Evaluation of Self and Peer Assessments in a Second Year Engineering Module

David Hassell
University of Bath, United Kingdom

Kok Yueh Lee
Universiti Teknologi Brunei, Brunei Darussalam

Abstract

This paper evaluates the use of peer and self-assessments as part of the learning process of an open ended, essay-based course in a second-year degree engineering module in Brunei Darussalam. The essays were marked using a rubric by the student, a peer, and the lecturer, with students being pre-trained on the use of the rubric prior to the exercise. Comparison of the marks awarded by the different markers (student, peer, lecturer) showed that whilst there might be correlations between different markers (i.e. peer - self; or lecturer - self) for marks on certain sub-sections of the work, there was no overall correlation between marks for this open ended problem. This lack of consistency highlights the subjective nature of marking essay-based work, even with the use of a rubric. Feedback on the students' experiences was obtained using a questionnaire, and most students felt that the peer assessment exercise was a worthwhile activity which aided both their learning and students' motivation to learn. Analysis of student performance in the exam, after the exercise, identified that almost all students did better in the question linked to the exercise than in others, further reinforcing this student view. The poor mark concordance in this study indicates that both techniques are not suitable to quantitatively evaluate student performance, however they had a positive impact on student learning. It is recommended that this approach is incorporated in other open-ended assessments as a form of formative feedback with the provision of adequate tutor and student preparation.

Keywords: peer-assessment; self-assessment; rubrics; engineering; student experience; higher education

Higher Educational institutions increasingly view assessment within curriculum as methods for learning rather than methods of measuring learning. Within the former, student, peer and self-assessment and the use of rubrics are favourably supported and encouraged in higher education (Falchikov, 2003, 2005; Hanrahan & Isaacs, 2001) and are a useful technique for the evaluation of student performance and focal point for self-reflection. Asikainen, Virtanen, Postareff, and Heino (2014) have suggested that long-term pedagogical training is not the only way to develop university teaching and learning, and that the application of rubrics and peer assessment can be an effective teacher-focused approach to improve student learning. However, Liu and Carless (2006) have indicated that there is resistance to this shift from lecturer assessment to peer assessment by both staff and students for reasons such as the reliability and fairness of peer assessment and the increasing the workload of lecturers as the peer marks would have to be collated. Contextual factors such as students and lecturers in Hong Kong perceiving assessment as the lecturer's duty and students believing that lecturers are more knowledgeable in assessing. To mitigate student reluctance, Sendziuk (2010) proposed lecturers deliver written feedback and not award grades in assignments to ensure students would value the feedback. Other approaches include involving students in creating the assessment criteria, the emphasis being the process of learning instead of performance.

Previous literature within engineering has focused on assessment of numerically based questions or problems (Davey, 2011), or student presentations (Montalvão & Baker, 2015), and there is little research on the application of self and peer assessments using rubrics in complex problem-based essays. This paper presents an evaluation of the use of peer and self-assessments using rubrics as part of the learning process for essay based open-ended coursework in a module studied in year two of an engineering degree. The work investigates the effectiveness of the peer-to-peer marking in accurately capturing the final student mark when compared to lecturer marks, and investigates the impact of this assessment process on student experience and learning.

The aims of this study were to:

1. Assess the capacity of engineering students to grade their own work and other students work when provided with suitable training and a rubric marking scheme.
2. Determine the statistical correlation and concordance between the students' peer and self-assessed marks and that of the lecturer.
3. Identify whether students valued this type of active self and peer assessment exercise and in what ways they found it effective/ineffective using an anonymous and voluntary established survey.
4. Identify any differences in performance and perception of the exercise based on course of study.

Literature Review

Self-assessment refers to the assessment exercise where students evaluate their own work in relation to their performance and ability or achievements (Andrade, 2010; Andrade & Boulay, 2003; Andrade & Valtcheva, 2009). It has been reported by Andrade (2010) that it enhances learning and achievement and aims to provide informative feedback on students' achievements in order to improve their abilities. In a similar manner, Nicol, Thomson, and Breslin (2014) describe peer-assessment as a classroom exercise whereby students take on the role as the assessor to evaluate their peer's work, either in the form of scoring, grading or through feedback. Arendt, Trego, and Allred (2016) stated that involving students in their own

assessment has been shown to improve students' performance if implanted effectively while Boud (1995) reported that both assessments engage students to be active participants in their own learning.

Whilst some researchers such as Montalvão and Baker (2015) applied peer-assessment without rubrics in what they described as a "holistic approach", in general it is more common to provide students with a marking rubric when applying peer and self-assessment. There is a large amount of literature available outlining the use of rubrics over a wide range of disciplines and academic levels (see for instance, Andrade, 2000; Andrade, Du, & Wang, 2008; Cho, Schunn, & Wilson, 2006; Moni & Moni, 2008; Tierney & Simon, 2004). Whilst there are still instances such as those reported by Reyna and Meier (2018) where inadequate rubrics are used, the benefits of using rubrics in educational contexts have been reported by Andrade (2000, 2005), Andrade and Du (2005), and Reddy and Andrade (2010) to be of help to students to comprehend tutor's expectations, understand the specific intended learning outcomes of the assignment or task, as well as providing feedback to students indicating their strengths and weaknesses.

Using rubrics during summative assessment poses multiple challenges for the lecturer, including rubric reliability and validity (Andrade, 2005) and rater reliability (Moskal & Leydens, 2000). Work by Cho et al. (2006) looked at the reliability of peer review and found that it requires multiple peer assessors to be reliable. When evaluating the reliability of students to accurately capture their performance in comparison to that of their lecturer, there are conflicting results reported within the literature. A recent review of literature (Brookhart, 2018) reported that most literature claims a high inter-rater reliability, however the criteria for these claims are variable and whilst some studies report high correlation between lecturer and student marking (see for instance, Freeman, 1995; Fry, 1990; Longhurst & Norton, 1997; Oldfield & Macalpine, 1995; Orpen, 1982) there are others that acknowledge low correlation (see for instance, Kwan & Leung, 1996; Rushton, 1993). Low correlation suggests that lecturers and students have different interpretations towards the criteria set out in the rubrics indicating that rubrics can be rather subjective. Both Andrade (2000), and Jonsson and Svingby (2007) have stated that a careful and well-designed rubric can promote students' learning, enhancing the teaching and learning process whilst stimulating thinking processes. However other studies have found no direct effect of rubrics on student performance (Tobajas, Molina, Quintanilla, Alonso-Morales, & Casas, 2019) and to adequately capture the development of student learning, rubric validity is important, with minimal student mark sensitivity based on the assessor. The lecturer also has to have a well-defined and transparent understanding and definition of what is required, with Rezaei and Lovorn (2010) reporting that they also need to be well-trained when it comes to designing and implementing rubrics.

Within the field of engineering, Davey (2011) and Davey and Palmer (2012) found average marks awarded by assessor and assessee using rubrics were similar, although a closer look at the results indicate considerable scatter. Later work by Davey (2015) reported that students undertaking self-assessment of a mid-term test marked their work on average 16% higher than the tutor did. The main differences were observed in only two of the five questions, and indicates that rater reliability is a consequence of the type of question posed as well as any training raters receive. Recently work has been presented arguing that peer assessment can provide similar marking to the lecturer (Rodgers, 2019), however the considerable scatter in the results again indicate a danger when interpreting student marks through statistics. These seemingly conflicting findings illustrate the challenges faced when implementing rubrics and the use of peer and self-assessments into the evaluation of student learning.

Apart from assisting in the evaluation of students' performances, rubrics can also be used for self and peer assessments as part of formative assessment. Nagori and Cooper (2014) have outlined the usefulness of these techniques for formative assessment, where students are partial assessors of their own work. In this, the emphasis is on the learning attainment rather than scores or grades where the peer and self-assessments allow students to be judges of their own work as well as of their peers. Whilst studies such as that presented by De Grez, Valcke, and Roozen (2012) and Davey (2015) have reported students expressing a positive opinion on the experience, there are limited studies providing evidence of the approach leading to improved performance in subsequent assessments.

Methodology

Participants

Participants were from a Petroleum Engineering Bachelor's degree (38 students) and Foundation degree in Process Engineering (58 students) who were all studying the same module. The participants were selected based on convenience sampling as the students would have undergone multiple assessment methods and were familiar with peer and self-assessment exercises. The entry requirements of the students entering these two courses is different: Foundation degree D, D in A-level mathematics and physics/chemistry; Petroleum Engineering B, B, C in A-level mathematics, physics and chemistry. In both cohorts, almost all students were nationals of Brunei Darussalam, with just one or two foreign students from Malaysia. All 96 participants volunteered to take part in the study and were allowed to withdraw from the study at any time without any negative implications. Ethical considerations to protect students' rights included completing an anonymised questionnaire and assessing their peers anonymously.

