Electronic peer review: A large cohort teaching themselves?

Michael de Raadt
Department of Mathematics and Computing
University of Southern Queensland

Mark Toleman
Department of Information Systems
University of Southern Queensland

Richard Watson
Department of Mathematics and Computing
University of Southern Queensland

Abstract

Electronic peer review can empower lecturers of large courses to produce rapid feedback, promote social interaction and encourage higher order learning for students. But what are the payoffs to educators? Do students recognise the benefits of such a system? Foundation Computing is one of the largest courses at the University of Southern Queensland. A system of electronic submission and peer reviewing with instructor moderation is now being used in this course. This system is innovative and unique and delivers benefits to students, lecturers and the University. This system has been evaluated, proven successful and is being considered for wider use.

Keywords

electronic peer review, rapid feedback, social interaction, higher order learning

Introduction

Peer review, online or in the classroom, is not a new pedagogical practice. The great advantage of peer learning is that it offers the opportunity for students to teach and learn from each other, providing a learning experience that is qualitatively different from the usual teacher-student interactions and which offers mutual benefits (Saunders, 1992). Peer learning can take on differing forms (Griffiths, Houston, & Lazenbatt, 1995; Anderson & Boud, 1996), from informal peer gatherings to mentor-mentee relationships. The Internet provides communication potential that can be used to improve teaching beyond delivery of course materials (Johnson & Aragon, 2003). McLoughlin and Luca (2001) suggest quality online education can be achieved by creating tasks that are authentic, involve social interaction with peers, and allow learner control with sufficient scaffolding.

Much peer review literature relates to assessing peers on contribution to work completed in a group. In online peer-review research, focus is often on online discussion, and involvement in discussion being used as a means of assessment (Prins et al., 2005). The system presented here is different as it creates peer review relationships for each assessment item. This allows students to give reflective feedback immediately after submission of their own work and reduces the delay from submission to feedback receipt. The system allows students to submit and review documents of differing formats related to the various applications that are studied during the course. Kurhila et al. (2003) present a system that allows students to create web (HTML) documents that are peer-reviewed but not peer-assessed. Student reviews in Foundation computing are used with instructor moderation for assessment purposes. Davies and Berrow (1998) used two word-processed reports in an MSc course covering computing for non-computing graduates. Students had electronic access to all their peers' first submissions and were expected to reflect on these to improve their own work for a second submission. In Foundation Computing electronic peer-review is applied to seven of eight independent assignments.

Aims

Foundation Computing is a computing concepts course that covers applications skills (one third) as well as theoretical aspects (two thirds). The course is run by domain experts and services students from various disciplines. Over three semesters in a year there are a total of around 1000 enrolments. Two thirds of students enrolled are external (studying at distance). All students have access to online facilities.

In the previous incarnation of the course, two paper assignments were assessed; a process that could take six weeks from submission to feedback receipt. Management and marking created a great cost burden for the University. Paper assignments were handled in two areas of the University before being logged to markers and returned by the reverse route. Introducing electronic submission can be seen as saving the equivalent of at least one person for one day per week when considering up to 600 students can be enrolled in a single semester. Previous teaching of application skills in the course relied on prescriptive materials that focussed on *how* to achieve specific tasks with specific software. Tutorials were poorly attended and students failed to understand *why* they were completing tasks. Many students failed to demonstrate conceptual understanding in the final exam as these were not clearly integrated with other teaching during the semester. Some students felt the course was not worthwhile due to prior computing experience.

The course was altered with the intention of delivering improved outcomes for students.

- **Regular assignments and rapid feedback**
  Using electronic means, submission and feedback delivery is almost instantaneous. An electronic peer reviewing system with moderation means students receive feedback, from multiple sources, in greatly reduced time. These factors allow for eight regular assignments consisting of focussed, learner-centred tasks. Electronic submissions which receive rapid peer feedback benefits external students with limited study time; it also provides flexibility for highly motivated students by allowing them to work ahead and still receive feedback within a reasonable time.

