

Assessment of Expertiza: A Methodology for Building Reusable Learning Objects Through Peer Review

Final Report, June 2007

Edward F. Gehringer
efg@ncsu.edu

ABSTRACT

Expertiza is a suite of software applications for developing reusable learning objects through peer review. The goal of this project was to assess the benefits of this approach, and to refine it based on our experiences. During the grant period, Expertiza was used by the investigator and by nine other instructors, four of them on other campuses (UNC-Charlotte, University of Virginia, Georgia Southern, and UNC-Wilmington). Students were generally positive on the system itself, believing that they learned from the process of peer review. They thought the system could be improved, especially the quality of reviews. The investigator's classes produced reusable learning resources—examples and exercises for a textbook, and animations of important concepts in parallel computer architecture. Both of these led to peer-reviewed publications. However, as of yet, the project has produced a similar success in only one other instructor's class.

We found two main hurdles during the project. First, while many instructors are very interested in using the system in their classes, less than half of them follow through. Second, of those who follow through, many of them seem just interested in peer review, and not in producing reusable learning resources. Because of this, in the future, we are going to emphasize a two-part approach. First, encourage instructors to use the system for peer review. Second, after they are comfortable with it, encourage them to produce resources.

The project has attracted considerable interest, both at NCSU and around the country and the world. More than two dozen educators have asked to use the system in their courses. We have established a good framework for evaluating the system, and have gained important insight on how to improve the software and the process. While the national and international visibility of the project is largely a consequence of the NSF funding it has received, the support of the LITRE project and the NCSU Director of Assessment have been instrumental in putting our evaluation efforts on a sound footing.

INTRODUCTION

The Expertiza project uses peer review to produce reusable learning objects. Students select a homework project from a list of tasks (e.g., create an example of a particular concept from the textbook, or make up a problem over the material covered in this lecture). The number of tasks is limited, so that several students will select the same task. Their work is reviewed by their peers, and they revise it based on feedback they receive. The reviewers then assign a score to the revision. For each task, the submission rated most highly is then "published," i.e., made available to other students in the class, and students who take the same class in later semesters.

Objectives: The first objective¹ of this project is to evaluate the Expertiza platform's ability to increase the amount of material that students learn, and how much they retain. This will be accomplished using peer-reviewed homework to increase student engagement in the learning process. When working on a typical homework assignment, students do the work and submit the homework for evaluation. By adding the peer-review aspect, students are able to see what other students have submitted, and are forced to engage the material more critically.

The second objective is to create learning objects that will add value to courses through students' use of peer review and the Expertiza platform. That is, as part of their course, students will help develop material to be used in the course the next time it is offered.

Identifying different patterns of use is the third objective. It is expected that faculty will adapt Expertiza to their specific needs. By doing so, they will create new patterns of use of the software and expand its usefulness for the future. The Expertiza software is continually under development and improving. While this proposal does not cover the development of software, the usage patterns and feedback from students and faculty will be of great help to the software developers. This information will be collected through surveys and interviews. The ability for comments and suggestions will always be open to students and faculty.

The final objective is to produce documentable and publishable results. The outcomes of these experiments will be written into papers, and published. The purpose of this objective is to provide our results to others who would find them useful.

Background: The PI is Ed Gehringer, with ten years of experience doing peer review in the classroom. The students are the students in several of his courses (CSC 216, CSC 253, CSC 379, ECE 463/521, CSC 506, and CSC 517), and other courses at NCSU taught by Jessica Jameson (Communication), Harry Perros (Computer Science), Orlin Velev (Chemical & Biomolecular Engineering), and Jason Swarts (English). The system has also been used on four other campuses (computer-science classes taught by Tiffany Barnes at UNC-Charlotte, Kevin Skadron at the University of Virginia, and Kera Bell-Watson at Georgia Southern, and a music class taught by Dan Johnson at UNC-Wilmington). Of these, Georgia Southern is a historically black university.

This grant has supported two master's students in computer science: Susan Conger (2006) and David Edelman (2007). Susan was responsible for configuring PG/Expertiza in a way that would allow it to be used by other classes over the Web while development proceeded on a different server, and also for helping to recruit instructors to participate in the project. Dave worked on the software for doing evaluations and on the design of the questionnaires and the analysis of the results.

Student learning outcomes: Our hope was that students would become more engaged in their homework, due to the experience of writing for their peers. This has largely been realized. We also hoped that students, with the resources produced by their forbears,

¹ The Objectives section is taken directly from the LITRE grant proposal.

would find it easier to learn the material. As of yet, we do not have adequate data to establish this.