Research Context

This study was carried out on a piece of coursework in a second-year engineering module, Petroleum Refining, which consisted of 56 hours of content time between the lecturer and students over 14 weeks.

The coursework to be assessed was handed out to the students at the beginning of the semester and took the form of a 600 word essay worth 10% of the final grade. The task involved describing the various factors to be considered when locating an oil refinery. The coursework handout is provided in Appendix A. The students were provided with six weeks in which to complete their work and once the students had finished the course, they were provided with a set of rubrics to evaluate their work. At the end of the module students undertook an exam which was worth 70% of the total marks. As part of the exam, one section worth 15% evaluated students' understanding of the topics covered in the assignment, and this was used in part to evaluate the students' retention of information relevant to the assignment.

Procedure

Both Jonsson and Svingby (2007), and Reddy and Andrade (2010) have indicated that student use of a rubric must include an element of training for the student to understand its implementation. In this study, students were given a half hour oral presentation and demonstration prior to implementation of the rubric for self and peer assessments. The students were then given one hour to mark two pieces of work using the rubric, their own (self-assessment) and that of one other student (peer assessment). For expediency, peer assessment was facilitated by students collecting work from the front of the lecture hall, with each piece of work being assessed by oneself and one peer marker. The reviewing process was

anonymised (no assessor names) and as a result students were unaware of who assessed their work. Whilst grading of work was mandatory, the provision of written feedback was made optional, and marking by the lecturer took place subsequent to this activity. The total process took approximately two hours to complete, and was undertaken during a normal lecture period for the module. The self and peer assessment marks, whilst provided to the students, did not contribute to the overall mark of the module.

Of the 96 students from both cohorts, 59 participated in the self and peer assessment tasks (a response rate of 62%) and 65 students took part in completing the questionnaire (a response rate of 68%). Six students did not complete the assessment forms. This highlights one limitation of the voluntary nature of the work, with students choosing whether to attend the session and submit their assessment for evaluation.

Rubric

A set of descriptive rubrics was distributed to students. The rubric included specific points that should have been made in the coursework, and is provided in Appendix B, along with the list of points used during assessment. Whilst it is normally the case that rubrics are handed out with the assessment, they were not provided in this case as elements of the rubric included specific answers which would undermine the assessment purpose. These points were included to facilitate more accurate marking with the intention of reducing subjectivity caused by variable markers. After marking, students were asked to return the assessment rubric to the lecturer for subsequent evaluation, and the lecturer marked all coursework with these marks contributing towards the final student mark for the module. These marks were then compared with the results of self and peer assessment. Upon analysis it was found that some data were missing. Not all peer and self-assessment forms were submitted and there were six omissions (all from Petroleum Engineering). This highlights that more attention should have been taken by the academic staff when receiving the assessment forms, and as a result there were slightly more questionnaire responses than there were complete self and peer assessment pairs, with a summary provided in Table 1.

Questionnaire

This study implemented a mixed methods approach for data collection and analysis. Data was collected using both quantitative and qualitative methods. Once the assessment process was finished, students were asked to complete an anonymised questionnaire seeking information to investigate students' experiences of and attitudes towards rubrics and peer assessment. The questionnaire is provided in Appendix C and comprised 21 statements of fixed-response type rating their agreement using a seven-point Likert scale (Likert, 1932). Ratings ranged from Strongly Agree to Strongly Disagree. The questionnaire focused on students' perception of peer marking to identify the extent to which students felt that they were adequately prepared to assess others work based on a complex open-ended problem. Complementary and contradicting statements were used in the questionnaire in order to check the validity and reliability of student's response. For instance,

> Q11. I took a serious attitude towards marking peers' work.
> Q12. I felt that I was critical of others when marking it.

were examples of complementary statements, whereas

> Q17. I think that the rubrics was written in a clear manner which allowed me to accurately assess the work.
> Q20. I found the rubrics for the coursework confusing.

were examples of contradictory statements

There was also an optional, open-ended question where students were prompted to offer additional comments on peer assessment. The responses were generally short, descriptive comments reflecting their thoughts. Upon completion, students were then asked to return the questionnaire results to the lecturer for analysis. A total of 65 questionnaires from both cohorts were obtained (as shown in Table 1). The response rate of the questionnaire for the entire cohort was between 67 and 72% for the Foundation degree cohort and 66 and 72% for the Petroleum Engineering cohort, with not every student answering all questions in the questionnaire and not all students providing comments for the optional open-ended question. Student comments on their thoughts were coded into common themes: experiences of and attitudes towards rubrics; and experiences of and attitudes towards peer assessment.

Table 1: Number of questionnaire responses, and self and peer assessment marking for coursework.

Course	Assessment paring			Questionnaire responses
	Male	Female	Total	Total
Foundation Degree (N=58)_	13	29	42	42
Petroleum Engineering (N=38)	10	7	17	23

(Note: Six students from Petroleum Engineering did not complete the assessment forms)

Analyses

Marks and responses were statistically evaluated using Excel software, and the mean and standard deviation were calculated to quantify group responses. In addition, Spearman's correlation coefficient was used to measure the strength and direction of association between ranked variables. A value of 1 illustrated a perfect correlation between both variables, meaning that an increase in one was found to indicate an increase in the other variable. A value of -1 was taken as a perfect anti-correlation between the variables, indicating that as one variable increased, the corresponding response for the second variable decreased. As the significance of the coefficient varies with sample size, results were taken to be statistically significant based on the data provided in Zar (1984) using a significance level (α) of less than 0.025 unless otherwise stated in the text.

Results and Discussion

Montalvão and Baker (2015) reported that students marked over a narrower distribution than the lecturer when undertaking peer assessment, with one conclusion drawn being that students were reluctant to fail their peers. Comparison of the marks obtained in this study do not support this view, with a minority of marks being in the failed range for both cohorts. Montalvão and Baker (2015) applied a "holistic approach" with a scale from 1 – 10 rather than a detailed rubric as used in this study, and it is likely that this provision of a detailed framework on which to evaluate both themselves and peers led to increased confidence and understanding to provide a fail mark.

Comparison of Marks Between Lecturer, Self and Peer Assessment

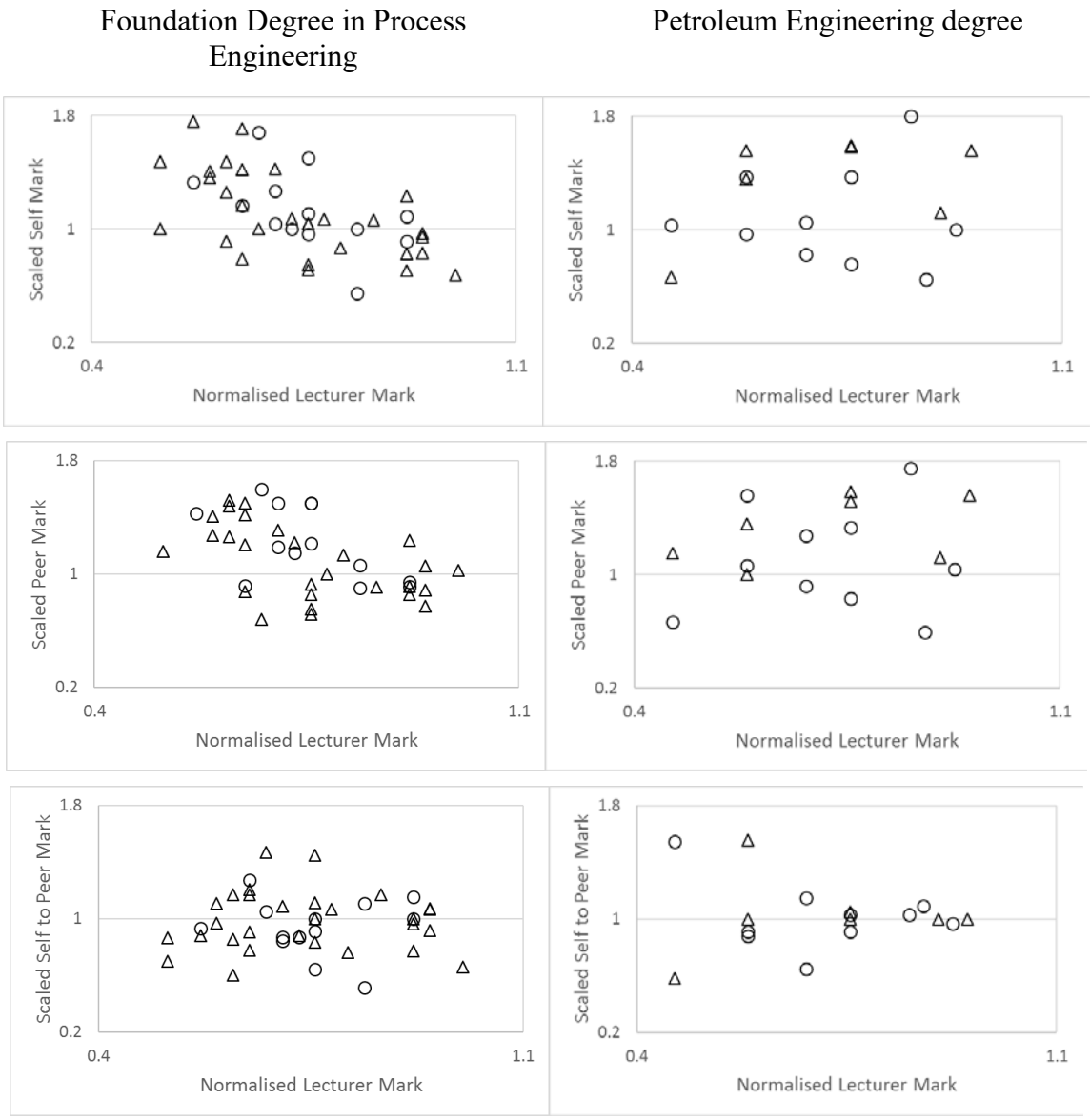
A comparison is presented in Table 2 between the marks awarded by each assessor using the lecturer mark as a reference. The data is presented as the difference between the average cohort marks, calculated as the total marks allocated within the cohort divided by the number of students, and then as the average variation in individual marks, calculated as the summed difference between markers for each student divided by the number of students.

