

A CRITICAL EVALUATION OF AN ONLINE PEER ASSESSMENT SYSTEM (OPAS)

N.L. Clarke^{1,2} and P.S. Dowland¹

¹Centre for Security, Communications & Network Research, University of Plymouth, Plymouth, UK

²School of Computer and Information Science, Edith Cowan University, Perth, Western Australia
info@cscan.org

Abstract

The method of assessing knowledge and understanding can vary, with new approaches being developed periodically. Although traditional methods such as exams, essays and oral presentations still form the backbone to many undergraduate assessment programmes, much focus is being given to newer techniques that are able to more effectively assess a student's abilities. Peer assessment is one such technique that enables the learning process to go beyond summative submission and incorporates the assessment into the learning process itself. This approach however, has traditionally included a large manual overhead for the academic and the student. This report describes a study into the application of peer assessment using online resources, which seeks to evaluate the feasibility of the approach. The online nature of the implementation meant much of the manual overhead was removed. An end-user evaluation was undertaken with 136 students. On completion of the exercise 90% of respondents had a positive experience, with 79% having learnt something new from the process.

Keywords - Assessment, peer assessment, web-based, OPAS

1 INTRODUCTION

Assessment forms a key component of module and course design. With students' learning increasingly driven by the assessments, it is imperative to ensure that assessment is aligned with the intended learning outcomes [3]. There are a wide variety of assessment methods, with the use of many being dependent upon the scenario in which the assessment approach needs to be used [11]. One deficiency with the majority of assessment approaches is the lack of critical examination of submitted assignments by the students, with many students simply taking a note of the mark. In addition, the level of feedback provided to the student by the assessor can vary in both content and relevance, with feedback often being short, generic and impersonal [5].

Peer assessment is one method that assists in ensuring the process of assessment does not merely finish at the submission stage, and assists in providing to the student a greater awareness and understanding of the assignment problem. By having students read and mark their peers' work, students are not only able to gain an appreciation of the level and content others are submitting in relation to their own, but more importantly it will help to fill the gaps in their knowledge and understanding. Even for students who perform very well, it is likely that gaps will still exist in their knowledge which other students may have addressed, and if not, this process will still help in reinforcing what they already know. However, the use of peer assessment in higher education is an atypical form of assessment, with academics tending towards more traditional forms of evaluation [25]. Compared to other more traditional forms of assessment, peer review is often regarded as an innovative assessment method which offers a number of advantages over prior approaches, such as [7, 25, 29]:

- Improving motivation by giving a sense of ownership to the assessment process
- Encouraging responsibility for their own learning
- Encouraging deep rather than surface learning
- Practising the transferable skills needed for life-long learning
- Treating assessment as part of the learning process, and continuing to learn beyond the point of submission

Although, peer assessment has been around and in practice for some time, its application as an online resource is somewhat newer. A review of online peer assessment systems at the conception of this project found few examples, with the majority being fairly bespoke implementations [18, 26]. It was

therefore necessary to design the system in-house to meet the specific requirements of the Faculty. This paper outlines this system and an end-user evaluation of it and of peer-assessment itself.

The outline of the paper is as follows. Section 2 presents background literature on on-line peer assessment and Section 3 describes the design and operation of the On-Line Peer Assessment System (OPAS). Sections 4 and 5 present the experimental methodology and results from an end-user evaluation, with Section 6 discussing the findings. The conclusions and future work are presented in the final section.

2 PRIOR PEER ASSESSMENT SYSTEMS

It is not the purpose of this section to justify peer assessment as a legitimate assessment approach. Previous studies dating back 50 years have sought to better understand the numerous pedagogic arguments for and against its use, with issues such as reliability, validity, collusion, student dislike and mistrust, time savings, improved grades and feedback all having been investigated [1, 2, 4, 6, 7, 9, 10, 12, 15, 16, 19, 20, 23, 27, 28, 32]. From an analysis of these studies and current practice, it is possible to conclude that whilst peer assessment has been around for some time, it has yet to reach the mainstream of assessment approaches. The purpose of this section is to review past and present peer assessment systems.