- **Authentic and personal tasks**
  Current tasks force students to discover how the real world of computing affects them personally. For example, students learn about word processing (an application) and computer hardware (covered theoretically) in the course; students are asked to deliberate on their computer hardware needs, then search online computer parts stores to discover the cost of such hardware. Using this information, students create a word-processed report on how their needs can be met and how much this will cost.

- **Higher order thinking**
  Higher order thinking can be encouraged through synthesising finished works and evaluating the works of others (Bloom, 1956). Students are required to complete reviews of two other students' submissions per assignment. Students evaluate and give feedback on their peers' completed tasks; this also promotes comparison between the work of their peers and reflection on their own.

- **Social interaction**
  Students are able to communicate through the course website. A list of users is displayed and is rarely empty of students who are online. The focus of course communication is the course Bulletin Board, where questions are asked and answered. Students are required to post a Bulletin Board message and send an email in their first assignment, which encourages later use of these facilities (and flags students who may require additional assistance). In remaining assignments, students electronically review other students' work and give feedback using a purpose built system. These aspects establish an online community of learning, reducing student isolation and further encouraging higher order thinking (Brook & Oliver, 2003).

The electronic submission and review systems, which replace the previous paper based assignment approach, greatly reduces cost of managing assignments, both in time and people-power. This benefits University staff, freeing them to focus on other tasks such as consultation.

Description of the innovation

During the semester students create word processing documents, spreadsheet documents, presentations and HTML documents. Students are introduced to an application then use that application to explore theoretical parts of the course. For instance word processing is introduced with a simple résumé task, then, in the next assignment, students write a report covering computer hardware using a word processor.

Students submit assignments electronically through a Web facility. To prevent submission to incorrect assignments, students must submit assignments in order. As students will see other students' solutions when completing reviews, only one submission is permitted per assignment. Students can (repeatedly) practice using the submission and review systems with a special assignment to build confidence before actual submission and reviewing. As deadlines are regular and frequent, heavy late penalties apply and late assignments are only accepted for five days after the due date. Students can work ahead by submitting early. Some students have completed all assignments during the first half of the course.

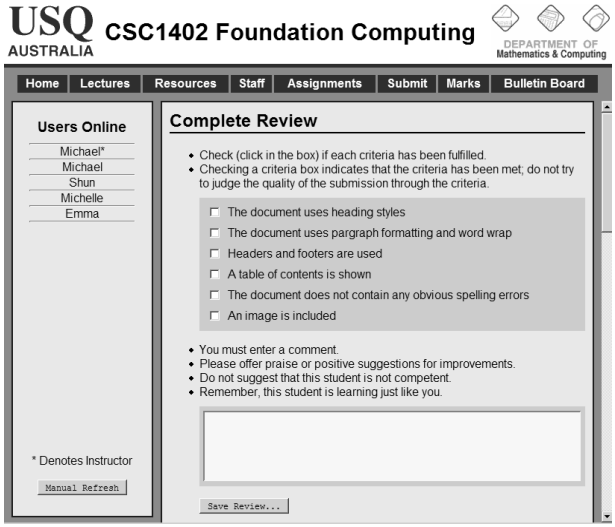


Figure 1: Review facility

After submission, students are automatically allocated two other students' assignments to review. Students are awarded marks for completing reviews. The first few students to submit must wait for other assignments to be submitted before they can review, and the system notifies these students by email when reviewing is possible.

Each student downloads and anonymously reviews the work of two other students based on set criteria using the facility shown in Figure 1. Students are required to give a comment and are encouraged to give praise and constructive criticism. Student reviews are used as the basis for marking. The success of the system relies on students being able to make consistent and fair reviews. To achieve this, criteria must be objective and easily discerned. Students must be able to correctly recognise whether criteria have been met in the work of a peer, even if they have failed to meet the criteria in their own work. Criteria focus on completeness of task rather than judgement of quality. Students are made aware of the criteria in the assignment specification, so they know how they will be reviewed before they submit.