Table 2: Difference in marks given to students as compared to the lecturer

Gender	Course	Average overall marks for the cohort (%)		Average variation in individual marks for the cohort (%)			
		Self-assessment	Peer assessment	Self-assessment		Peer assessment	
				M	SD	M	SD
Male	Foundation Degree	+10	+20	21.2	21.8	26.7	20.4
	Petroleum Engineering	+3	+4	24.2	24.6	30.0	22.9
Female	Foundation Degree	+7	+7	24.1	20.2	28.2	25.6
	Petroleum Engineering	+30	+30	39.8	20.8	31.1	22.4

When looking at the average overall marks of the cohort, it can be seen that the total number of marks awarded for Petroleum Engineering students is similar for all assessment types whilst marks given for self and peer assessment are much greater for the Foundation degree students. At a rudimentary level this might indicate that the self and peer assessment gave an accurate indication of the cohort average performance for Petroleum Engineering students. However, a more detailed comparison for individual students indicates that the average difference between assessors was over 20% with Foundation degree students actually being slightly closer to the lecturer mark than the Petroleum Engineering students. The cohort averages for self-assessment indicate that students were less generous with themselves (excepting female Petroleum Engineers) when compared to peer-assessment, with the average difference being three to ten percent higher than the lecturer. Interestingly, peer assessment marks were generally higher than self-assessment apart from female Petroleum Engineers where there were no major differences between their self and peer marks. The average variation in individually awarded marks is considerably larger than the difference in the cohort average, and this is best represented for the case of Petroleum Engineering male students. The average overall marks agree within 4% for both self and peer assessments, whilst the average absolute difference between the marking is closer to 24 – 30%. It is important to represent the results as critically as possible, as any future use of the techniques evaluated can affect individual student attainment and its measurement. This was also observed in by Davey (2015), although not explicitly stated, who reported agreement in terms of question averages but comparison of the data illustrated significant average difference between markings similar to this study.

Spearman Ranks were calculated for the individual cohorts, and no statistically relevant correlation was observed for the Petroleum Engineering students, perhaps as a result of their small cohort sizes. Figure 1 provides the ratio of self/peer to lecturer marks (scaled) to against the normalised lecturer mark with respect to the highest mark awarded for self-assessment, peer assessment and ratio of self to peer mark. Amongst Foundation Engineering students, there are negative correlations for both peer and self for both male and female students [Spearman Ranks: male self (-0.898), male peer (-0.623), female self (-0.604), and female peer (-0.615)]. This indicates that using the lecturer mark as a benchmark of student performance, students who performed weakly in the assessment were more likely to be over-marked by both themselves and their peers.



Note: The triangles (Δ) represent female students and circles (○) represent males

Figure 1: Comparisons of lecturer marks awarded to students from self, peer and lecturer assessment. Unless explicitly stated in the figure, scaled marks are those divided by the lecturer mark for that student.

No correlation was observed in Figure 1 for the ratio of self to peer mark plotted against lecturer mark, and Figure 2 presents a comparison of the same ratio plotted against normalised peer mark.

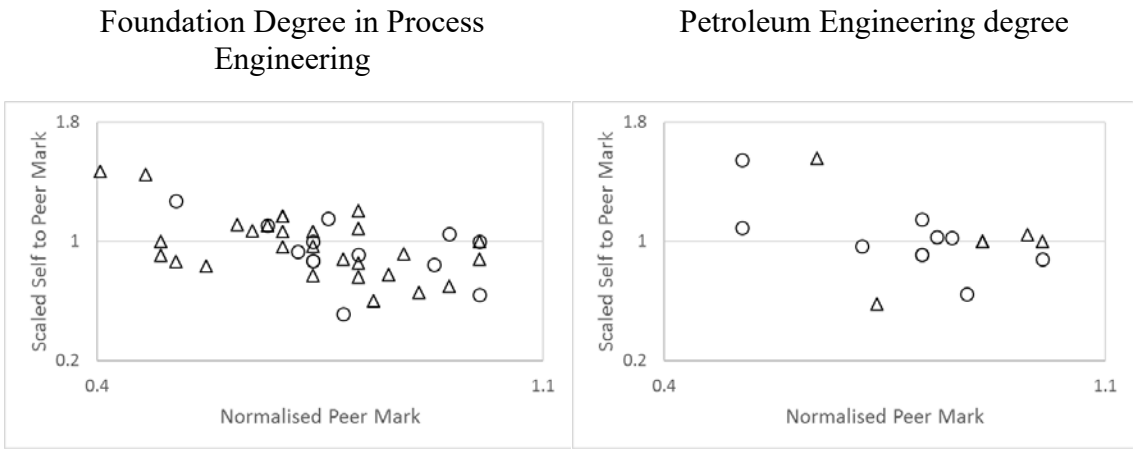


Figure 2: Comparison of self to peer marks. Scaled marks are those divided by the peer assessment mark for that student.

A negative correlation for the Foundation students [Spearman Ranks: male (-0.633), female (-0.435, significant for $\alpha = 0.05$)] is observed, indicating that as the peer mark decreases, students have a tendency to mark themselves more highly in self-assessment. This could indicate that weaker students tend to overestimate their own ability in comparison to others. The results in Figure 1 also indicate that higher scoring students were given lower marks by peers in this study, when compared to marks given to the lower scoring students. However, students are more likely to base their perception on student ability on the historical performance throughout the degree rather than unknown performance in an individual assessment.

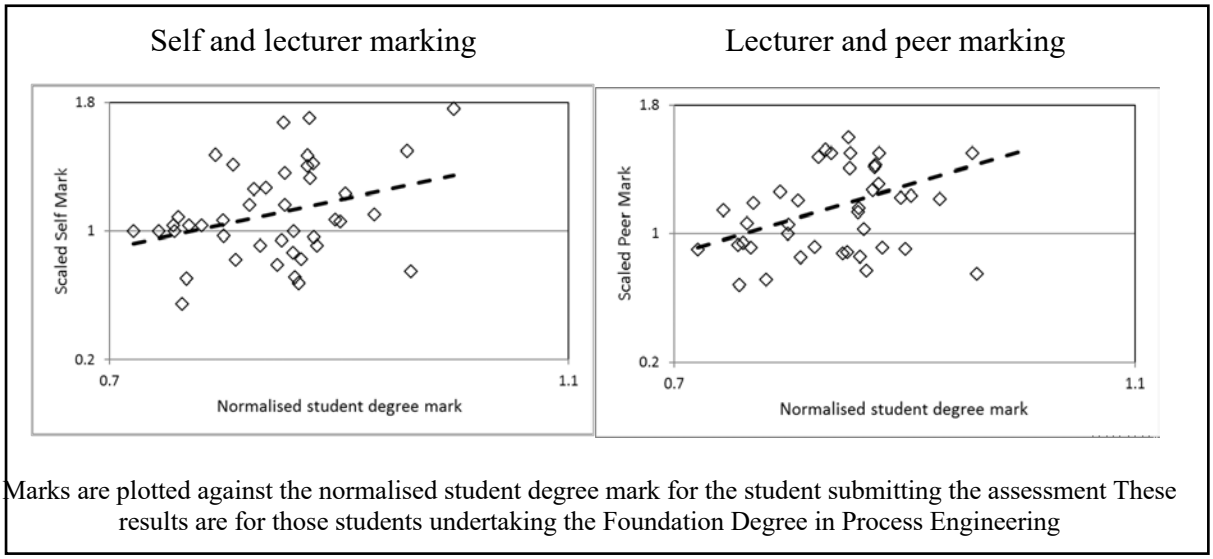


Figure 3: Comparison of marks between self and lecturer and lecturer to peer. Scaled marks are those divided by the lecturer mark for that student.