Prior to reviewing the literature it is worth highlighting two differing aspects or modes of peer assessment that are frequently interlinked. Peer assessment can operate in either:

1. Between (inter) group peer assessment. An individual assesses another individual/group assignment against the pre-defined assessment criteria.
2. Within (intra) group peer assessment. An individual assesses the contribution of other group members within their own group. This assessment provides a weighting measure to ensure all members of the group receive a proportion of the marks that is felt appropriate by the group.

An analysis of the literature shows a number of inter-group peer assessment systems were developed: Computerised Assessment with Plagiarism (CAP) [9]; Calibrated Peer Review System (CPR) [22]; NetPeas [24]; Oasys2 [34]; QPPA [35] and OPAS [31]. Whilst reviewing the state of technology in early 2004, only the Calibrated Peer Review System has the necessary functionality – in terms of what and how they assess. The system required students to assess three scripts that had already been marked and purposely selected to reflect low, medium and high quality. Once the students had understood how their assessment compared to the academic, they were given three further anonymous scripts to assess. Whilst the system operated in the fashion required for inter-group assessment, it unfortunately does not operate in the second mode of intra-group peer assessment. Moreover, the system is under the control of developing author – rather than being a downloadable application one can control and therefore issues of data protection needed to be considered with storing students work on external resources.

The intra-group assessment mode has also been developed: Fair Assessment and Effective Reflective Learning (FAERL) [13]; OPAS [31]; Self and Peer Assessment Resource Kit (SPARK) [14]; and Espace [33]. Of the systems available, SPARK was the most appropriate to use in terms of functionality; however, the system relied on a number of licensable software components and suffered from an over-complex software design for simple integration into the Institution's existing infrastructure. For these reasons, it was necessary to design and implement a bespoke solution that integrated both aspects of peer assessment into a simple 3-tier web application that was not dependent upon numerous software licenses and components.

3 FUNCTIONAL OVERVIEW OF OPAS

The on-line peer assessment system (OPAS) was developed by the authors following both a review of the requirements of a number of staff seeking to apply peer assessment in their modules and an evaluation of the functionality available within a variety of opensource, freeware and commercial peer assessment packages. Although a number of solutions were available (as described in the previous section), none provided both the breadth of features required and the ease of integration with the university's IT infrastructure. Of particular importance was the ability to facilitate both modes of peer assessment within a single environment and to integrate with a Windows Active Directory Service (ADS) to access student records (module membership).

The authors developed a solution in ASP running on a Windows Server 2003 platform, itself hosted on a virtual server platform within the university's IT server farm. This provided a stable and secure, centrally managed server architecture while still allowing full control of the applications and services running on the server. Student data is stored in a MySQL database which is backed-up on a nightly basis both to the local hard disk (for immediate restoration) and to a centralised backup facility for longer-term archiving. In addition to the application logic (implemented in ASP) ADS integration is facilitated by LDAP lookups via PHP scripts (to provide secure login against the main university user records and to access lists of module enrolments via ADS groups).

The main operation of the OPAS system is fully web-driven with staff and students accessing the system via a standard web browser. The system is designed to be intuitive and follows a simple wizard process guiding users through the various stages of peer assessment (as illustrated in Fig 1 - noting that steps 2 and 3 are only applicable to inter-group assessment).

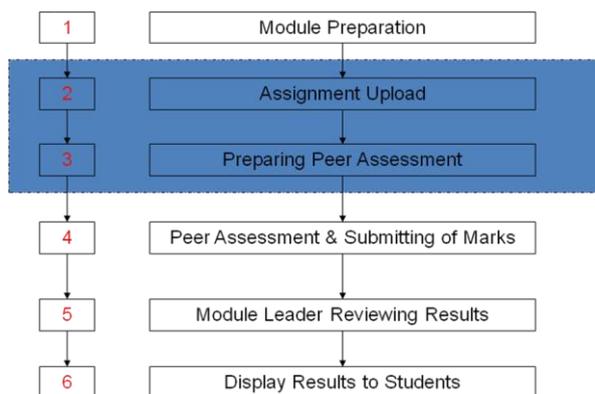


Fig 1. Student assessment process

Fig 2. OPAS staff user interface

Module Preparation: the module leader sets up the module by defining various customisable prompts; assessment criteria; example files (where required); importing student details from the university ADS; and, finally linking students into groups.