METHOD AND RESULTS

Our approach has been to have students use the system and then survey them on their experience. In Spring 2007, we instituted a new questionnaire that was more comprehensive than before, and focused on the desired outcomes. The questionnaire was administered to the 52 students in classes that used the system this spring. Results were received from 25, a response rate of 48%. Results are presented below.

Objective 1: Evaluate the Expertiza platform's ability to increase the amount of material that students learn, and how much they retain.

The questions that bear on this objective are Questions 1 and 2. By a margin of 13 to 5, our respondents thought their learning was enhanced by doing the peer-reviewed exercises. By a margin of 15 to 6, they felt that the experience of writing for their peers gave them a deeper understanding of the concepts in the course.

Objective 2: Create learning objects that will add value to courses through students' use of peer review and the Expertiza platform.

Our intent is to measure this by the instructors' perception of the ease with which students learn material in subsequent semesters. We do not yet have numerical evidence for this, but we do have qualitative evidence. Three courses have used the system to produce reusable learning objects, and two of these have led to peer-reviewed papers.

The first instance was in CSC 517 in Fall 2005, where students were assigned to develop an explanation, an example, and an exercise for an in-press textbook on object-oriented design. The most highly rated submissions were presented to the textbook author, who asked 17 students for permission to use them in his textbook. A peer-reviewed [paper](#) on the experience was presented at the 2006 OOPSLA (Object-Oriented Programming Languages, Systems, and Applications) Educators' Symposium.

The second instance was in Fall 2006, when Jason Swarts's ENG 421 students developed documentation for the Expertiza system, using it to review each other's contributions. The result was a much better set of documentation than previously existed. It can be seen at http://research.csc.ncsu.edu/efg/expertiza/reports/user_doc.pdf.

The third instance was in Spring 2007, when the investigator's CSC/ECE 506 class developed animations of cache-coherence and memory-consistency protocols in order to help future students learn these concepts, which are among the most difficult concepts in parallel computer architecture. A [paper on these animations](#) was presented at the 2007 Workshop on Computer Architecture Education.

| | Strongly agree | Agree | Neutral | Disagree | Strongly disagree | SA+A | SD+D | Average (SA=5, SD=1) |
|--|----------------|-------|---------|----------|-------------------|------|------|-------------------------|
| Question 1: My learning was enhanced by doing the peer-reviewed exercises. | 5 | 8 | 7 | 4 | 1 | 13 | 5 | 3.48 |
| Question 2: The experience of writing for my peers gave me a deeper understanding of the concepts in this course. | 4 | 11 | 4 | 4 | 2 | 15 | 6 | 3.44 |
| Question 3: I received more feedback from my peer reviewers than I normally receive from the instructor (and TA, if any). | 2 | 7 | 6 | 6 | 4 | 9 | 10 | 2.88 |
| Question 4: My peer reviewers provided feedback that was correct. | 0 | 9 | 7 | 7 | 2 | 9 | 9 | 2.92 |
| Question 5: My peer reviewers provided feedback that helped me to improve my submission. | 3 | 7 | 4 | 9 | 2 | 10 | 11 | 3 |
| Question 6: I enjoyed doing the assignment. | 3 | 7 | 9 | 1 | 5 | 10 | 6 | 3.08 |
| Question 7: There were too many deadlines. | 5 | 10 | 7 | 2 | 1 | 15 | 3 | 3.64 |
| Question 8: Peer review helped us students work as a team. | 2 | 5 | 10 | 4 | 4 | 7 | 8 | 2.88 |
| Question 9: This tool was so exciting that I spent extra time and effort doing the assignments | 4 | 2 | 5 | 5 | 9 | 6 | 14 | 2.48 |
| Question 10: The rubric questions were useful in evaluating other students' work. | 2 | 11 | 6 | 4 | 2 | 13 | 6 | 3.28 |
| Question 11: I found the system easy to use (to submit and review). | 2 | 10 | 7 | 4 | 2 | 12 | 6 | 3.24 |
| Question 12: The feedback I received fostered my analysis skills and critical thinking. | 1 | 6 | 7 | 8 | 3 | 7 | 11 | 2.76 |
| Question 13: I would be happy to use the system again. | 1 | 12 | 5 | 3 | 4 | 13 | 7 | 3.12 |

Table 1. Results of Spring 2007 Student Survey

Objective 3: To identify different patterns of use for the Expertiza software.