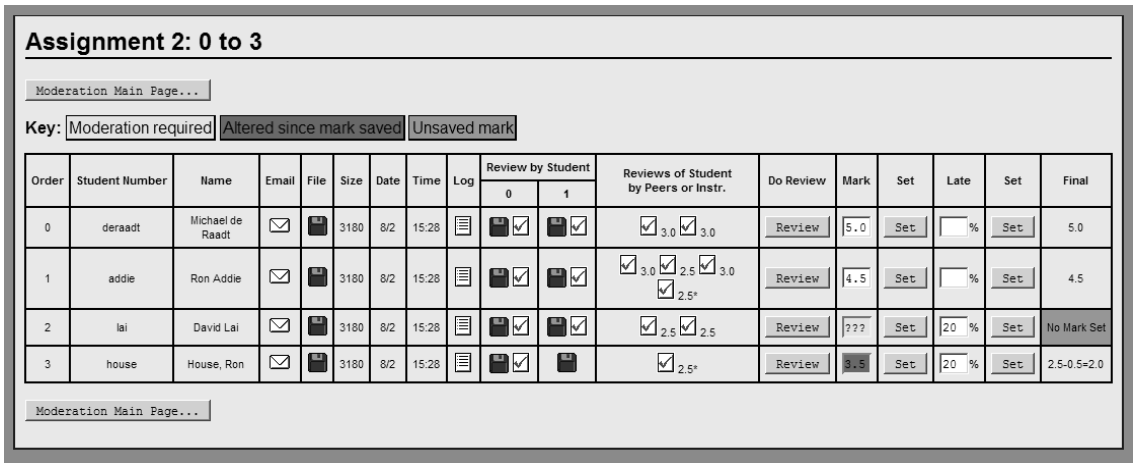


Figure 2: Moderation facility (false names used)

Where two reviews differ according to the criteria, an instructor moderates the assignment to give a definitive mark. Roughly one in every ten non-conflicting reviews are also moderated. Instructors utilize the same form students use for completing reviews, but employ a tabular interface to launch the moderation process as shown in Figure 2. Instructors performing moderation have access to a large pool of information about each submission, the student who submitted it and the students who reviewed it. This aids in detecting plagiarism and checking for possible collusion. Over the semester about half of all submissions are moderated. Consistency between student reviews improves as the course progresses.

Outcomes and evaluation

The system was piloted during the summer semester (November to February) 2004–2005 with 160 students. All students studying in the summer semester enrol externally. The system ran smoothly, without significant error throughout the semester, which is a feat in itself. One of the most pleasing results was the speed with which students received their first feedback (usually a peer review). Half of all submissions received feedback in 1hr 21min or less. There were exceptions as some students submitted well in advance of the deadline and at least three submissions must accumulate before any reviewing can commence.

Table 1: Time from submission to first feedback

Min	3min
1st Quartile	34min
Median	1hr 21min
3rd Quartile	4hrs 19min
90%	14hr 11min

Comparison of grade distribution with previous cohorts yielded little information that could be used for validating the new approach. With different lecturers, different grading styles and new course materials, it is difficult to attribute differences in pass-fail rates to the change in assessment approach. One interesting aspect was the reduction in the number of students who were enrolled for the entire semester but did not complete all assignments; this was down from 23.0% in summer 2003–2004 to 13.8% in the pilot semester of summer 2004–2005. This improvement in retention may indicate higher motivation caused by a more regular, real world, peer-assessed assignment model.

In the last weeks of the semester, students were asked to participate in a voluntary survey. The survey was conducted online and received a higher than expected response rate, perhaps due to students' experience of giving feedback during the semester. Ninety students responded to the survey, about 62% of the students who were submitting the last two assignments at around the same time. As well as collecting information about age, gender and an experience self-assessment, the survey consisted of 24 statements to which the students were asked to indicate their agreement on a five point Likert scale. Some of the statements were positive, such as "I would be happy to use the same submission and review facilities in other courses"; others were negative, such as "I did not receive enough support to complete the assignments". Some statements were designed to estimate participant willingness to adopt such technologies and such an approach to assessment in future (see Venkatesh et al., 2003). Other statements were used to elicit the students understanding of the potential pedagogical benefits of using this system. Participants had the opportunity to add comments.

