An Online Peer Review System for Teacher Artifact

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Abstract: We describe the development of an online peer review module for the Moodle (http://moodle.org) course management system. We have designed the system to be quite flexible for many different methods of peer review. One important feature is a rubric authoring tool that allows instructors to create a table of criteria in an online form which students can use to submit their feedback. We discuss some peer review literature and then present some scenarios of use for this tool. We cover some design issues and how we addressed them and conclude with a discussion of evaluation and future work.

Introduction

We have developed an online peer evaluation tool to be implemented in an open-source, course management system, Moodle (http://moodle.org). Our project problem was how to best facilitate the peer review process online. This includes providing for the creation of a peer review assignment, with the option for an evaluation rubric. Students need access to the work to be reviewed, and they need to be able to submit peer reviews either through online rubrics, annotated documents, or both. Finally, the system should support follow-up processing of feedback by students and faculty.

The system is quite flexible and can be used by a broad audience in secondary and higher education, as well as professional development settings. Provided the necessary preparation of the learners, peer review can be valuable for any number of course related objects: review of literature, lecture annotations, problem and answer statements, animations of concepts, and lecture question/answer exchanges (Gehringer, 2003). For teacher preparation, lesson plans are an obvious consideration for peer review, along with other resources teachers produce, such as portfolios and any content they contain. The peer review module could be used for assessment of other educational artifact: textbooks, technology, or web resources.

Cross (1987) compared three methods of peer review: face-to-face, computer mediated, and combined. He found that students were able to independently create useful comments and that each of the three methods produced comparable reviews, demonstrating that alternatives to face-to-face methods can be equally useful. There are numerous reasons to support peer review for preservice and inservice teachers in an online environment. The learner audience is often distributed geographically, so physical meetings can sometimes be a burden and the time available can be short. Plus, we argue for the importance of increasing access for teacher community, to which online technology can contribute significantly- access to other teaching professionals as well as their knowledge artifact.

The literature review exposed a number of online peer review issues, particularly control of anonymity, evaluating peer feedback, and the quality of peer reviews. An important theme of the literature is that a central component of supporting peer review is a rubric students can use to support quality evaluations of each others' work. Our paper proceeds with a discussion of the literature and then some brief scenarios on how the system is used. We briefly cover some design and developmental issues, with our solutions or compromises. Finally, we discuss evaluation results and future work on developing and using the tool.

Peer Review Research

There is not a great deal of agreement in the literature on how to handle the peer review process. Indeed, there are quite a few differences of opinion as to the protection of anonymity, for example, or the evaluation of reviews. Nonetheless, the literature helps us frame our problem and the needs for the peer review tool.

Why Teacher Peer Review

The National Board of Professional Teaching Standards requires that "Teachers are Members of Learning Communities" (Five Core Propositions). How can teacher preparation programs best support this standard? One method is to use strategies informed by the theory of community of practice (CoP) (Lave & Wenger, 1991; Wenger, 1998). The ideal CoP is a "persistent, sustained social network of individuals, who share and develop an overlapping knowledge base, set of beliefs, values, history, and experiences focused on a common practice and/or mutual enterprise" (Barab, McKInster, & Schekler, 2004, p. 55). With participation in CoP, "teachers are better able to make and sustain improved instructional practices" (Hawkes & Romiszowski, 2001, p. 287).

However, establishing the necessary mutual engagement and interdependent relations to support CoP can prove challenging. Intentional CoP efforts appear to neglect the need of addressing socialization and reasons for participation, the socially "conscious community" (Palloff & Pratt,1999). As Lave and Wenger (1991) stress, establishing mutuality among members is impossible without access to community members and their artifact. Collaborative or cooperative activities seem an obvious strategy to increase access and mutuality. Since teachers share a common cause of educating our youth, it seems important to encourage cooperation and a sense of mutuality among teachers to better serve this cause. One method that improves interaction and mutuality of participants is formal and informal mechanisms of peer feedback (Jonassen et al., 1999; McAndrew et al., 2004; Moore & Barab, 2002; Pearson, 1999; Scardamalia & Bereiter, 1996; Wenger, 1998).