Assignment Upload: students participating in a inter-group assessment submit their group work to the server via a simple file upload. This allows a single upload per group and immediately notifies other group members once this is complete (as no further submissions are allowed).

Preparing Peer Assessment: the module leader assigns reports (via automated wizard) to the students. This typically involves each student marking the work of 3 groups, depending on group size this usually results in group assignments receiving 8-10 assessments from distinct students.

Peer Assessment/Submitting Marks: the students undertake either 1) anonymised assessments of group work (inter-group), or, 2) evaluation of their own group members' contribution to their assignment (intra-group).

Reviewing Results: the module leader evaluates the assessments. In inter-group this will require a check that students have marked work appropriately (not simply assigning fixed percentages, e.g. 100% or 0%, to all pieces of work) as well as checking that in each the range of marks for each group seems reasonable. For intra-group assessment, this will involve checking that group members participate in the marking process and that any penalisation is accompanied by a suitable explanation (via the comments section) – again checking that students are providing appropriate, considered assessments. This process allows for staff moderation of marks at both an individual, group or cohort level.

Display Results: Once all checks are complete, the final results can be released back to the students. In inter-group mode, the system shows an average across all markers for the student's group together

with anonymised feedback from all markers. In intra-group mode, the student sees the lecturer assigned mark (the mark for the work submitted), the calculated percentage “contribution” to the module and the final mark (staff mark adjusted by the “contribution factor”). This is also accompanied by the anonymised feedback.

Manage student prompts

Use the form below to edit the content displayed to students for each section:

Edit the text prompts for the

Use the following form to edit:

Peer Assessment of Individual Contributions to Team Project

Each team member must undertake an anonymous peer assessment of the other members using this web site developed by Dr Paul Dowland and Dr Nathan Clarke from the Network Research Group. This site is available both on and off campus, full directions on the process of using this site will be given during lectures. This peer assessment of individual contributions to the team project must be completed electronically and has the same deadlines as the group reports. Failure to complete the peer assessment by an individual will result in the loss of 10% of that person's overall mark for the Team Project.

Peer assessment will be performance based, not personality based. It should, principally, be based on:

- Individual performance
- Contribution to the group effort
- Reliability as a team colleague

Fig 3. Editing “prompts” shown to students

Performance in routine tasks out of 5

- Did not contribute: 0;
- Token contribution: 1;
- Willing but not successful: 2;
- Average: 3;
- Above average: 4;
- Outstanding: 5

Synthesis/consolidation (drawing things together) out of 5

- Did not contribute: 0;
- Token contribution: 1;
- Willing but not successful: 2;
- Average: 3;
- Above average: 4;
- Outstanding: 5

Ability in tackling and sorting out problems out of 5

- Did not contribute: 0;
- Token contribution: 1;
- Willing but not successful: 2;
- Average: 3;
- Above average: 4;
- Outstanding: 5

Comments/Feedback

Fig 4. Student assessment interface

4 METHODOLOGY

The study sought to evaluate the feasibility of delivering an on line peer assessment system to students. Although predominately the study was concerned with the students’ attitudes and opinions towards online peer assessment, the usability, friendliness and security of the website application was also of interest. To this end, it was decided that the best method for achieving this was through the practical development and implementation of the system, with students interacting and using the system in a real and purposeful implementation. To meet with University regulations when using participants this project submitted and received the required ethical approval.

The current system as outlined in Section 3 has been in operation for 3 years and has serviced 33 modules and 1700 students in the Faculty of Technology at the University of Plymouth. Whilst the system has specifically been designed to operate in two peer assessment modes, the purpose of this evaluation only the inter-group peer assessment mode was evaluated. Further research will investigate the effectiveness of the intra-group assessment.

