INVESTIGATING PERCEIVED STUDENT LEARNING FROM PEER REVIEW IN STATISTICS EDUCATION

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Peer review is not regularly used in statistics education despite previous studies demonstrating it enhancing student achievement. This paper expands this knowledge by exploring how peer review contributes to perceived student learning in statistics education and how educators can stimulate students' learning through internal feedback. This study focused on two cohorts of statistics students with differing attributes. Students were surveyed post a peer review exercise. The post review questionnaire looked at the different stages of peer review and its impact on perceived student learning. Initial impressions indicate that the peer review activity contributed to student learning with comparing their work to a peers' contributing most on average to their perceived learning.

INTRODUCTION

Peer review is an active learning tool frequently used in higher education that allows students to provide qualitative and quantitative feedback on their peers written pieces of work such as essays or lab reports for formative assessment (Van Zundert et al., 2010). It is popular due to it being an effective method for providing students with feedback efficiently (Topping, 2009). However, the benefits of students undertaking a peer assessment activity also include facilitating re-evaluation of the students' own work (known as internal feedback), critical thinking, and problem solving, to name just some of the additional skills students develop whilst taking part in peer assessment (Carlsson Hauff & Nilsson, 2022; Dochy et al., 1999).

This study will focus on perceived student learning and internal feedback generated by completing a peer review exercise in statistics education. Internal feedback can be defined as the ideas a student generates on their own work when they compare their work to comments received by a peer on that piece of work and to the work of a peer (Nicol, 2019). This study is primarily motivated by Nicol and MacCallum's (2022) study looking at internal feedback through peer review. In their study, students completed several peer reviews before completing a self-review of their own work. The feedback given by the students was also compared to the feedback produced by the teacher. They found that comparisons students made against the comments they received from their peers did not add significantly to the feedback they had already gained from comparing their work to their peers' work. Peer review in general is not a feedback tool regularly used in statistics education. Some examples include Sun et al. (2015), Pittard and Rayens (2014), and ArchMiller et al. (2017). To our knowledge there have also not been any studies conducted looking into internal feedback and peer review in statistics education.

Therefore, this study looks to explore how peer review contributes to perceived student learning in statistics education and how educators can stimulate students' learning through internal feedback. The results and findings presented here are from the initial stage of the study, with more data being expected in coming academic years.

STUDY DESIGN

Study Participant Attributes

To better understand how peer review contributes to perceived student learning, we surveyed two cohorts of students. Both cohorts came from practical lab-based courses that are wholly assessed through continuous assessments, and this was the first time both cohorts had completed a peer review. These cohorts were selected for the study to allow perceived learning to be understood for a wide variety of differing cohort attributes. These are detailed in Table 1. The content of the courses is very similar with them aiming to give students experience in skills needed to be a professional statistician. This is achieved through providing students with experience of analysing data in multiple contexts, developing written and oral communication skills, and providing an opportunity for students to carry out a group project.

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Table 1. Summary of attributes for the two cohorts surveyed in the study

	Cohort 1	*Cohort 2*
Course name	Professional Skills	Data Analysis Skills
Level of study	Undergraduate (Honours)	Postgraduate (MSc)
Work being reviewed	Recorded virtual presentation	Statistical analysis plan
Peer review software used	Moodle	AROPA (Hamer et al, 2007)
No. reviews completed per student	3	3-4
No. responses (% of class)	11 (16%)	29 (35%)
Demographic of respondents	64% European, 36% Asian	7% European, 93% Asian

Study Design and Questionnaire

Both cohorts were asked to complete their reviews using a rubric provided by the course teacher. The rubric contained a set of criteria, and students were asked to rate how each piece of work met each criterion using a Likert scale. Following the peer review activity, both cohorts were given the same questionnaire with subtle modifications to some of the questions to ensure they were applicable to the pieces of work being reviewed.

The questionnaire was comprised of five sections: the first three related to perceived learning from the different stages of a peer review activity, whilst the other two related to ways that peer reviewing might contribute to student learning over what they get from a teacher and concerns they might have about the activity. Within each section students were asked to rate a given set of statements using a Likert scale. Detailed below are the prompts provided to students at the start of each section in the questionnaire.

- *Section 1:* The questions below ask about the extent of your *learning from the different processes that comprise peer review*. Please rate each item in terms of the extent to which it contributed to your learning.
- *Section 2:* Examine the learning outcomes below and identify the extent to which *reviewing the work of peers* contributed to that learning outcome.
- *Section 3:* Examine the learning outcomes below and identify the extent to which *receiving reviews from peers* contributed to that learning outcome.

For these first three sections, the Likert scale had responses: contributed nothing/contributed little/contributed moderately/contributed a great deal.

- *Section 4:* The list below suggests ways that peer reviewing might contribute to your learning over and above what you might get from teacher feedback. Examine the list and identify the extent to which these contributed to your learning *over what a teacher might provide*.
- *Section 5:* Which of the following concerns do you have about peer review?