Peer review supports higher-level learning skills like synthesis and analysis (Davies & Barrow, 1998). A key factor in Davies and Berrow's study is to make student work available/accessible to peers' through the support of networked computers. The researchers found that through the process of evaluating the work of peers, students increased their self-evaluation skills. Students felt a strong sense of positive interdependence and individual accountability. There was little anxiety in making work public as one might expect. Students appreciated having access to the work of others in helping to determine standards.

Wolfe (2004) describes the benefit of students learning from peers and claims the possibility of getting instant feedback of greater quantity than a teacher could provide. According to Wolfe, "Students exercise and refine their ability to be critical reviewers, often gaining a better understanding of the grading process and making it easier for them to accept criticism" (p. 34). Wolfe explains that peer review allows the instructor to function as a coach or resource rather than judge and jury. Further, students develop community and appreciation of each other as professional colleagues. Problems were far fewer than one would expect. Wolfe had only a few cases (out of thousands of reviews) where reviews were too harsh or insulting, and these were quickly reconciled. Wolfe found a strong positive correlation between degree of peer review participation and performance, and there was a high level of student satisfaction with the peer review process.

Anonymity

Sullivan (1994) notes two paradigms for peer reviews, walkthroughs and inspections. With walkthroughs, reviewers are guided through the work by the reviewee, but with inspections, reviewers explore the material on their own without benefit of the reviewee's explanations. For a type of walkthrough, Sullivan describes egoless teamwork, where peer review is reciprocal with small groups reviewing each others' work to, theoretically, "level the playing field." But other researchers (Anderson & Shneiderman, 1977; Cross, 1987; Sitthiworachart & Joy, 2004) note this ideal can be difficult to meet, and there is a need to model and monitor the outcomes of the reviews. Online peer review would typically take the form of Sullivan's inspections, and because the reviewee does not have an opportunity to present or defend his work to his peer, there may be greater vulnerability on the reviewee's part and a desire for anonymity.

Silva and Moreira's (2003) tool did not protect anonymity. In fact students openly debated their work with their reviewers, which caused unnecessary friction among some students. Students are not typically practiced in evaluation and may be overly negative. Anonymity and instructor monitoring of the process are some methods of reducing undue anxiety and hurt feelings due to overly negative criticism. Double blind reviews, in that neither reviewers nor authors know each others' identities, has been found to promote fairer and better quality reviews (Zeller, 2000). Zeller does not even allow instructors access to student reviews. He noticed an improvement in

grades with more submissions and more reviews per submission prompting students to submit early and often. A higher degree of fairness in grading was perceived by the students using this system. However, the authors do address possible quality issues with reviews with a lack of monitoring on their part.

The vast majority of the students Sitthiworachart and Joy (2004) interviewed thought double blind anonymity was important. Wolfe (2004) used only one-way anonymity where the reviewer knows the author's identity, but not vise-versa. Gehringer (2003) and Chalk and Adeboye (2004) all use double blind anonymity. There are few explanations for any of these anonymity scenarios. Anonymity may be useful for novice peer reviewers or novice students in a particular field; however, another important consideration is accountability. If a goal is to increase interdependence in support of community of practice (Wenger, 1998), then knowing who to depend on, having access to the person, is necessary. Anonymity reduces accountability and is a hindrance to mutuality of community. Nonetheless, it was clear we should support the option of anonymity, the double blind form. There appeared to be much less of a need to support anonymity in only one direction, though this is something for future consideration. A final note, Davies and Berrow (1998) warn that anonymity is never certain, i.e. MS Word embedding the author's details.

Quality of Peer Reviews

Wolfe (2004) has found that novice graders produced quite accurate assessments, to where even tenths of a point differences between average scores reflect qualitative differences in student work. However, Wolfe explains that 70% of reviews could be classified as superficial. Some steps that could be taken to ensure quality reviews include the design of better rubrics and the evaluation of reviews (Gheringer, 2003; Sitthiworachart & Joy, 2004).