It was made clear to the students from day one that although participation in completing the feedback about the peer assessment system was optional, as required by the ethics board, participation in the peer assessment system itself was not and formed a mandatory element of assessment for the module. Although no marks were awarded for completing the peer assessment, for each report they failed to mark appropriately they would be deducted 10%. The word ‘appropriately’ was used to make it clear to students that marking all reports with a 100% or 0% would not be seen as appropriate – a problem that colleagues had identified when trying to introduce peer assessment. This use of this penalty performed well, with none of the students failing to comply with the peer assessment.

In order to establish students’ attitudes and opinions towards an online peer assessment system, a series of questionnaires were developed. The use of questionnaires over techniques such as focus groups and interviews was felt appropriate to obtain the level of feedback from a large population of people. The option of using focus groups at the end of process was left open depending upon the level of feedback obtained. Initially it was envisaged that two questionnaires would be required:

- A questionnaire prior to completing the peer assessment, to gauge attitudes and opinions of various forms of assessment and in particular peer assessment. The questionnaire also asked questions regarding the level of feedback traditionally received.
- A questionnaire subsequent to the peer assessment which sought to identify how they felt towards online peer assessment and whether their attitudes and opinions had changed since completing the process.

However, as the second questionnaire was completed online immediately after completing the peer assessment but prior to the results being made available (in order to maximise responses) a third questionnaire was required. This also assisted in ensuring that the students response in the second survey were not prejudice based upon the marks they were awarded.

- A questionnaire seeking to find out what level of feedback was provided as a result of the peer assessment. Did the students find this feedback more comprehensive and constructive than was typical?

Upon drafting these questionnaires, all were tested using a cohort of local PhD students, to ensure that the individual questions made sense, and were not being misunderstood.

5 RESULTS

The students were given the voluntary opportunity to complete the questionnaires and a total of 296 responses were received across the three surveys. Table 1 illustrates the breakdown of respondents per survey, including by age and academic stage the respondent was in. Unfortunately, this demographic information was mistakenly omitted from the final survey. Nevertheless, the findings from the first two surveys illustrate a good cross section of students completed the survey, with a slight skew towards the older and (arguably) more established learners at final stage and MSc level.

	No. of Respondents	Age Group of Respondents (%)		Academic Stage of Respondents (%)		
		17-21	Older than 21	Year 1	Final Stage	Master's
Pre-Peer Assessment Survey	83	36	64	24	38	38
Post-Peer Assessment Survey	136	29	71	13	47	40
Post Feedback Survey	77	-	-	-	-	-

Table 1. Levels of participation and age demographics

The remainder of the analysis is presented in each of the corresponding sub-sections according to the surveys so that an appreciation of the changing attitudes and opinions can be obtained as the student completed the peer assessment process.

5.1 Pre-Peer Assessment Survey

An analysis of the assessment approaches previously undertaken by respondents, as illustrated in Fig 5, found that at least 70% had experienced all of them except that of peer assessment where only 31% respondents had previously undertaken it. Anecdotally, follow up discussions with students found some had experienced paper-based peer assessment but few (if any) had experienced online-based peer assessment.