Demographics

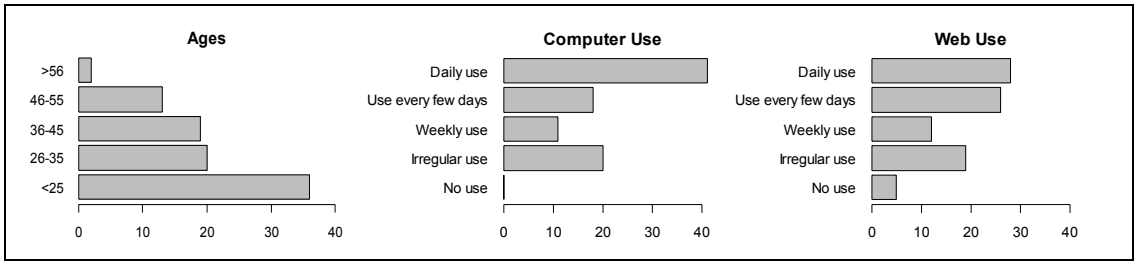


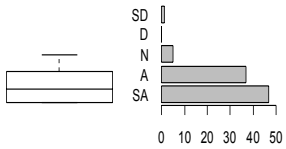
Figure 3: Age and Computer Experience

The participants were three quarters female and one-quarter male, which was representative of the students enrolled in the course. Figure 3 shows number of student responses to questions of age range and level of computer and Web use prior to commencement of the course. Students who participated in the survey covered a wide age range; 40% of participants were 25 or under, the remaining participants could be considered as 'mature aged'. All participants had used a computer prior to starting the course. Very few participants had not used the World Wide Web before studying in the course.

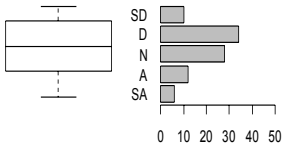
Each of the 24 survey statements is shown below with a summary of responses. Possible levels of agreement were *strongly agree* (SA), *agree* (A), *neutral* (N), *disagree* (D), or *strongly disagree* (SD). In summaries the number of responses to each level of agreement is revealed in the bar chart on the right. On the left of this the distribution of responses is exhibited using a box and whisker plot with a mean response indicated by the middle line, a single standard deviation shown by the boxes around this and two standard deviations shown by whisker lines.

Ease of use

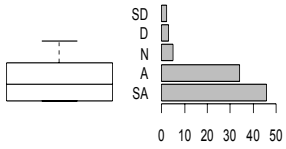
1. The process of uploading assignments was easy to follow.



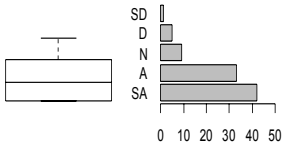
2. I felt limited by only being able to submit each assignment once. *(Negative)*



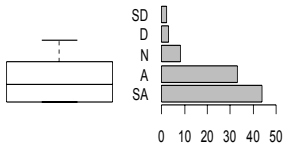
3. Submitting assignments electronically requires less effort than submitting an assignment on paper.



4. The process of reviewing other students' assignment submissions was easy to follow.



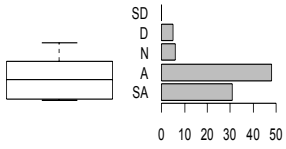
5. The review criteria were objective, which made reviewing simple.



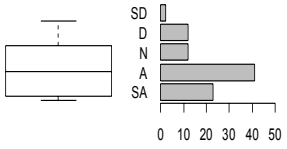
Participants strongly indicated ease of use in the process of submitting, the process of reviewing and applying review criteria (in statements 1, 4 and 5 respectively with agreement SA+A over 83% in each). This indicates that the facility was well designed and implemented. The vast majority of participants recognised that there was less effort in submitting electronic assignments compared to a paper submission (statement 3, SA+A=89%). A neutral response was given about being limited by one submission per assignment (negative statement 2, D+SD=49%, N=31%, SA+A=21%). There was a mechanism for dealing with accidentally submitting incorrect documents, which required lecturer intervention, but students were not told about this explicitly.

Benefits to learning

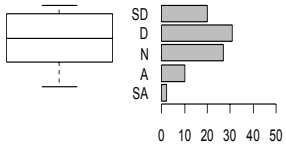
6. The assignments required me to reflect on my use and understanding of computers.



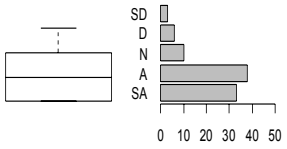
7. The assignments forced me to research and learn beyond the materials provided.



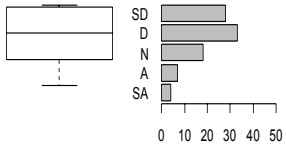
8. I did not receive enough support to complete the assignments. *(Negative)*



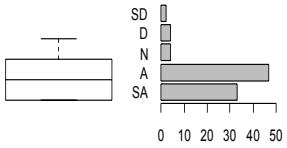
9. Completing regular assignments forced me into a regular pattern of study.



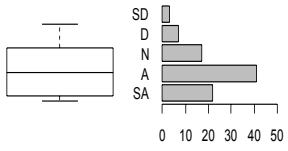
10. The assignments were too big and took too much time to complete. *(Negative)*



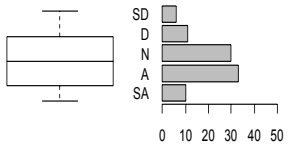
11. When I saw other students' submissions I compared them to my own work.



12. Through completing reviews of other students' work I developed a better understanding of the concepts covered in each assignment.



13. The feedback I received from my peers through reviews was useful to my understanding of each assignment.

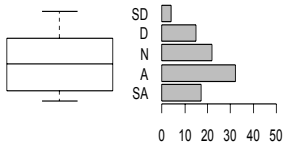


Most participants saw the system's learning benefits without any prompting. The assignments caused the greater majority to reflect on their computer use (statement 6, SA+A=88%). Completing regular assignments forced students into a regular pattern of study; most participants recognised this (statement 9, SA+A=79%, N=11%, D+SD=10%). A strong correlation was found between students with little prior computer/web use and those who reported being forced into a regular pattern of study (0.39, $p<0.05$). This may be because they were forced to use a computer more regularly to complete assignments, submit and review.

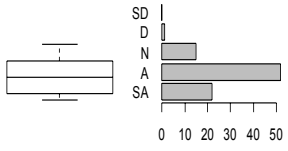
The same group was also correlated to a strong response in reflecting on their understanding of computers (0.28, $p<0.05$). Participants indicated completing reviews caused them to compare their own work with their peers' (statement 11, SA+A=89%) and through completing reviews, most students developed better understanding of concepts (statement 12, SA+A=70%, N=19%, D+SD=11%). The assignments forced most participants to learn beyond the materials (statement 7, SA+A=71%, N=13%, D+SD=16%), which was intended for most assignments. Participants were not prompted to suggest if they felt this was a positive or negative aspect of the course. Many participants were neutral about if there was enough support provided to complete assignments (negative statement 8, D+SD=57%, N=30%, SA+A=13%). The assignments were designed to encourage students to construct their own learning in several areas. Instructor assistance was provided through several means, but this response may indicate that many students expected a more prescriptive teaching approach. Participants indicated the assignments were not too large (negative statement 10, D+SD=68%, N=20%, SA+A=12%), however there were a reasonable proportion who did feel the assignments were too large. It is difficult to determine if these participants were responding from a learning perspective or from a workload perspective. One aspect that became apparent was that many participants were neutral about, or gave little value to, the reviews of their work conducted by peers (statement 13, SA+A=48%, N=33%, D+SD=19%). This may be because students felt the assessment of their work by peers carried little expertise (as indicated by some student comments) or that the amount of feedback or aspects reviewed were not sufficient using the review system.

Time

14. I worked ahead through the semester to get my assignments in early.



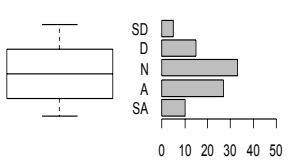
15. Feedback about my submissions came rapidly from peers and instructors.



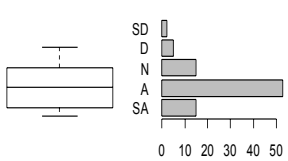
Some students did work ahead; most submitted on the due date. In comments from students, some said they liked the idea of being able to work ahead, but did not take advantage of it. Of course, working ahead was not required, but from students' comments, some participants misconstrued this statement as suggesting they should have been working ahead and were expressing that this was not required. The vast majority recognised the response time benefits (statement 15, SA+A=82%, N=17%, D=1%).