Gehringer (2003) describes work with large classes where he has reviewers communicate with their peers in a shared web page for each author, where the author can view reviewers' comments and vice versa. The system can be configured to allow or disallow reviewers' access to the other reviewers' scores. (They note that access promotes better dialogue on quality of reviews, but the first reviewer might have undue influence) Grading is based on a rubric of several questions answered with a numeric score, the weights of which can be adjusted. The rubrics insure students are evaluated on the same criteria. Additional comments can be made to support the numeric scores. 25% of the grade is based on evaluations of peer reviews. Gehringer found students to respond strongly to this incentive to review carefully.

Chalk and Adeboyle (2004), however, question whether students can be trusted to assess their peers; they use peer evaluation as a learning exercise alone. Even when reviews count toward a quarter of the reviewer's grade, the researchers found no significant correlations between tutors' and students' evaluations in 4 of the 9 weeks, suggesting that students' evaluation scores were unreliable for actual assessment. Nonetheless, the researchers note evidence in the student reviews of higher level thinking skills of analysis and evaluation. Chalk and Adeboyle suggest further investigation into criteria specificity and its influence on score reliability.

A well defined rubric is clearly preferred to solicit quality reviews. Hence, the development of a rubric authoring tool became a central focus of our project. We discuss rubrics further in the rubric section. Also, some mechanism was required for an instructor to provide feedback on peer reviews. Our module allows the instructor to direct feedback to the reviewer and the reviewee separately. The instructor can comment on the quality of the review(s) submitted by a student and/or provide his own review of the student's assignment.

Assignment of Reviewers

Wolfe (2004) handled assignment informally with an indication of how many reviews a student has received and direction to review a student's work with the least number of reviews. Chalk and Adeboye (2004) describe weaknesses with the system they used. A student would first have to submit work before evaluating peer's work. With late work allowed, a student might log in and find only one student to evaluate, when three were required. Also, the work submitted last would get the fewest, if any evaluations. The random way in which students were assigned evaluations did not work well.

We support automatic assignment, but to avoid issues of students not getting reviewed or not getting work to review in a timely manner, a firm deadline for assignment submission would be highly recommended. Since this

may not always be possible, our peer review module also offers an interface for manual assignment. This way there is at least the option for the instructor to control for students on different schedules. It also allows instructors to pair reviewers based on ability and provides flexibility for multiple reviewers and reviewees. Of course, manual assignment takes more time and consideration on the instructor's part, but peer assignments from previous reviews can be copied to new reviews.

Rubrics and User Interfaces

Sitthiworachart and Joy (2004) note that rubrics are important, especially in cases where students may not be comfortable or knowledgeable enough to create their own specific guidelines (probably most cases). They note rubrics must be of a sufficiently large scale (5-point is better than 3-point) so that the students can mark effectively. Still there are concerns regarding the reliability of peer review. In contrast to Cross (1987) and especially Wolfe (2004), who discuss consistency in peer rating, Preston and Shackelford (1999) have found difficulty with inter-rater reliability and getting raters to embrace an online marking system which integrates in-document annotation with a criterion referenced scoring system.

After examining rater behavior more closely, the Preston and Shackelford (1999) found that raters actually lead with the student's work rather than the rubrics. This high to low level analysis, from the bigger picture to the finer details, is also how writing and other domains are typically, and appropriately, evaluated. The lesson appears to be that while it may be tempting to offer fancy integration of criteria, annotation, and scoring into one interface, this method fragments or compartmentalizes the feedback to such a degree that reviewers find the structures too confining or lacking in cohesion.