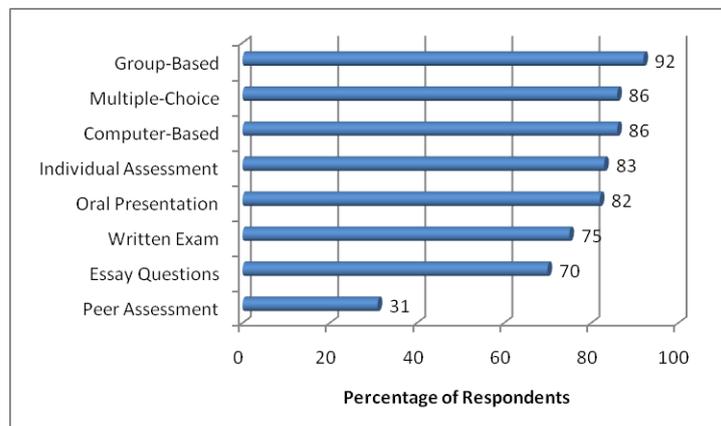


Fig 5. Experienced assessment approaches

Interestingly, of the 31% that had undertaken peer assessment, 88% had found the experience to be positive. Moreover, when asking all respondents to rank in order their preference towards the principal forms of assessment, peer assessment came out mid-table after computer- and multiple-choice tests but before oral presentations and essay questions (as illustrated in Fig 6.). Given only a third of the students had experienced peer assessment, the proportion of respondents ranking the approach favourably indicates that they either have a preference towards an assessment approach they have not experienced to date or more likely have a particular dislike for some forms of assessment.

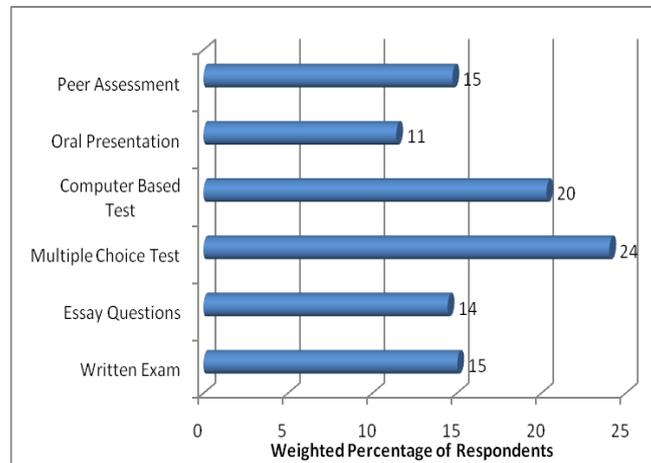


Fig. 6. Weighted preference towards assessment approaches

Note: The weighted average was calculated by multiplying Rank1 by 6, Rank 2 by 5 and so on and summing the result for each approach.

An analysis of the comments made when asking their reasoning behind the ranking revealed a number of interesting aspects: the perception that multiple-choice tests are quicker and easier than other forms of assessment; a preference towards written exams as they are individually-based and therefore permit more competent students to do well; a dislike of written exams as they find them very stressful; and a lack of confidence when giving oral presentations. A re-occurring comment throughout was their preference was based largely upon experience.

The survey then proceeded to ask several questions that sought to understand whether peer assessment would be beneficial to learners and to provide a baseline for comparison against their attitudes after undertaking the peer assessment. A key requirement for peer assessment to operate effectively, where each of the assessments is marked by 10-15 students, is to operate the assessment in group mode. 43% of respondents favoured group work. When asking students about their preference, a number of common themes kept appearing in their responses:

“More minds working on 1 document tends to produce a better document. People notice things you’ve missed, you notice things they would miss, etc.”

“Group based work, allows me to develop my team workin skills, learn people management techniques.”

“Bouncing ideas off eachother is a very effective method of problem solving.”

“In an educational point of view i’d not like to depend on other students. Your partners may not want to do the work, or prefer to leave the work until a later date or do not put much effort in which makes my job harder.”

“In a group, certain members may hold up work considerably, causing friction and upset to other group members. Personal experience in this and other group work modules have proved this.”

“Often I find that some members of the group do not contribute and let the group carry them through the module.”

Another key advantage of peer assessment is the level of feedback that can be obtained – as there are a larger number of assessors. As illustrated in Fig 7, the respondent group felt that overall the Institution was providing a reasonable level of feedback, with 50% stating a good level. However, a third only thought the feedback was adequate and only 13% thought it was very good.