For Section 4 the response scale was: contributed nothing over what a teacher could provide/contributed little over what a teacher could provide/contributed moderately over what a teacher could provide/contributed a great deal over what a teacher could provide was used. Whilst for Section 5, the scale of not concerned/moderately concerned/very concerned was used for responding.

In addition to these five main sections, students were also asked for demographic information and open response questions allowing them to highlight any other concerns they may have had and to make suggestions to improve future peer review activities.

RESULTS

The Likert scale responses used for the first four sections in the questionnaire relating to perceived student learning and what peer review might offer over and above what teacher feedback offers were converted to a numeric scale; contributed nothing (1)–contributed a great deal (4). These numeric values were then used to compute mean responses for each statement and are presented in Table 2.

Due to the small sample sizes (n = 11 and n = 29), robust quantitative analysis was not conducted; however, we are still able to form some initial impressions from the data that are available. It is envisaged that in the future, more data can be collected to allow for a more in-depth quantitative

analysis. Looking at Table 2 for both cohorts we can draw the following preliminary findings noting that no statistical tests have been conducted to verify these findings.

Table 2. Mean (SD) of responses to each statement in section 1–4 of the questionnaire distributed to students' post-peer review using responses contributed nothing (1)–contributed a great deal (4)

	Statement to be ranked in relation to learning	*Cohort 1*	*Cohort 2*
Section 1	Comparing different peer works against the criteria in the rubric	3.09 (0.70)	3.17 (0.66)
	Comparing one peer's work against another's	2.82 (0.75)	3.14 (0.74)
	Writing out feedback comments for peers	2.82 (0.60)	3.48 (0.69)
	Comparing peers' works against your own	3.36 (0.50)	3.55 (0.63)
	Comparing your work against the comments received from peers	3.27 (0.79)	3.31 (0.71)
Section 2	Knowledge of where your work was strong/weak	3.36 (0.81)	3.31 (0.71)
	Ideas to improve your work that you had not thought of before	3.27 (0.65)	3.41 (0.73)
	Understanding of the assessment criteria	2.82 (0.75)	3.31 (0.71)
	Different perspectives on presentations	3.27 (0.79)	NA
Section 3	Knowledge of where your work was strong/weak	3.27 (0.65)	3.28 (0.70)
	Ideas to improve your work that you had not thought of before	3.09 (0.70)	3.34 (0.72)
	Understanding of the assessment criteria	3.00 (1.00)	3.14 (0.83)
	Different perspectives on presentations	3.00 (0.89)	NA
Section 4	Alternative perspectives on how to produce good work	3.18 (0.75)	3.21 (0.74)
	Ideas about how you were doing relative to peers	3.27 (0.79)	3.44 (0.74)
	Opportunities to critically evaluate others' work	3.18 (0.87)	3.31 (0.66)
	Opportunities to reflect and generate your own feedback	3.09 (0.83)	3.48 (0.69)
	Opportunities to learn to give others' feedback	3.60 (0.70)	3.51 (0.57)
	Opportunities to take greater control over your own learning	3.09 (0.83)	3.17 (0.76)
	Opportunities to take the role of assessor	3.09 (0.83)	3.24 (0.74)

The average integer response of at least 3 ("*contributed moderately*") for almost all statements in the first three sections suggests that students felt the exercise contributed to their learning. The low standard deviations suggest there was little variation in the responses. In Section 1, comparing peers work against their own contributed the most, on average, to students learning in both cohorts (3.36 and 3.55, respectively). From the results for Section 4, it is apparent that students felt, on average, that peer reviewing *contributed moderately over what a teacher could provide* (all mean responses for the seven statements are above 3 for both cohorts) for all the suggested ways that peer review contributed to student learning over and above what a teacher might provide.

The final sections of the questionnaire addressed concerns that students had about the peer review activity. The responses indicated that, on average, the second cohort had stronger concerns compared with the first cohort; however, the average responses across both cohorts for all statements was approximately equivalent to *moderately concerned.* For both cohorts, on average, they were least concerned about *sharing their work with other peers* whilst they were most concerned, on average, with *ending up not knowing what constitutes good quality work.*

DISCUSSION

Due to a lack of data, it is difficult to draw conclusions from this study; however, these are the preliminary stages of what is envisaged to be a long-term study covering several years of cohorts of students. Initial impressions from the small sample of data available indicated that the peer review activity contributed to student learning with comparing their work to peers' work contributing most on average to their perceived learning. This is a similar conclusion to Nicol and MacCallum (2022).

In the open questions at the end of the questionnaire, several students mentioned that it would have been helpful to have seen the teacher's feedback on the same piece of work to allow them to compare it with the feedback they gave. This is an idea that could be incorporated post-review to prevent having access to teacher feedback influencing the feedback provided by the student.

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