During our interactions with instructors, it became clear that (1) most of them did not desire to use our review-of-review quality-control method (see below) and (2) several instructors desired to be more involved with their students' work that a strict peer-review process would allow.

A classroom peer-review system needs some mechanism of quality control. Otherwise, most students would not be motivated to expend any effort in giving helpful feedback to

their reviewees. Our practice has been, after all the reviews are in, to have students evaluate each other's reviews. That is, after the review period ends, student *A* scores student *B*'s review of student *C*. This score is factored into the students' grades. However, few instructors who use the system have opted to use this quality-control mechanism. This leaves the process with no way to insure careful reviews. And two questions on the survey seem to identify deficiencies with this approach. By a margin of 11 to 10, the students felt that the feedback they received was not really helpful for improving their submission. And by a margin of 15 to 3, they felt that there were too many deadlines (with the review-of-review deadline being just one more deadline).

This experience has led me to hypothesize that reviews of reviews could be partially automated. It is usually very easy to review a review. One can usually judge whether the feedback would be helpful without even reading the author's submission. A strategy based on volume of feedback, and the degree to which the keywords of the submission appeared in the feedback, should offer a good first approximation to the value of the review. Moreover, if the strategy were automated, the system could inform the reviewer of the "helpfulness" of a review immediately after the review was submitted. If the review was deemed not to be helpful, the student could go back and redo it. I am hoping to interest a master's student in this project. Then the student could be asked to rate the review on how helpful it really was (a strategy suggested by Kera Bell-Watson, one of our instructors). Armed with the automated feedback on the review, as well as the author's assessment of it, the instructor should be in a good position to very quickly rate the quality of a student's reviewing.

The second functionality that several instructors desire is a way to be involved with their students during the review period. The instructor may want to review students' work before their peers review it (to help focus the peers on what is important to look for in revisions of the work), or to review the work after the peers have their crack at it (to use their evaluations as an aid in assigning grades to the authors). Or instructors may want to weigh in on the feedback given by peers during the review process. These comments have led me to the idea that *peer-assisted* review might be a more promising approach than the strict peer-only review that the software currently supports.

Objective 4: Produce documentable and publishable results.

During the grant period, we have published five papers on Expertiza. While one of them was an unreviewed summary of our UNC TLT 2006 presentation, the others underwent varying peer-review processes. Our 2006 OOPSLA Educators' Symposium paper was published in a venue that typically accepts 20% to 40% of its submissions. Our [Frontiers in Education 2006 paper](#) underwent review at the abstract and full-paper stages, and a further set of revisions supervised by the track chair. Our 2007 [Workshop on Computer Architecture paper](#) received five reviews, and ranked 5th out of 13 papers submitted to the workshop. And the publication that I consider the best synopsis of the system—our [Innovate! article](#), was accepted by an online journal whose acceptance rate is 25%. While I would admit that we would not have achieved the same level of prominence without outside funding, it is still true that the personnel funded by our LITRE grant were instrumental in making these publications possible.

EFFECT ON FACULTY PEDAGOGY

This project has challenged the faculty to create homework assignments that add value for the students. While this promises gains in productivity in future semesters, the start-up overhead is considerable. For example, when I had my class produce animations, we needed to have some examples for them to work from. Fortunately, a previous instructor had prepared some, but we still needed to do considerable work to create templates that the students could use and exercises that they could do. Sometimes it seemed that my assistant and I were doing 2/3 of the homework ourselves. This overhead would not have been present if I had my students make up homework or test questions, but even in this case, I need to provide them with good models in the other homework and exams I supply to them. In the future, I want to discuss these ideas with other faculty when they begin to use the system. This will help them move their focus from mere peer review toward producing resources that will benefit future students.

One of the faculty who used the system thought that the main benefit students would get from working together is in a team format; he saw peer review as less beneficial than teamwork. Of the three other instructors who used the system in 2007, two are interested in using it again, and the third is noncommittal.

The current user interface is not particularly easy for faculty to use. Following the first focus groups of students, we redesigned the student interface. Currently, we are engaged in a reimplementing of the entire PG system (the peer-review portion of Expertiza). The instructor interface in the new version is much more intuitive, and this should make it easier for faculty to set up their own assignments.

DISCUSSION

This grant has given us the ability to assess the viability of the Expertiza strategy for producing reusable learning objects through peer review.