Our approach has been to provide no integration whatsoever. The student work or annotation view and rubric view are entirely separate and independent. We do support in-document annotation, but the reviewer's hands are not tied to a rubric and criteria. Rather, the rubric is optional and can function more as a guide for in-document annotation. Our literature review reveals a problematic balance between a strict model and list of criteria and a more flexible system where the rubric is more globally applied and narrative comments can be provided for each criterion. The later approach is clearly a better design for a course management system like Moodle, which is used in many contexts and for various disciplines. We've designed our rubric authoring tool to be quite flexible, allowing for reuse of rubrics, and individual criteria. Individual criteria can be presented in different forms, such as a likhert scale (multiple choice) or check-off lists, and can be weighted as needed. The same rubric can be used by the instructor to provide feedback to a student, for an assignment and its peer reviews.

Though there is little discussion of rubric design and creation in this literature, we feel that a simple rubric authoring tool is a requisite component of any peer review system. Indeed, we discuss later that such a tool should probably be available for any assignment, not only for peer review. The rubric and its criteria define clear expectations and reinforce trust among all involved by allowing for more objective evaluation.

Other Considerations

The literature we discuss here does not address all potential needs. In-document review is one area that has only been superficially addressed. Though this method of providing feedback is likely more time consuming for both the student and instructor, it could certainly provide more specific or elaborate feedback. It was a fairly simple matter for us to at least support the submission of peer annotated files. It would be up to the instructor to provide appropriate directions on the process, and perhaps a rubric guide.

Also, there would likely be instances where an instructor would have students evaluate other resources not authored by peers. Indeed, the ability to arrange for students to evaluate example assignments from past courses with similar rubrics would be a useful way of modeling the review process and providing students some practice before they get their hands on current peer work. Also, there is the option of having student teachers evaluate other educational resources such as web content or the work of future students. In our peer review assignment module wizard, we have simply provided the option for an instructor to choose a resource for review rather than choose an existing student assignment.

There is an important opportunity that we do not support but with which we were much intrigued: the potential of the peer evaluation system to support the indexing of best practices, or worst, as with Gehringer's (2004) "education engineering." The peer review module could potentially be used as a rating or valuation system for any knowledge artifact, such as teacher lesson plans. This is an item for future work.

Scenarios and Workflow

Here we discuss some simplified scenarios of use for the peer review assignment module, presented in chronological order and centered on the instructor creating the assignment and rubric, the student providing feedback on peer assignment, and instructor and student views of the feedback.

Instructor Configures Peer Review Assignments

Dr. Smith, an elementary education teacher educator, opens the peer review module wizard where she first selects from a drop down list the assignment she wishes students to peer review. These are assignments she has already created in the Moodle assignment module. She selects a one-week lesson plan and in the next text box she titles the peer review assignment, below which is a larger text editor box where she writes some instructions. Next is a drop down list where she has choices for peer review type, in-document, rubric, or both; she chooses both. With the in-document review type, the reviewer will see a document submission form with which he will submit annotated documents. The rubric selection provides an online form for the reviewer with various criteria by which he will evaluate the assignment.

There are a number of additional configuration options for the peer review assignment. Dr. Smith allows students to resubmit their peer reviews by leaving the dropdown box for that option at its default value. For the size limit dropdown box, she chooses 6 MB and then she picks 100 for the maximum number of points. As this is the middle of the term and her students are working well together, she decides against anonymity. She then selects email notification (student receives an email indicating that peer's work is ready to be evaluated). Finally, she indicates the deadline for the peer review assignment.

The Rubric Tool

As Dr. Smith has selected the rubric option, the next page of the peer review assignment configuration wizard is the rubric tool where she can configure the rubric by which students evaluate their peers. Dr. Smith can select to edit a former rubric or name a new one, for which she can write instructions, select number of review attempts, and a maximum grade. Individual criteria from past rubrics are available for reuse, listed by category. She can select from the existing criteria or create new ones in the right pane (see Figure 1). The left displays the criteria she's chosen for the rubric. The more common rubric criteria is essentially a multiple choice question, where Dr. Smith can choose the number of answers, include a comment box (the default), and then edit the answers with specific details as to how the work meets that specific answer or criterion. If Dr. Smith decides to amend the rubric later, she knows she can return to the rubric tool directly from her instructor view of the peer review assignment.