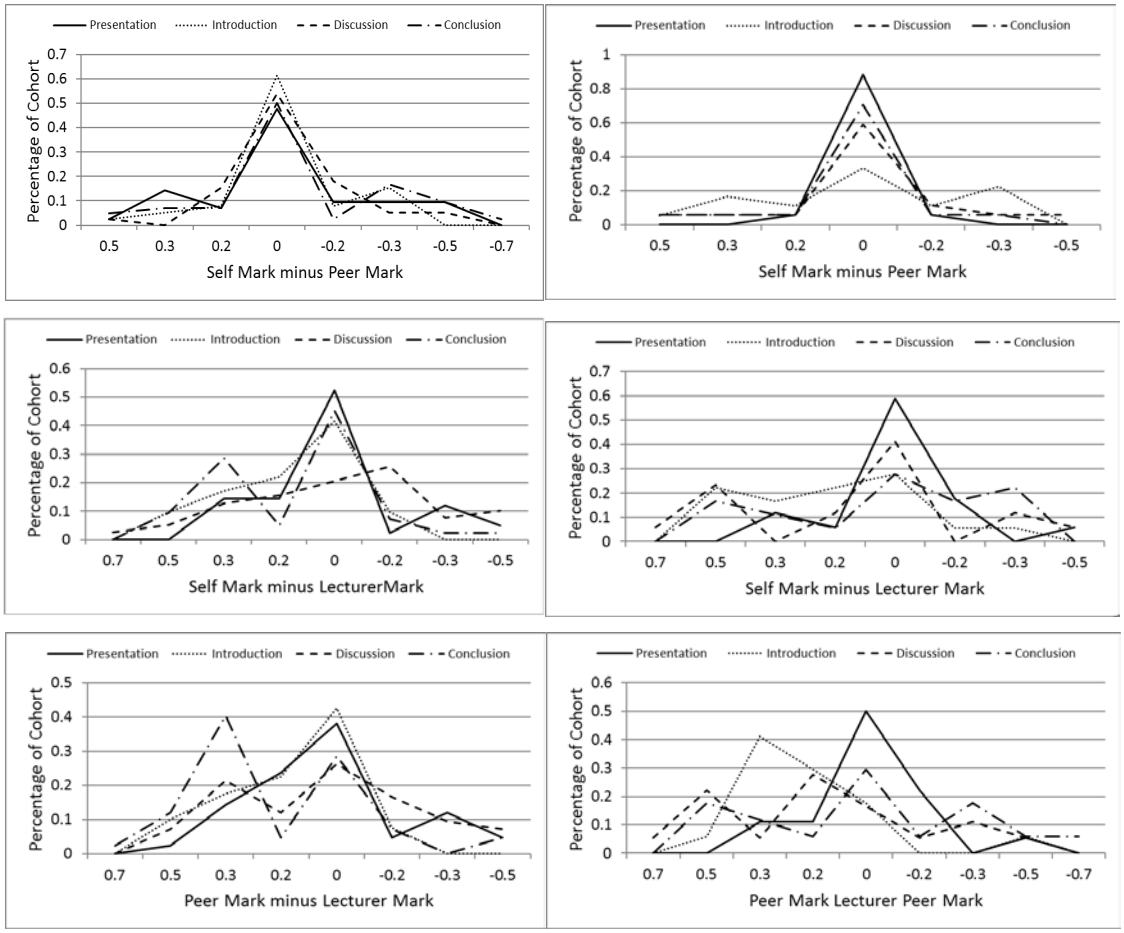
Figure 3 presents results for Foundation students of self and peer assessment, marks scaled by lecturer mark against their normalised performance in their overall degree. It indicates the level to which the students over or under mark themselves with respect to actual performance as determined by the lecturer. The correlation factors for these results are relatively low [Spearman Rank: peer (0.340) and self (0.255)] however, they could still be considered statistically significant for the sample size (n=40) at higher α values of 0.05 and 0.1 respectively and indicate a positive correlation between both self and peer assessment marks and student degree performance.

Whilst there is considerable scatter in the data, this positive correlation indicates that as academic performance (as measured by performance in overall degree) increases, both perception of performance by self and peer increases with respect to actual performance for students. In a study in the United States of America, Sadler and Good (2006) reported that poorly performing students have the tendency to overrate themselves as compared to tutor's grading, and this is different from the findings presented here. One possibility for the difference is as a result of the cultural background of the students involved in this work. Unlike in some Western societies, anecdotal evidence and experience indicates that students in South East Asia are more likely to view good academic performance with admiration rather than jealousy. As a result, there will not be the same negative perception of good performance, akin to that seen with "rate-busting" in western industries, and hence the students in this study are biased in the opposite manner, that is, towards rather than against high performing students.

It is noted that the quantitative results presented here have similarities to previous studies. The results concur with Davey (2015) with very poor agreement in marks between assessors and there is significant scatter in data as seen by Davey and Palmer (2012). The results also indicate poor rater reliability similar to Andrade (2005) and Moskal and Leydens (2000). As with Andrade and Du (2005), there was no obvious gender bias in the poor correlation, and students provide on average higher marks for both self-assessment (as with Davey, 2015) and De Grez et al., 2012) and peer-assessment (as with Montalvão and Baker, 2015). However, the analysis presented here are more scattered than for Davey (2015) indicating that self-assessment is more unreliable when compared to lecturer assessment when the assessment is based on open ended rather than closed questions.

Even with a rubric to guide students as in this work, or model answers as in the case of Davey (2015), students seem to be on average more generous than the lecturer. As a result, it seems that to maintain fair and consistent marking, all students in a cohort should be marked by the same individual or group of individuals. These large differences contradict the assertion by Asikainen et al. (2014) that when using peer assessment, only assessment marking with substantially different marks given by the assessors should require reassessment by the teacher to ensure reliability.

To see whether discrepancies in marking were caused by a specific element of the rubrics, the marks between each assessor (lecturer, self and peer) for the total marks were compared within the four categories: Presentation, Introduction, Discussion, Conclusion. Figure 4 presents a detailed evaluation of the similarity in marking between various assessors with the observed difference scaled with respect to maximum positive or negative deviation possible.



Difference is scaled with respect to maximum positive or negative deviation possible. Zero indicates that both assessors provided the same score.

Figure 4: Comparison of marks between assessors for the different sections

The degree to which marks between assessors were similar for the different sections of the rubric for Foundation degree and Petroleum Engineering is represented on the x-axis, where for a value of zero both assessors provided the same score. The result indicates that whilst there was a relatively high agreement on marks of individual sections between assessors, equivalent to 70% – 90% exact agreement in some cases, these were not carried forth into consistently high agreement in the total marks awarded. The sections with the highest level of agreement between assessors tended to be the presentation or introduction sections, but quantitatively the marks were not consistent between lecturer and either self or peer assessments. This poor correlation between different markers highlights the challenge in the development of a thorough methodology for the implementation of robust and repeatable student self and peer assessments. A past study in a Chemical Engineering class by Davey (2011) found that students generally gave higher marks for descriptive questions as compared to the lecturer, whilst both students and lecturer marked the numeric questions equally on average. The development of rubrics, even in non-technical disciplines, requires a great deal of effort and time and in this work, the very poor agreement in areas that require a higher level of technical knowledge are

likely attributed to a lack of in-depth knowledge by students on the arguments surrounding each technical point.

Hassmén, Sams, and Hunt (1996) found that students who undertook self-assessments performed better in the final test, whilst Andrade and Du (2005) stated that students' perceptions were that they attain better results or grades as a result of the use of rubrics. To compare the impact in this study, a comparison of the total marks awarded in the final exam is given in Figure 5 against the marks awarded for the question related to the topic covered in the coursework. As can be seen, both cohorts on average performed significantly better in the coursework related question than in the overall exam. Whilst this indicates that the coursework had long term impact on the students learning and recall of information, it should be noted that the improved performance could also be due to the level of the questions in the exam or be indicative that students found those topics easier to learn than others. It cannot be definitively proven which of the above arguments resulted in the increased student performance, however the results when combined with student feedback in Table 3 do suggest that at the very least, the use of rubric has not hindered the students learning as shown by subsequent assessments. The overall results of this study agree with those of others such as Falchikov and Boud (1989) and indicate that even though there is a lack of agreement between students and tutor's marks, self-assessment and peer assessment are valuable assessment tools by providing feedback to students on their learning and educational standards. Through undertaking the marking themselves they are learning through active practice, rather than passive participation, and therefore more likely to remember the information over a longer timeframe.