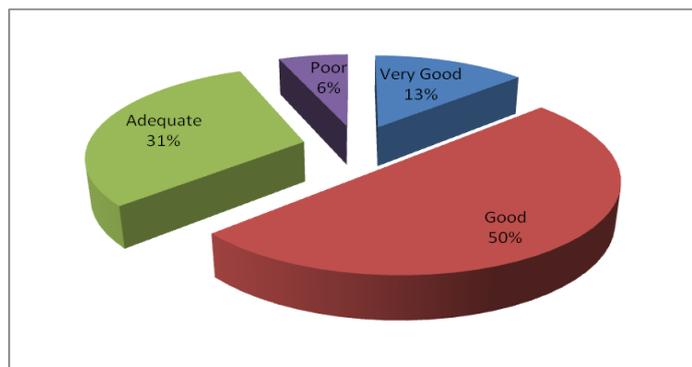


Fig 7. Perceived level of feedback being provided by the institution

Furthermore, breaking feedback down into specific areas, it can be seen that whilst feedback can be improved throughout, two-thirds generally thought the feedback was constructive, clear and helpful. Unfortunately, a far smaller proportion felt the feedback was comprehensive in nature.

	Comprehensive	Constructive	Clear	Helpful
Yes	47	67	67	65
No	7	6	4	6
Uncertain	46	27	29	29

Table 2. Perceived level and type of feedback being provided by the institution

Encouragingly 93% of respondents stated they would read their feedback; but a far smaller proportion (40%) would bother discussing it with their tutor. Therefore, what feedback they received is obviously key to their understanding of what was good within their work and what areas need improving upon.

5.2 Post-Peer Assessment Survey

The post-peer assessment survey sought to understand what the respondent's attitudes and opinions were towards this specific online-based peer assessment system. Overall, 90% of respondents found the experience to be positive – whilst this is in-line with the 88% of respondents who had previously encountered peer assessment and found it positive, it is worth pointing out that this result actually accounts for a significant increase in actual learners (from 26 in the first survey to 122 in the second) and is specifically orientated towards the use of an online system of peer assessment.

The respondents were asked to comment upon their selection – the common topics are extracted below:

"It is good to see how other groups tackled the problem. also good to see how different groups structure their work."

"Interesting to see how other people construct their documents and read about the areas they covered."

"I feel I learnt something from marking my peers reports."

"Gave me an in-sight into the crap that lecturers have to mark. My reports in future will be more professionally written."

"I can compare my work with others assignment and understand my standard."

"The process has provided me the opportunity to see the quality of work coming from others set the same task. Therefore allowing better comparison to my own work, showing ways in which I can improve and also mistakes to avoid."

"Although it was useful to read others work, there were obvious problems with reports, of huge proportions (like people who completely missed the point of the report) this is a problem as if they are marking my work maybe they will assume that my group misread the assignment."

"I feel that i am not a lecturer and i do not have enough experience in marking to have the responsibility of marking peoples work. This is the final stage of our course and my marking could potentially bring down much needed percentages points."

Generally, the comments portrayed a positive perspective and typical of the types of learning objectives previously documented to be achievable with peer assessment: understanding the standard of others work; understanding how others tackle the problem, structure the report; and showing ways in which they can improve their own work and avoid making mistakes.

Asking the participants specific questions regarding the peer-assessment system itself found it had generally received a positive response. As illustrated in Table 3, respondents on the whole found the system easy to use, logical and understandable; with a small percentage of users experiencing problems with the system. Further analysis of the results found these incidents revolved around issues with the server timing out mid-way through an assessment. Whilst the students were instructed to read the assessment fully prior to uploading marks, some uploaded marks whilst reading the assessment. If this took longer than 20 minutes, the server would time-out and the marks would be lost – resulting in the student needing to upload the marks again.

	Easy to Use	Logical	Understandable	Any Problems
Yes	96	88	96	7
No	2	4	2	93
Uncertain	1	8	2	0

Table 3. Usability of the peer assessment system

With regards to the difficulty in performing the assessment and providing feedback, respondents on average found it relatively easy with 56% and 59% selecting 1 or 2 on a 4-point scale of difficulty with 4 being difficult. The breakdown of participant responses is illustrated in Fig. 8 and Fig. 9.