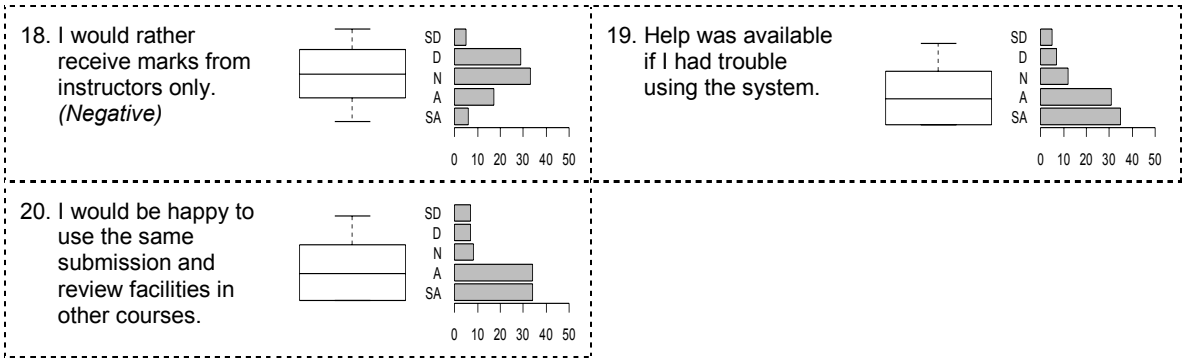
Quality

16. Feedback on my submission was as good or better than what I would expect on paper based assignments marked by hand by an instructor.



17. The reviews I received were fair and consistent.



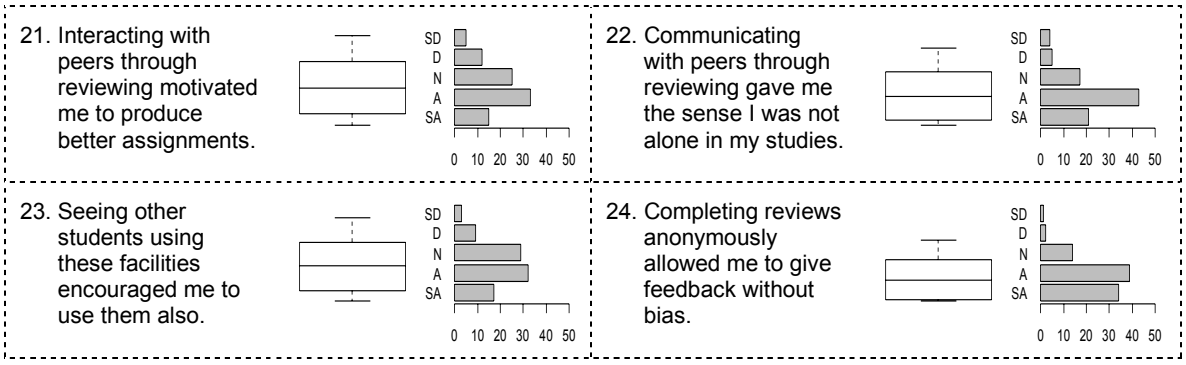


Participants expressed varied opions on whether feedback they received was superior to hand marking (statement 16, SA+A=41%, N=37%, D+SD=22%). While the system delivers rapid feedback from more sources and other learning benefits through reflection, it does not necessarily deliver better feedback than a hand-marked paper assignment. One goal of the system is to match the feedback quality possible with hand marking. Part of this feedback quality relies on students providing accurate reviews. Participant's responses varied widely about peer feedback compared to instructor-only feedback (negative statement 18, D+SD=38%, N=37%, SA+A=26%). It was noted during moderation that some students did not give useful comments or made errors during reviews. It is possible for a student to complete a review without viewing the submitted document by blindly checking all criteria boxes and leaving a comment such as, "Well done." Instances of this were discovered due to conflicting student reviews. One student had reviewing marks removed where it was obvious they had not made an effort to review their peer's work.