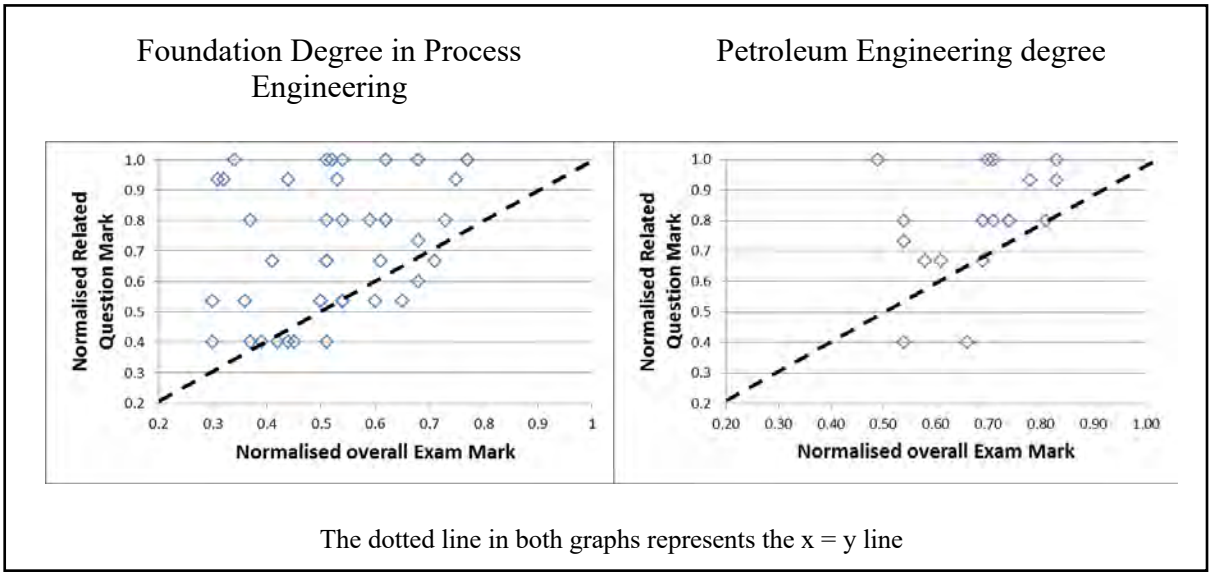


Figure 5: Comparisons of the exam mark against related question mark

Students' Experience of Learning

In addition to the correlation of rubrics with lecturer, self and peer marks, this study was also concerned with the students' perceptions of and the attitudes towards the peer and self-assessment exercise. Table 3 provides information on the student responses to the questionnaire survey along with cohort averages and standard deviations for each question. In subsequent sections these averages will be presented in square brackets to support interpretation of students' experiences.

Table 3: Summary of number of questionnaire responses and category of response for each survey statement. Numbers in brackets are the number of students who filed a response.

	Survey Statement Response							Foundation Degree (n)		Petroleum Engineering (n)		TOTAL (n)	
Q.	1	2	3	4	5	6	7	M	SD	M	SD	M	SD
1)	7	5	3	4	11	26	6	4.21 (39)	2.13	5.70 (23)	0.82	4.76 (62)	1.90
2)	0	0	2	11	26	17	6	5.25 (40)	0.95	5.18 (22)	1.01	5.23 (62)	0.97
3)	0	1	5	12	15	20	12	5.43 (42)	1.19	5.04 (23)	1.40	5.29 (65)	1.27
4)	1	2	4	21	12	20	5	5.12 (42)	1.17	4.39 (23)	1.44	4.86 (65)	1.31
5)	0	0	1	12	22	20	10	5.50 (42)	1.04	5.22 (23)	0.95	5.40 (65)	1.01
6)	0	0	3	24	18	12	6	4.85 (40)	1.05	5.00 (23)	1.13	4.90 (63)	1.07
7)	2	3	11	22	11	9	5	4.23 (40)	1.46	4.52 (23)	1.38	4.33 (63)	1.43
8)	11	12	17	22	2	0	1	3.05 (42)	1.10	2.74 (23)	1.51	2.94 (65)	1.26
9)	0	0	1	7	27	23	7	5.52 (42)	0.92	5.26 (23)	0.81	5.43 (65)	0.88
10)	0	0	3	20	20	18	4	5.14 (42)	1.05	4.74 (23)	0.92	5.00 (65)	1.02
11)	0	0	4	14	15	17	13	5.17 (42)	1.19	5.67 (21)	1.24	5.33 (63)	1.22
12)	0	0	4	19	22	15	5	4.81 (42)	1.02	5.26 (23)	1.05	4.97 (65)	1.05
13)	1	3	8	12	22	10	9	4.86 (42)	1.30	4.70 (23)	1.66	4.80 (65)	1.43
14)	0	0	1	7	28	19	10	5.43 (42)	0.89	5.52 (23)	1.04	5.46 (65)	0.94
15)	0	0	0	5	15	23	20	5.88 (40)	0.88	6.00 (23)	1.04	5.92 (63)	0.94
16)	0	0	0	4	14	23	19	5.90 (39)	0.88	6.05 (21)	0.97	5.95 (60)	0.91
17)	0	0	2	5	22	24	12	5.55 (42)	0.89	5.70 (23)	1.15	5.60 (65)	0.98
18)	0	0	1	7	20	26	11	5.52 (42)	0.77	5.74 (23)	1.21	5.60 (65)	0.95
19)	1	1	3	19	20	15	5	5.05 (42)	1.01	4.59 (22)	1.47	4.89 (64)	1.20
20)	5	10	8	25	9	2	1	3.53 (38)	1.37	3.59 (22)	1.33	3.55 (60)	1.35
21)	3	6	8	23	12	6	3	4.00 (39)	1.34	4.18 (22)	1.59	4.07 (61)	1.42

Note: Seven point Likert scale: 7 = strongly agree, 1 = strongly disagree, and 4 = no opinion or neutral response.

Statements:

1. I have undertaken peer assessment previously.
2. Peer assessment is a worthwhile activity.
3. Giving feedback to my peers is very difficult.
4. I feel that my peers have adequate knowledge to evaluate my work.
5. I feel that peer assessment is helpful to my learning.
6. Giving feedback to my peers is useful to me.
7. I would prefer not to do peer assessment on others.
8. I prefer peer assessment rather than lecturer's feedback.
9. I learnt something through performing peer review.
10. Peer assessment activity motivates me to learn.
11. I took a serious attitude towards marking peers' work.
12. I felt that I was critical of others work when marking it.
13. When marking the coursework, I focused on the task at hand, and did not find my mind wandering to how my own coursework was being marked.
14. I learnt something further about the subject through marking coursework using the rubrics.
15. Having used the rubrics, I now have a better understanding of what was expected in the coursework
16. Having marked coursework using a rubrics, I now have a better understanding of what is expected of me during coursework.
17. I think that the rubrics was written in a clear manner which allowed me to accurately access the work.
18. I think that the presentation given at the beginning of the class on how to use rubrics prepared me well enough to assess the work.
19. I think rubrics based peer assessment is a fair method to assess student's performance.
20. I found the rubrics for the coursework confusing.
21. I would like more assessment run in this manner in the future.

Experiences of and Attitudes Towards Rubrics

Previous research (Andrade & Du, 2005; Davey & Palmer, 2012; De Grez et al., 2012) has shown that students' perceptions on using rubrics are largely positive, and this was the general trend observed in this work. Students from both cohorts reported that they found the rubric well written [Q17: FD 5.55, PE 5.70] and did not find it confusing [Q20: FD 3.53, PE 3.59]. They also felt that the presentation and training at the beginning of the session prepared them well enough to implement the rubrics [Q18: FD 5.52, PE 5.74]. This indicates that despite the differences between assessor marks results presented previously, students felt that they were adequately prepared to assess their work using the provided rubric. Students also felt that the rubrics is a fair assessment method to assess students' performance [Q19: FD 5.05, PE 4.59]. This is highlighted by one student, as shown in the following extract.