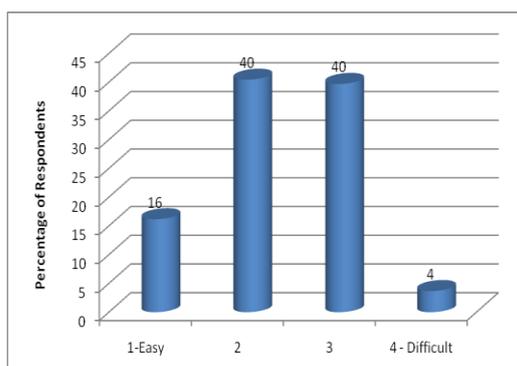


Fig 8. The level of difficulty in marking the assessments

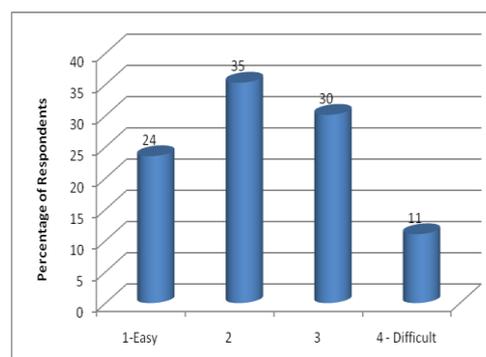


Fig. 9. The level of difficulty in providing feedback for the assessments

When asking the respondents to re-list their order of preference towards the assessment approaches, in order to appreciate whether anything had changed since completing the peer assessment, the results showed that no change in ordering had occurred. This is particularly encouraging for the use of peer assessment. Additionally, when asked if they would undertake peer assessment again, 65% responded they would.

5.3 Post Feedback Survey

The final survey sought to understand participant's attitudes towards the overall process of peer assessment once feedback and the grades had been released by the system. Table 4 illustrates their response on the level and type of feedback they received. Notably, in comparison with the same question pre-peer assessment, the level of constructive feedback has reduced by 7% but the comprehensive nature of the feedback has increased by 13%. Further analysis of the results indicates that for the comprehensive nature of the feedback, the majority of the change in attitudes has come from the "Uncertain" category rather than moving from "No" to "Yes".

	Comprehensive	Constructive	Clear	Helpful
Yes	60	58	68	60
No	10	12	10	10
Uncertain	30	30	22	30

Table 4. Perceived level and type of feedback being provided by the peer assessment system

When analysing the overall level of feedback being provided, as illustrated in Fig 10 it can be seen that 42% of the respondents felt they were receiving a greater level of feedback than they usually obtain – with only 14% stating they received less. A manual analysis of the feedback revealed respondents across the board were certainly receiving more feedback in terms of volume than they usual would; the usefulness of the feedback did vary depending upon the assessor's willingness to provide it.

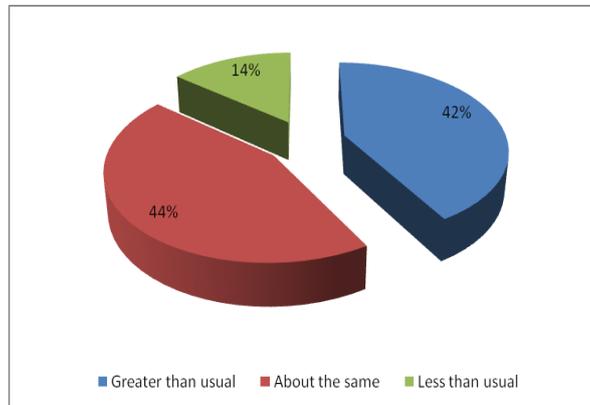


Fig.10. The level of feedback provided by the peer assessment system versus normal assessments

Final questions in the survey asked whether they felt the mark they received was fair, whether peer-assessment was fair and whether peer-assessment had helped them to improve their understanding of the subject domain. 70% and 61% of respondents considered their mark and the peer-assessment process to be fair. Encouragingly, 79% of respondents felt the process had enabled them to improve their understanding of the subject.