Most participants felt the reviews they had received were fair and consistent indicating the set criteria were objective and easily discerned (statement 17, SA+A=76%, N=17%, D+SD=8%). Most students felt there was help available if needed in using the system (statement 19, SA+A=73%, N=13%, D+SD=13%). Very few students requested assistance during the initial running of the system. This approving response is perhaps also indicative of the system's perceived ease of use.

Perhaps the biggest endorsement of this approach is most participants agreeing that they would like to use the same facilities in other courses (statement 20, SA+A=76%, N=9%, D+SD=16%). Some participants commented that this should definitely happen.

Interaction



One aspect of general technology adoption (commonly applied to business and industry settings) involves potential adopters witnessing colleagues, especially superiors, using the proposed technology. A majority of participating students in this study felt encouraged by seeing their peers use the system, but there was a large group who were ambivalent (as suggested by statement 23, SA+A=54%, N=32%, D+SD=13%). This may be because all participants were studying externally, not having face-to-face contact with their peers. This may also be an indicator of an approach to study that differs from an industrial/business setting or it may indicate that participants did not see their student peers as superiors. One might think that a student, knowing their peers would be reviewing their assignment, might be motivated to produce a better assignment submission. Again, a majority indicated that this motivated them; however, there was a large group who were neutral or not motivated (statement 21, SA+A=53%, N=28%, D+SD=19%). Perhaps participants were indicating that they would have produced assignments of high quality if only an instructor was marking them.

In order to encourage fair and unbiased reviews it is important that anonymity be maintained between the reviewer and the reviewee. The reviewer must be confident to deny marks or provide criticism where appropriate. The system did not identify reviewees to reviewers or vice-versa, however, in several cases, even though submission of anonymous work was encouraged, students identified themselves within the documents they submitted. Despite this, most students acknowledged they felt free to give comments without bias (statement 24, SA+A=81%, N=16%, D+SD=3%).

Participant responses showed it is possible to create a community in the setting described here (statement 22, SA+A=71%, N=19%, D+SD=10%). A feeling of community is essential to avoid to effects of isolation that a student can feel when studying independently at a distance.

Comments

Most comments were positive, reflecting responses to statements shown above. Only one student protested about peer reviews being used as part of the assessment.

> I think the review process is simply designed to get the courses examiner/tutors out of reviewing assignments.

It is surprising more students did not protest in the same way. Saving of time and people-power was an intended product of using the system, freeing staff for other tasks, such as student contact. Some students did not recognise the learning benefits of the reviewing.

> I don't believe the process of reviewing other students work is a valid or worthwhile process.

But this was outweighed by the number of students who apparently did recognise such benefits.

> the process of reviewing assignments was very helpful and a great teaching tool

The greatest weakness of the system is that it relies on students to give accurate and fair feedback, and this cannot always be relied on. Even with clear, objective criteria, instructor moderation and the potential to fix problems, students are still affected by bad reviews.

> I received one very pompous,negative review which,though the reveiw was incorrect,was disturbing and disappointing(received 5 marks from moderator).
>
> …sometimes the reviews were not done correctly - I had one where all of the criteria check boxes had been left blank, even though the comments said I had done good work and met all the criteria etc.

The assessment had changed from two quite large assignments to eight smaller assignments in order to encourage students into a regular, more focussed approach to study, and to discourage plagiarism by reducing the scale and value of each assignment. Some students perceived that eight assignments were too many, regardless of scale, and should have been valued more highly.

> …There seemed to be a lot of work involved in this subject for little gain. I felt that there were too many assignments and too little time to do them in.

Some students did not like peer reviews being used as a basis for marking, even with instructor moderation. The following comment was made by the contributor of the first comment in this section.

> This type of marking system is crap! As students we should not be subjected to peer reviews from other students. …Current course students do not have the expertise nor qualifications to take on this sort of review process. We, the students are not being paid a huge salary $$$$ for these type of duties…

Even with moderation of conflicting reviews and random moderation, it is possible that students may be overlooked and might not receive instructor feedback through the semester. It is important that students feel that an instructor is overseeing the marking of all assignments, even if they only moderate some.