> *It is nerve wrecking but at least I know why I lost and won some marks.*

Davey (2015) found that the use of rubrics stimulated interest in the course. Students from both cohorts felt that by marking their coursework using rubrics enhanced their understanding of the module content [Q14: FD 5.43, PE 5.52], and students also found that the use of the rubrics improved their understanding of what was required for the coursework [Q15|Q16: FD 5.88|5.90, PE 6.00|6.05]. This is further supported by students' additional comments in the questionnaire, as shown in the following extracts below.

Rubric is very useful in the sense that we know what points we should raise while writing our report.

Interesting way of marking the coursework. Looking forward for the methods results.

Fun activity.

It was fun and a new experience for me.

An increased understanding of coursework expectations through the use of the rubric is an expected response, as students were provided with a detailed written description of how the work was to be marked alongside the demonstration of how to implement it. The use of the rubrics encourages students to learn more about the content of the module as they are motivated to at the very least on a superficial level to understand the content relating to the coursework in order to assess their peers. Andrade (2010) stated that rubrics provide informative feedback on students' knowledge and competency, and this is further illustrated in the results presented here.

Experiences of and Attitudes Towards Peer Assessment

The previous experience of students in this study to peer assessment was varied [Q1: FD 4.21, PE 5.70] with a greater proportion of the Petroleum Engineering cohort having undertaken it previously to the Foundation degree cohort. The results in Table 3 highlight that students in both cohorts found the use of peer assessment to be a useful activity [Q2: FD 5.25, PE 5.18] which aided their learning [Q5|Q9: FD 5.50|5.52, PE 5.22|5.26]. Students also found the peer assessment exercise motivated them to learn [Q10: FD 5.14, PE 4.74]. A previous study by Nicol et al. (2014) found that peer assessment is favoured positively by students and this is further illustrated in this work, and the students from both cohorts also felt that their peers had adequate knowledge to assess their them [Q4: FD 5.12, PE 4.39] and that they took on a professional attitude in doing the exercise [Q11|Q12|Q13: FD 5.17|4.81|4.86, PE 5.67|5.26|4.70]. Despite this, some students voiced concerns or doubts on peer assessment as noted by some students in the following extracts:

Some people do not have enough knowledge to actually give extra point for additional points.

I need to refer to someone more expert when marking other's papers in order to minimise the errors during marking.

I need more experience when marking others/papers as wrong way of marking might disrupt others' outcome.

I am concern on how people will see the way I mark their paper.

Bolton (2006) found that the use of rubrics can be useful in providing feedback to students, whilst Andrade (2005) have stated that it is not a direct replacement for instruction, lecturer feedback and opportunities to ask questions. These findings are consistent with the response of students during this work, and whilst both student cohorts find providing feedback to others useful [Q6: FD 4.85, PE 5.00], they did not view it as an acceptable replacement for lecturer feedback [Q8: FD 3.05, PE 2.74]. Unfortunately, it cannot be evaluated through their responses

whether or not the students realised that through applying the rubric to their and others' work they are obtaining much more detailed indirect feedback from the lecturer on both their work and that of others. Davey (2011) reported broad student agreement that peer assessment is an effective way to learn and stimulates interest in course material although idealised solutions of the lecturer were essential for successful peer assessment outcomes. Preferences for lecturer's feedback was also apparent as expressed by some of the students in their comments, illustrated by the following from three different students:

> *I would like the lecturer to mark it first, so that we could compare our marking with the lecturer straight away.*
>
> *I prefer if the lecturer marks our report because they have deeper understanding on this module/topic of the report.*
>
> *I prefer the hands of experts to mark the coursework.*

In spite of students highlighting that the activity increased their learning and understanding of both the coursework expectations and course content, they acknowledged that giving feedback to peer was a difficult task [Q3: FD 5.43, PE 5.04] and they weakly indicated that they would rather not do it [Q7: FD 4.23, PE 4.52] and were non-committal about the approach being adopted in other modules [Q21: FD 4.00, PE 4.18]. This result is different from student perceptions reported by Davey (2015) for self-assessment at an Australian University who reported using a similar Likert scale that students were keen to have in other courses [average 4.7]. This indicates the challenges present in applying teaching methodologies across different cultures and provides data contrary to the views presented in Richmond (2007) that Asian students are willing to move away from the spoon-fed teaching culture which they have been traditionally subjected to and embrace other forms of learning. One student also suggested to be given more time in the peer assessment activity as 90 minutes can be rather tight when they had to do a self-assessment followed by a peer assessment.

Given the results presented in both the marks and questionnaire analysis, the students seem to have been unknowingly ill-prepared to accurately evaluate their work. One issue is that a 'non-expert' might have been awarding marks when the listed relevant points were raised in the essay, even when that argument point was presented incorrectly. Subsequent informal discussion with students highlighted that when evaluating the points in Appendix B, there were differences in interpretation depending on the context surrounding where in the work the point was raised. The technical expert caught numerous examples where the points raised met the initial rubric criteria however they were presented in the wrong context (specifically Discussion points 6-9). This level of subjectivity to the marking highlights a major failing with the manner in which the rubric was presented, with additional detail being required for each point to allow the students to accurately identify its relevant inclusion. Whilst a more detailed rubric might reduce ambiguity, it is unlikely that the assessor can foresee every argument in an open-ended problem. Indeed it was for this reason that the rubric allowed for "additional points". From a practical perspective, a balance is required between the need to develop robust and thorough rubrics for the assessment of work and the competing demands of lecturer time.

Conclusion

The work presented in this study presents an evaluation of the use of peer and self-assessments as part of the learning process of an open-ended essay-based coursework in a year two degree

engineering module in Brunei Darussalam. The present study sets out to investigate whether, given reasonable training on rubrics, students were capable to assess their own work as well as of their peers; the correlation between the assessed work (self, peer and lecturer) and students' perceptions of the self and peer assessment exercise. The study was undertaken on two different cohorts of students, and comparison of the marks awarded by different markers; student; peer; and lecturer; showed very poor correlation between marks. Whilst there were correlations between different markers (i.e. peer – self) for certain subsections of the work, these tendered to be for the non-technical sections and there was no overall correlation between marks. Correlation for the technical components was very poor, and likely the result of the in-depth understanding required to accurately apply the rubric to the context surrounding the various points required in the coursework. Comparison between student marking and lecturer found differences to those observed elsewhere, indicating that cultural background impacts how students perceive themselves and others with respect to academic ability and their use of rubrics to evaluate others work. Student feedback to the exercise found that most students held positive attitudes towards peer-assessment and felt that peer-assessment was a worthwhile activity which aided both their learning and motivation to learn. Bruneian students were open to being critically evaluated by their peers and appreciated the opportunity to experience new approaches and methodologies in the classroom. However, they then contradicted themselves somewhat by indicating that they would have preferred not to have to do it, perhaps as a result of finding it a difficult process to go through. This indicates the difficulty in introducing new pedagogical practices into the classroom, where negative student feedback to difficult situations is in conflict with the positive learning experience. Whilst the poor mark concordance in this exercise indicates that both peer and self-assessment are not suitable to quantitatively evaluate student performance, the overall student experience was seen as positive and motivational to their learning and suitable for formative assessment.

The results of the present study suggest that more training is necessary for students in using rubrics as part of their assessment. A crucial message lies in the validity and reliability of rubrics having an impact on the quality of peer and self-assessments. This study only involved one second year class student undertaking a specific module within a programme, this limitation should be taken into account when considering the extent to which the results can be generalised into the wider higher education contexts. Although careful consideration was accounted for with respect to interrater reliability, the rater found that there is still a requirement for comprehensive training to increase the accuracy of rating. The implementation of rubrics in higher education has always been contextual, challenging and subjective. Peer and self-assessments can be alternatives to assessment along with the use of rubrics, provided all aspects are planned methodically and students are made conscious of the steps and procedures in order to execute it well.

References

Andrade, H. G. (2000). Using rubrics to promote thinking and learning. *Educational Leadership*, *57*(5), 13–19.

Andrade, H. G. (2005). Teaching with rubrics: The good, the bad, and the ugly. *College Teaching*, *53*(1), 27–31. https://doi.org/10.3200/CTCH.53.1.27-31

Andrade, H. G. (2010). Students as the definitive source of formative assessment. In H, Andrade & G. Cizek, (Eds.). *Handbook of Formative Assessment*, (pp. 90–105). Florence, KY: Routledge.

Andrade, H. G., & Boulay, B. A. (2003). Role of rubric-referenced self-assessment in learning to write. *Journal of Educational Research*, *97*(1), 21–30. https://doi.org/10.1080/00220670309596625

Andrade, H. G., & Du, Y. (2005). Student perspectives on rubric-referenced assessment. *Practical Assessment, Research & Evaluation*, *10*(3), 1–11.

Andrade, H. G., Du, Y., & Wang, X. (2008). Putting rubrics to the test: The effect of a model, criteria generation, and rubric-referenced self-assessment on elementary school students' writing. *Educational Measurement: Issues and Practice*, *27*(2), 3–13. https://doi.org/10.1111/j.1745-3992.2008.00118.x

Andrade, H. G., & Valtcheva, A. (2009). Promoting learning and achievement through self-assessment. *Theory into Practice*, *48*(1), 12–19. https://doi.org/10.1080/00405840802577544

Arendt, A., Trego, A., & Allred, J. (2016). Students reach beyond expectations with cafeteria style grading. *Journal of Applied Research in Higher Education, 8*(1), 2–17. https://doi.org/10.1108/JARHE-03-2014-0048

Asikainen, H., Virtanen, V., Postareff, L., & Heino, P. (2014). The validity and students' experiences of peer assessment in a large introductory class of gene technology. *Studies in Educational Evaluation*, *43*, 197–205. https://doi.org/10.1016/j.stueduc.2014.07.002

Bolton, F. C. (2006). Rubrics and adult learners: Andragogy and assessment. *Assessment Update*, *18*(3), 5–6. https://doi.org/10.1002/au.183

Boud, D. (1995). Assessment and learning: contradictory or complementary? *Assessment*, 35–48.

Brookhart, S. M. (2018). Appropriate criteria: Key to effective rubrics. *Frontiers in Education*, *3*(22). http://doi.org/10.3389/feduc.2018.00022

Cho, K., Schunn, C. D., & Wilson, R. W. (2006). Validity and reliability of scaffolded peer assessment of writing from instructor and student perspectives. *Journal of Educational Psychology*, *98*(4), 891–901. http://dx.doi.org/10.1037/0022-0663.98.4.891

Davey, K. R. (2011). Student peer assessment: Research findings from a case study in a master of chemical engineering coursework-program. *Education for Chemical Engineers*, *6*(4), e122–e131. https://doi.org/10.1016/j.ece.2011.08.004

Davey, K. R. (2015). Student self-assessment: Results from a research study in a level IV elective course in an accredited bachelor of chemical engineering. *Education for Chemical Engineers*, *10*, 20–32. https://doi.org/10.1016/j.ece.2014.10.001

Davey, K. R., & Palmer, E. (2012). Student peer assessment: A research study in a level III core course of the bachelor chemical engineering program. *Education for Chemical Engineers*, *7*(3), e85–e104. https://doi.org/10.1016/j.ece.2012.04.001

De Grez, L., Valcke, M., & Roozen, I. (2012). How effective are self- and peer assessment of oral presentation skills compared with teachers' assessments? *Active Learning in Higher Education*, *13*(2), 129–142. https://doi.org/10.1177%2F1469787412441284

Falchikov, N. (2003). Involving students in assessment. *Psychology Learning & Teaching*, *3*(2), 102–108. https://doi.org/10.2304%2Fplat.2003.3.2.102

Falchikov, N. (2005). *Improving assessment through student involvement: Practical solutions for aiding learning in higher and further education*. Oxon, UK: Routledge.

Falchikov, N., & Boud, D. (1989). Student self-assessment in higher education: A meta-analysis. *Review of Educational Research*, *59*(4), 395–430. https://doi.org/10.3102%2F00346543059004395

Freeman, M. (1995). Peer assessment by groups of group work. *Assessment & Evaluation in Higher Education*, *20*(3), 289–300. https://doi.org/10.1080/0260293950200305

Fry, S. A. (1990). Implementation and evaluation of peer marking in higher education. *Assessment and Evaluation in Higher Education*, *15*(3), 177–189. https://doi.org/10.1080/0260293900150301

Hanrahan, S. J., & Isaacs, G. (2001). Assessing self-and peer-assessment: The students' views. *Higher Education Research & Development*, *20*(1), 53–70. https://doi.org/10.1080/07294360123776

Hassmén, P., Sams, M. R., & Hunt, D. P. (1996). Self-assessment responding and testing methods: effects on performers and observers. *Perceptual and Motor Skills*, *83*(3_suppl), 1091–1104. https://doi.org/10.2466/pms.1996.83.3f.1091

Jonsson, A., & Svingby, G. (2007). The use of scoring rubrics: Reliability, validity and educational consequences. *Educational Research Review*, *2*(2), 130–144. https://doi.org/10.1016/j.edurev.2007.05.002

Kwan, K., & Leung, R. W. (1996). Tutor versus peer group assessment of student performance in a simulation training exercise. *Assessment & Evaluation in Higher Education*, *21*(3), 205–214. https://doi.org/10.1080/0260293960210301

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*.

Liu, N.-F., & Carless, D. (2006). Peer feedback: the learning element of peer assessment. *Teaching in Higher Education*, *11*(3), 279–290. https://doi.org/10.1080/13562510600680582

Longhurst, N., & Norton, L. S. (1997). Self-assessment in coursework essays. *Studies in Educational Evaluation*, *23*(4), 319–330.

Moni, R. W., & Moni, K. B. (2008). Student perceptions and use of an assessment rubric for a group concept map in physiology. *Advances in Physiology Education*, *32*(1), 47–54. https://doi.org/10.1152/advan.00030.2007

Montalvão, D. & Baker, T. (2015). Correlating peer and tutor assessment on a low-stakes engineering assignment. *International Journal of Mechanical Engineering Education*, *43* (3), 168-179. https://doi.org/10.1177/0306419015603008

Moskal, B. M., & Leydens, J. A. (2000). Scoring rubric development: Validity and reliability. *Practical Assessment, Research & Evaluation*, *7*(10), 71–81.

Nagori, R., & Cooper, M. (2014). Key principles of peer assessments: A feedback strategy to engage the postgraduate international learner. *IAFOR Journal of Education*, *2*(2). https://doi.org/10.22492/ije.2.2.07

Nicol, D., Thomson, A., & Breslin, C. (2014). Rethinking feedback practices in higher education: a peer review perspective. *Assessment & Evaluation in Higher Education*, *39*(1), 102–122. https://doi.org/10.1080/02602938.2013.795518

Oldfield, K. A., & Macalpine, J. M. K. (1995). Peer and self-assessment at tertiary level - an experiential report. *Assessment in Higher Education*, *20*(1), 125–132. https://doi.org/10.1080/0260293950200113

Orpen, C. (1982). Student versus lecturer assessment of learning: a research note. *Higher Education*, *11*(5), 567–572. https://doi.org/10.1007/BF00194421

Reddy, Y. M., & Andrade, H. G. (2010). A review of rubric use in higher education. *Assessment & Evaluation in Higher Education*, *35*(4), 435–448. https://doi.org/10.1080/02602930902862859

Reyna, J., & Meier, P. (2018). Learner-generated digital media (LGDM) as an assessment tool in tertiary science education: A Review of Literature. *IAFOR Journal of Education*, *6*(3). https://doi.org/10.22492/ije.6.3.06

Rezaei, A. R., & Lovorn, M. (2010). Reliability and validity of rubrics for assessment through writing. *Assessing Writing*, *15*(1), 18–39. https://doi.org/10.1016/j.asw.2010.01.003

Richmond, J. E. D. (2007). Bringing critical thinking to the education of developing country professionals. *International Education Journal*, *8*(1), 1–29.

Rodgers, T. L. (2019). Peer-Marking and peer-feedback for coding exercises. *Education for Chemical Engineers*, *29*, 56–60. https://doi.org/10.1016/j.ece.2019.08.002

Rushton, C. (1993). Peer assessment in a collaborative hypermedia environment: A case study. *Journal of Computer-Based Instruction*, *20*(3), 75–80.

Sadler, P. M., & Good, E. (2006). The impact of self-and peer-grading on student learning. *Educational Assessment*, *11*(1), 1–31. https://doi.org/10.1207/s15326977ea1101_1

Sendziuk, P. (2010). Sink or swim? Improving student learning through feedback and self-assessment. *International Journal of Teaching and Learning in Higher Education*, *22*(3), 320–330.

Tierney, R., & Simon, M. (2004). What's still wrong with rubrics: focusing on the consistency of performance criteria across scale levels. *Practical Assessment, Research & Evaluation*, *9*(2), 1–10.

Tobajas, M., Molina, C. B., Quintanilla, A., Alonso-Morales, N., & Casas, J. A. (2019). Development and application of scoring rubrics for evaluating students' competencies and learning outcomes in Chemical Engineering experimental courses. *Education for Chemical Engineers*, *26*, 80–88. https://doi.org/10.1016/j.ece.2018.11.006

Zar, J. H. (1984). *Biostatistical analysis*. (2nd ed.). New Jersey: Prentice-Hall, Inc., Eaglewood Cliffs.