- Nine other faculty have used the system in their courses.
- We have produced three sets of reusable learning objects, and published papers about two of them in peer-reviewed venues.
- A majority of students believe that the system has enhanced their learning.
- The list of faculty interested in using the system has grown to more than 160 worldwide, with approximately two dozen of them saying they definitely plan to try it in their own courses.

We have also encountered several challenges.

- Students and faculty believe the usability of the system could be improved.
- While faculty are eager to use the system, they have difficulty seeing how it could be applied to create reusable learning resources for their course.

- Faculty seem more willing to use the system in small classes, and therefore it will require considerable work to get data on enough students to show a statistically significant benefit to this approach.

This experience has taught us that students want to use tools that have an intuitive user interface. My own computer science/engineering students had no trouble with the first user interface, but students from other fields did. After we redesigned the student interface, it posed much less of a hurdle, and has been used successfully by undergraduates in English and Music, for example. Our feedback indicates that further improvement is possible and desirable.

The second lesson is that students appreciate the ability to work collaboratively with their peers, and believe it improves their learning experience. The results reported for Spring 2007 agree with the results from previous semesters (though the question was phrased differently). In both cases, two to three times as many students thought that the peer-review process improved their learning experience as thought that it did not improve their learning experience.

The third lesson is that it requires more effort to disseminate a teaching/learning strategy than to disseminate a teaching/learning tool. It is much easier to find faculty who want to do electronic peer review in their courses than to find faculty who have ideas about how students can build resources to improve the learning of other students. Perhaps this should not come as a surprise; faculty can learn to use the software in a few hours, but thinking about how students can take charge in improving the course requires more careful planning and changes the kind of homework that is assigned.

Our immediate goal is to get the rewritten Expertiza system operational. This will yield a great improvement in user interface, especially for instructors, who are the ones who actually have to adopt the system. As indicated in the Methods and Results section, we are also looking at how to automate reviews of reviews, to provide a more timely assessment mechanism for the quality of reviewing. Our experience indicates that instructors want to be more involved in the review process, so we are looking at ways to combine instructor review with peer review. We are also working on a wiki interface so that the system can be used to review contributions to wikis. This is important, as faculty are increasingly teaching with wikis, but finding that it is very difficult to adequately assess student contributions, which may range across many different Web pages, each of which may have several contributors.

Two dozen NCSU faculty have registered their interest in using the system in their courses. The system has been used to review technical documentation in an English course. One considered using it in a service-learning course to come up with an FAQ/manual for students to use to share their expertise in handling situations that arose during their project. Our [Frontiers in Education paper](#) describes several other ways the system might be used.

We are very grateful for the support provided to the Expertiza project by this LITRE grant. It has enabled us to do a much more serious job of evaluating the effectiveness of this system, and of interesting others in using it.

PUBLICATIONS

- Edward F. Gehringer, Luke M. Ehresman, Prasad Wagle, and Susan Conger, North Carolina State University, [Expertiza: Reusable learning objects and active learning for distance education](#), *Proc. University of North Carolina Teaching and Learning with Technology conference*, Raleigh, NC, March 15–17, 2006. [[Slides](#)]
- Edward F. Gehringer, Luke M. Ehresman, Susan G. Conger, and Prasad A Wagle, [Work in progress -- Reusable learning objects through peer review: The Expertiza approach](#), *36th Annual Frontiers in Education Conference*, San Diego, October 28–31, 2006. [[Slides](#)]
- Edward F. Gehringer, Luke M. Ehresman, and Dale J. Skrien, [Expertiza: Students helping to write an OOD text](#), *OOPSLA 2006: ACM SIGPLAN International Conference on Object-Oriented Programming Systems, Languages, and Applications Educators' Symposium*, Portland, OR, October 22–26, 2006. [[Slides 1](#), [Slides 2](#)]
- Edward Gehringer, Luke Ehresman, Susan G. Conger, and Prasad Wagle [Reusable learning objects through peer review: The Expertiza approach](#), *Innovate: Journal of Online Education* 3:5, June/July 2007
- Mohit Gambhir, Edward F. Gehringer, and Yan Solihin, “[Animations of important concepts in parallel computer architecture](#)”, *Workshop on Computer Architecture Education*, San Diego, CA, June 12, 2007

PRESENTATIONS

- Edward F. Gehringer and Mohit Gambhir, “Animations of Important Algorithms in Parallel Computer Architecture,” Workshop on Computer Architecture Education, San Diego, June 12, 2007.
- Edward F. