication of what our lecturers would be looking for as well perhaps of how our peers may view our written work. Additionally from this exercise, I can gauge how effective my written communication skills are in the scientific field norms “.

Interestingly, even where some students expressed a negative opinion about the peer assessment activity, there was indication of student learning;

“I don't feel that I benefited from the peer assessment activity, however, the detailed marking scheme did help to show what the lecturers are looking for in future reports”

“It is quite a bit risky marking someone else's work but it was quite beneficial in understanding the criteria used in marking our laboratory reports”.

Reductions in moderation burden

To enhance the resource efficiency of the activity the students were asked to comment on their mark and indicate, with explicit reference to the marking criteria, where they believe they had been over, or under, marked. Sixteen reports were moderated using the online submitted report. Extra marks were awarded to ten reports (9.4 ± 1.8 mean%, \pm SEM). It was estimated that this saved approximately 25 staff marking hours (Lou *et al.*, 2010).

Discussion of student reflections

The introduction of the reflection element of the peer assessment provided greater insight into student opinions on the activity, and further support for the argument that peer assessment benefits student learning.

As considered above, the data suggest that that the peer assessment activity supported the development of scientific writing skills that students were able to transfer across modules. However, compounding factors prevented this from being a definitive conclusion. The reflections from students do, however, support the argument that peer assessment benefited their learning through their increased understanding of what is required within laboratory reports and also indicated that they felt better prepared for future reports.

Providing students with a structured opportunity to reflect on their feedback and mark together with the consideration of their experiences of marking someone else's report, reduced the moderation burden for staff. Previously, a number of students (approximately 20%) had approached staff immediately after the marking session to complain about being marked unfairly and requesting staff re-marking. The complaints were often related to one or two marks within a specific section and it was evident from the immediacy of the complaints that the students had not reflected effectively on their own work in relation to the assessment criteria and the feedback they had received.

The structured reflection via the data gatherer, reduced these challenges, as students were given time to consider their mark and the comments in detail. Requests for moderation of marks had to be explicitly justified according to the assessment criteria and only 9% of the students made a case for additional moderation.

Conclusion

Analysis of the results of peer assessment incorporated into a level 4 Human Physiology at the University of Hertfordshire demonstrates the potential to engage students in productive learning. Qualitative and quantitative findings indicate that students benefited from being actively engaged with assessment criteria, both prior to the writing of the laboratory report and during the marking process. The peer assessment activity helped

students to better understand the requirements of scientific writing; skills which they were able to transfer to other modules within their programme of study. The peer assessment activity also provided prompt and relevant feedback as all students had their marked scripts returned to them during the marking activity which took place one week after submission of the report. The marking session certainly stimulated dialogue between staff and students, as well as between peers. This encouraged deep learning and hopefully a better understanding of the subject material. All of these benefits are recognised within principles of good assessment and feedback (Gibbs and Simpson, 2004; Nicol and Macfarlane-Dick, 2005).

The introduction of the data gatherer in 2009-2010, enabled students to reflect more effectively on their learning. Through the comparison of their own work with someone else's and against the marking criteria, they felt better prepared for future assignments. The peer assessment process not only has the potential to benefit student reflection and learning but also provides tangible benefits to staff in terms of reducing the marking burden. The peer assessment activity adopted at UH thus demonstrates educational effectiveness, together with resource efficiency; two things all busy academics must be striving for within their teaching and assessment.

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