Assigning Peer Reviewers

The third and last page of the peer review assignment configuration wizard addresses assignment of reviewers. Dr. Smith first has the option for the system to automatically assign reviewers to students by choosing the number of reviewers she wants each student to have and then clicking the "Assign" button. Or she could copy reviewer assignments from a previous manual peer review assignment, if more consistent review groups were desired. To do this, she would select the previous assignment from a drop down list and then click the "Copy" button. In this case she decides to use manual assignment to attempt to break up some of the cliques that have formed. Before or after assignments have been submitted, Dr. Smith can return to this screen and add reviewer(s) to students' projects by selecting the reviewer from a dropdown list and clicking the "Assign" button. A delete button next to each reviewer allows changes.

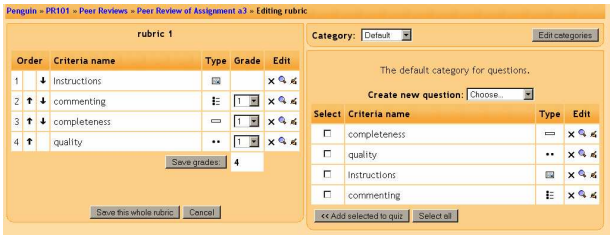

Figure 1: Instructor Authors Rubric

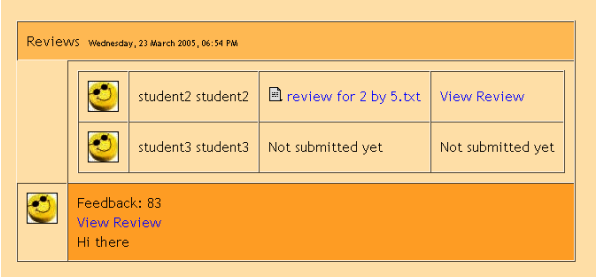

Figure 2: Student Accesses Feedback

Student Processes Feedback

John gets an email notifying him that his peer's lesson plan is ready to be evaluated; the message includes a link to his peer review assignment page where he'll find relevant information and a link to his peer's work to be reviewed. John opens the link and downloads the file. He goes back for a quick review of the rubric and then annotates his peers work as needed. He saves the file and returns to the peer review page where there is a form for him to upload and submit the annotated file, after which he clicks the rubric link. This link opens the rubric form where John provides appropriate scoring and commenting for each of the criteria. John's peer review assignment page now displays a link to the annotated version of his peer's files that he submitted, and a link to the rubric form he completed in evaluating his peer's work, both of which are also available in the student view of the peer he evaluated.

Later, John receives an e-mail notification that the peer review of his work is now available; again there is a link to the peer review assignment page where he finds the annotated file and a link to the rubric form submitted by his peer (Figure 2). John opens the file and reads his peer's in-document notes. He opens the rubric and sees the criteria where he lost points. His peer and Dr. Smith have both made some comments on possible improvements. He sees that Dr. Smith generally agrees with the peer's review, except for one minor point, and she provides some additional detail for adjusting the lesson plan. Because anonymity is not protected in this case, there is a link to the reviewer if John has some questions.

Instructor Processes Feedback

Dr. Smith has the ability to monitor and grade the peer reviews and provide her own review of a student's work. Her instructor view provides a list of all submissions per assignment; for each student there is a list of reviews given and reviews received. She had examined John's reviews of his peer's work and provided some comments. Dr. Smith took the time to provide her own feedback on John's work by typing in comments, using the same rubric used in the peer reviews. She also reinforced some of the peer feedback John received.

Design Notes

A significant design dilemma was whether this peer review assignment module should not be considered a replacement for the current Moodle assignment module. One major consideration here is that an instructor should have the ability to create a rubric for any assignment, peer reviewed or not. It is odd to have to use the peer review module for access to the rubric tool, when no peer review is desired. Another consideration is that peer review would then be better integrated with the original assignment, with easier configuration and less fragmentation of instructor and student views. Students would have an easier time managing their assignments and processing feedback all in one location. There is a significant instructional design problem in providing an evaluation rubric in a different module than the actual assignment, particularly if it is provided after a student has already completed the assignment.