Corresponding author: Lee Kok Yueh
Contact email: kokyueh.lee@utb.edu.bn

Appendices

Appendix A: Coursework Handout

Scenario: You are an employee of Hengyi, and you are evaluating the viability of building an oil refinery in Brunei (please ignore the fact that they are already building one). You have been asked to compile a 600-word report outlining the following:

Introduction: Basic introduction to your report, which should include the following; description of what an oil refinery does, including characteristic refinery size and life expectancy; main feedstock; main products and market for those products; introduction to Brunei, it's location and resources. (100-150 words)

Discussion: This is where you discuss the advantages and disadvantages of locating a refinery in Brunei. The points for discussion could include, but are not limited to; suitable geographical location; access to and quality of raw materials over life cycle of the plant; access to product markets over life cycle of the plant; possible issues which affect refinery profitability; human capital resources; any social and political issues. (300-400 words)

Conclusion: This is where you highlight whether or not you think Hengyi should build a refinery in Brunei, along with the main arguments supporting your decision. (100-150 words)

Resources: You have been provided with a supporting document which you can use to start understanding where an oil refinery is placed within the "fuel supply chain", along with some of the issues facing refineries. This document focuses on North America, and you are also expected to undertake your own research when considering both refineries and the local conditions present in Brunei.

Marking: This coursework will be peer evaluated by a fellow student in your class, and to help guide them a marking rubrics will be provided by the lecturer. The evaluation is provisionally scheduled to take place during a formally scheduled time slot in week 13 of the semester, prior to the exams. The report will subsequently be second marked by the lecturer, before a final mark is awarded to each student.

Appendix B: Rubrics and additional information

Name of student **self assessing**: _____ Course (FD or PE): _____

	Excellent (10 marks)	Good (8 marks)	Adequate (5 marks)	Needs improvement (3 marks)	Marks
Presentation (2)	• Information is presented logically and naturally. • There are no more than two mechanical errors or misspelled words to distract the reader.	• Information is presented in a logical manner that is easily followed. • There is minimal interruption to the work due to misspellings and/or mechanical errors.	• The information is presented in an orderly fashion that can be followed with little difficulty. • There are some misspellings and/or mechanical errors, but they do not seriously distract from the work.	• Information is presented in a disorganised fashion causing the audience to have difficulty following the author's ideas. • There are many misspellings and/or mechanical errors.	
Introduction (2)	10 – 11 of the points highlighted in the introduction list.	8 – 9 of the points highlighted in the introduction list.	5 – 7 of the points highlighted in the introduction list.	4 or less of the points highlighted in the introduction list.	
Discussion (4)	13 – 16 of the points highlighted in the introduction list.	10 – 12 of the points highlighted in the introduction list.	8 – 9 of the points highlighted in the introduction list.	7 or less of the points highlighted in the introduction list.	
Conclusion (2)	• The audience is able to easily identify the focus of the work and is engaged by its clear focus and relevant details. • Does not bring in any new arguments which haven't been included in the main text. • Provides a summary of the main arguments covered in the discussion.	• The audience is easily able to identify the focus of the student work, supported by relevant ideas and supporting details. • Does not bring in any new arguments which haven't been included in the main text. • Provides a summary of most of the main arguments covered in the discussion.	• The audience can identify the central purpose of the student work without little difficulty and supporting ideas are present and clear. • Introduces one new information or argument which isn't included in the main text. • Provides a summary of some of the main arguments covered in the discussion.	• The audience cannot clearly or easily identify the central ideas or purpose of the student work. • Introduces more than one new information or argument which isn't included in the main text. • Provides a summary of only one of the main arguments covered in the discussion.	
				TOTAL MARKS	

	Points to raise
Introduction: description of what an oil refinery does, including characteristic refinery size and life expectancy	(1) Oil refinery takes a mixture of crude oil feedstocks and converts it into a range of petroleum products. (2) The configuration of the refinery depends on both the feedstock composition and product demand. (3) Depending on prevailing economics the life expectancy would be multiples of 10's of years. (4) A characteristic size for a refinery would be of the order 100-200,000 barrels per day. (5) Whilst global range is 10,000 – 1.24million barrels per day.
Introduction: main feedstock; main products and market for those products;	(6) Main feedstocks are crude oil of various qualities, normally a mixture of heavy, light, sweet and sour crude. (7) Products are a combination of gasoline (petrol), diesel, jet fuels, kerosene, waxes and coke. Additional products are various petrochemical products used as intermediaries in chemical processes. (8) Market for those products depends on global economic circumstances, and demand varies depending on the geographical location of the refinery.
Introduction: introduction to Brunei, it's location and resources	(9) Brunei is a small country in SE Asia, located on Borneo Island. (10)Brunei has a population of approx. 450,000. (11)Brunei is a net exporter of oil and gas.
ADDITIONAL	If additional points are raised which you feel are valid information or arguments, you may allocate an extra point.
Discussion: suitable geographical location; access to and quality of raw materials over life cycle of the plant; access to product markets over life cycle of the plant;	(1) Brunei is strategically located close to major international shipping lanes and several fast growing Asian economies. (2) Brunei has good quality oil reserves for at least the next 25 years, which would meet the refineries medium term needs. (3) Brunei has several deep water access points for importation of additional crude feedstocks and export of products. (4) Products would be for other domestic (Bruneian) use or in subsequent Hengyi processes. Access to Hengyi plants in China should not be an issue as Brunei is well placed to serve this market. (5) Both domestic demand and that in China should continue to grow as their populations grow and their economies mature.
Discussion: possible issues which affect refinery profitability; human capital resources; any social and political issues.	(6) One factor which could affect profitability would be cost of raw materials. (7) One factor which could affect profitability would be labour costs. (8) One factor which could affect profitability would be safety laws. (9) One factor which could affect profitability would be product demand and price. (10)In relation to pt (6), long term contracts could reduce impact of feedstock and product price fluctuations. (11) In relation to pt (7), salaries in Brunei are reasonable and additional labour is available from other Asian countries at reasonable costs. (12) In relation to pt (8) safety laws in Brunei are acceptable but not excessive, whilst environmental laws are "forgiving". (13)Brunei has many young, intelligent and qualified people suitable for employment at an oil refinery. (14)Competition for jobs is increasing in Brunei, so it is likely that the company would be able to choose top employees at reasonable cost. (15)Brunei employees are more likely to remain with their company than employees in some other countries, so staff retention should be very good. (16)Brunei is socially and politically stable, so it is unlikely that the refinery will be affected by outside influences (war etc).
ADDITIONAL	If additional points are raised which you feel are valid information or arguments, you may allocate an extra point.

Appendix C: Student Questionnaire

Student Questionnaire 1

STUDENTS' EXPERIENCES MARKING COURSEWORK USING A RUBRIC

We are interested to find out students' learning experiences at Universiti Teknologi Brunei (UTB) and would like to know a little more about your experiences and how you found today's exercise marking peers coursework using a rubric. There are no right or wrong answers in this questionnaire, and all the information gathered will be dealt with in a confidential manner.

1. **Personal Information**
   a) Course (FD or PE): _____
   b) Gender: □ Male □ Female
   c) What is your mother tongue/first language?
   □ Malay □ English □ Chinese □ Others, please state: _____

2. **Questions**

Please tick (√) your level of agreement on the following statements. Please answer every item by giving your immediate response.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree or Agree	Somewhat Agree	Agree	Strongly Agree
I have undertaken peer assessment previously.							
Peer assessment is a worthwhile activity.							
Giving feedback to my peers is very difficult.							
I feel that my peers have adequate knowledge to evaluate my work.							
I feel that peer assessment is helpful to my learning.							
Giving feedback to my peers is useful to me.							
I would prefer not to do peer assessment on others.							
I prefer peer assessment rather than lecturer's feedback.							
I learnt something through performing peer review.							
Peer assessment activity motivates me to learn.							
I took a serious attitude towards marking peers' work.							
I felt that I was critical of others work when marking it.							

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Disagree or Agree	Somewhat Agree	Agree	Strongly Agree
When marking the coursework, I focused on the task at hand, and did not find my mind wandering to how my own coursework was being marked.							
I learnt something further about the subject through marking coursework using the rubrics.							
Having used the rubrics, I now have a better understanding of what was expected in the coursework							
Having marked coursework using a rubrics, I now have a better understanding of what is expected of me during coursework.							
I think that the rubrics was written in a clear manner which allowed me to accurately access the work.							
I think that the presentation given at the beginning of the class on how to use rubrics prepared me well enough to assess the work.							
I think rubrics based peer assessment is a fair method to assess student's performance.							
I found the rubrics for the coursework confusing.							
I would like more assessment run in this manner in the future.							

3. Additional comments

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