6 DISCUSSION

On the whole students have responded very receptively to the online peer assessment system, with many having never experienced this form of assessment previously. From the feedback received by respondents students found marking the assignments and providing the feedback relatively straight forward. It was also noticed that the level and relevance of the feedback also varied between students, with some providing detailed and comprehensive feedback and others writing just a few words. Whilst students were penalised for not providing feedback, it would be difficult due to the subjective nature of the feedback to establish a penalty for not being comprehensive or constructive. This resulted in a minority of students providing poor levels of feedback. Further focusing upon the importance of feedback at the outset of the process might improve this.

Some students had felt they gained little from the experience and although they were in the minority, this is unfortunate. The reasons for this cannot be concluded from the feedback that was obtained during the data collection; however, it can be suggested that even though students may not have learnt anything new, having undergone the process itself will have helped in reinforcing their understanding and knowledge of the subject area. Although the use of focus groups might have proven useful to obtain some additional insight into this particular area, the time scales were not sufficient to do so, and it was felt prior to the analysis that the questionnaires would provide sufficient information.

During the peer assessment itself, two students in particular were concerned about how to mark a report (but others have also indicated this in their feedback). This particular student found it difficult to mark as the students concerned had used a technology that he had no knowledge of. To compound this problem, although anonymised, the student had recognised whose report it was, and was worried about not marking the report appropriately. After a brief discussion regarding the technologies the students had utilised, in addition to making him aware that these reports were being marked by multiple people, so therefore any anomalies that existed in marking would be smoothed out, he felt more confident about the report. This does however raise an interesting concern regarding the need to have an open exchange of information between the students and the academic before and during the

peer assessment exercise. The aim of the exercise is not to add additional stress to the student but to help reinforce their learning. Overall, this aim was met with 79% of the respondents feeling that had increased their knowledge and understanding as a direct consequence of the peer assessment. Encouragingly, the comments made by respondents in the post assessment questionnaires had implicitly made reference to many of learning outcomes that one would hope students gained from this type of assessment method (i.e. a sense of ownership and responsibility over the assessment process, deep rather than surface learning and treating the assessment as part of the learning process). Students felt the peer assessment had lifted the mystery surrounding the marking process and given them an insight into how they can use marking criteria as a guide to focussing their work.

The use of online resources in providing this peer assessment removed much of the manual processing required for this type of assessment. The majority of students felt the web application was logical and easy to use; however, a small number of respondents had experienced some sort of problem in using the website during the assessment exercise. These problems turned out (for the most part) to be due to unforeseen usability issues (i.e. students using the website in a manner not predicted when designing the application). For instance, students were attempting to submit a mark for a report after the web applications session variable had timed out, and therefore was unable to submit a valid result under their name. An increase in the timeout variable solved this issue. An interesting point to note is that no matter how well you test the web application, it will always tend to be used in a manner you had not predicted. Subsequent reviews of the peer assessment system will enable incremental modifications to be made to the application, making it more robust, stable and user friendly.

7 CONCLUSIONS & FUTURE WORK

The use of an online peer assessment tool has been a positive and successful learning experience for most. Students have felt that they have increased their knowledge and understanding of the topic as direct consequence of the peer assessment exercise. The findings of this study are inline with a number of previous studies that have identified peer assessment as a valuable tool within an academics assessment strategy. The amount and level of feedback provided by the students is also key in understanding what aspects of the work they understood and moreover the lack of feedback perhaps indicating areas that they did not, and therefore need focusing upon for future groups.

Providing the peer assessment as an online resource has removed much of the paper traditionally associated with this approach. The system has specifically been designed to compass the two forms of peer assessment on an open platform, using standardised technologies with minimal licensing implications. The usability of the system itself has been carefully considered from the outset; however, further work needs to focus upon the design of a more inclusive web-front end that conforms to all accessibility and compliance standards.

8 ACKNOWLEDGMENT

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