> I didn't receive any feedback from instructors on my assignments - except for when I had two differing reviews.

There were several positive comments that showed set aims were being achieved.

> As someone who has done this course before,(and failed) the set out this time was much better, and doing the weekly assignments meant I was keeping on top of the readings, and made it a much more pleasurable experience.
>
> I found every second assignment I could do quicker as I knew my way around the computer a little more each time

Conclusions

Electronic peer reviewing can deliver benefits to students, lecturers and the University. Students profit by learning how to share documents, gaining experience in using online computerised facilities, evaluating other students' work, reflecting on their own work and, perhaps most importantly, becoming more involved in the course. Most students recognise the benefits of electronic peer reviewing. Instructors can experience reduction in marking load and gain potential to encouraging greater learning outcomes. The University benefits through less management of assignments at various levels.

The system used in Foundation Computing works well and is useful because students can submit and review documents in various formats and submission management is automated. By creating new review relationships automatically for each assignment, feedback to the student is rapid and the student receives feedback from more sources than normal. The system is therefore easily scalable.

Feedback from participants showed students found the system easy to use. Electronic submission requires less effort than submitting paper assignments. Reviewing prompts students to evaluate the work of other students and reflect on their own work, helping students develop a better understanding of course concepts. Regular assignments can force students into a regular pattern of study, particularly those with little previous computer experience. Using less prescriptive assessments can encourage students to construct their own learning, although some students do resist this. By providing clear and objective criteria, fair and consistent peer-reviews can be achieved. Peer reviewing can contribute to a community-focused environment and help to lessen isolation of students studying at distance. Most students would happily adopt this approach in other courses. Using the system does place constraints on students, for example, a single submission. Students need to feel comfortable about submitting, and know that a lecturer can easily — and without penalty — resolve problems that might arise. The value of reviews and comments made by peers is not valued highly by many students. Encouraging greater accuracy may raise this value. Students must feel they are being assessed regularly by course instructors, even if it is not apparent for all assignments. Students are not likely to be motivated by what their peers think when determining their willingness to use such a system.

The use of a peer-review system could be challenged as a valid means of assessing and teaching. The use of this system is justifiable from a pedagogical standpoint, and attempts to consider ethical and legal perspectives also. The system identifies conflicting reviews and the use of instructor moderation provides fairness and reliability, so no student is disadvantaged. Requiring students to make judgement on the work of their peers is a justifiable approach while students are benefiting from such interaction.

The benefits of the facilities and assessment approach discussed here are not apparent to all students. It is incumbent on course examiners to explain the benefits of the peer-review process to students. Examiners should admit that reducing marking load is a motivation for using peer-review and assessment systems. It is then possible to claim that time saved can be applied to more productive teaching. The benefits to the student from reviewing such as evaluation, rapid feedback and other aspects of the approach could be explained to students so they are more aware of why such systems are used.

Planned improvements to the reviewing system include:

- Adding the potential for students to identify unfair reviews or request more feedback.
- Tracking moderations to ensure all students get regular instructor moderation.
- Providing more guidance on how to write reviews.

Following the initial success of this approach, it has been adopted as the continuing model of assessment for Foundation Computing with great enthusiasm by the team that manage this course. The approach is being applied to both external and on-campus students. Where sixteen staff were previously required to run the course, a number far less is now used. With greater confidence in the system, and to reward the effort put in by students who participate in it, the value of all eight assignments has been increased from 40% to 56%, leaving 44% for an exam which the students must still pass to pass the course. The peer-review system shown here is being considered for use in other courses, including an introductory programming course.

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Author contact details

Michael de Raadt
Email: deraadt@usq.edu.au
Address: Department of Mathematics and Computing
University of Southern Queensland, Toowoomba, Qld, 4350, Australia

Mark Toleman
Email: markt@usq.edu.au
Address: Department of Information Systems
University of Southern Queensland, Toowoomba, Qld, 4350, Australia

Richard Watson
Email: rwatson@usq.edu.au
Address: Department of Mathematics and Computing
University of Southern Queensland, Toowoomba, Qld, 4350, Australia