By creating a separate module, however, we are better able to support reviewing of other Moodle objects. As mentioned, we support the reviewing of resources provided by the instructor. If we were using a single module,

this would be less intuitive as there is no submission of a Moodle assignment, only the peer reviews. In the end we went with a separate module mostly due to time and technical constraints. There are certainly good reasons for each approach and it is something that deserves more consideration.

Other design issues involved what question styles to include for the rubrics, default settings for the rubrics, and whether to have a comment area for each criterion (which we do). We also considered the need for protecting the anonymity of only one participant and for now have not included this function. Having this form of anonymity may make sense in certain instances, but since most cases will either be completely anonymous or completely open, it seemed reasonable to err on the side of less complexity and leave out the extra functionality. Another question was how to support instructor feedback. We've provided an interface where the instructor can use the same rubric to evaluate student work and provide comments on peer reviews for that work.

Evaluation and Future Work

Our initial evaluation took place in a graduate level computer science course. As part of the class, students were asked to complete a short project proposal and submit it to Moodle. The students were assigned to review two other proposals and then rate their experience via a short questionnaire. The survey consisted of five likert scale questions and two free response questions. Twelve students completed the survey.

In general, there reaction was positive, but the there were a few problems highlighted. All but one of the respondents felt that it was easy to provide feedback to others through the module. Seven people strongly agreed with the statement. Similarly, when asked if the rubric tool was easy to use, nearly everyone agreed with four people strongly agreeing. Two people were not as positive; one responded neutrally and the other disagreed. While most of the students did not find the interface to be confusing, two did. One person stated that he was not sure where to find the reviews of his assignment. This problem also showed up when the students were asked if it was easy to access their feedback. One person strongly disagreed and two people were neutral. A reason for this response could be that in the current interface, the reviews a student receives are placed below all of the information about the reviews to be given. This means that the reviews may be off the screen and not visible when the page initially loads. A possible solution would be to add a link at the top of the page that would take the user directly to the reviews.

There also seems to be a need for some additional feedback. Three students noted that it was somewhat difficult to determine what work was left to do. Currently, when a review is uploaded as in-document review or when a rubric is completed, a new link is added to allow reviewers to look at what they have just finished. This may be too subtle in some cases. Additional visual cues, such as changing part of the background color, may be useful to eliminate some confusion. Finally, another student remarked that the rubric screen does not display details to associate the rubric with a particular review and reviewee. This could be an issue if a user opens multiple reviews into new tabs or windows. This information will be added.

Our first pass at evaluation focused on the students' view of the module to locate some of the high level interface issues. Additional evaluation, from both teachers and students, will need to be conducted as the interface matures and as new features are added. The current focus is on the usability of the interfaces to determine if our interaction design is intuitive and useful to instructors and students as they carry out peer review tasks. Down the road we'd like to determine that we have made the module flexible enough and that all the necessary functions are available. Many of the systems we reviewed make assumptions about peer review methods, which we tried to avoid. Our system should be tested with a number of different audiences to determine whether it can meet their needs. Of course, there are a number of interesting context-specific investigations one could carry out on peer review method, regarding anonymity, rubrics and criteria, their affect on peer review quality and the general impact of peer review.

For future work, there are a number of useful features that could be added to the module, such as the rating and publishing of strong and weak work to be used as exemplars in future classes. Another improvement would be to allow for more types of reviewable objects. Support for importing and exporting rubric questions as well as for backing up and restoring assignments is needed. Supplying some statistical analysis of the rubrics is also a consideration. Finally, we should definitely give more consideration to our notification schemes and allow for more flexibility as to when notification takes place and what it includes. Currently a student is notified immediately when a peer has evaluated the student's work, before the instructor has had a chance to review that evaluation. For more

advanced students, this may not be a problem, but for students new to the peer review process, the instructor should perhaps have greater monitoring opportunity. Once we've addressed some of these issues, we would certainly want to add some help or FAQ pages.

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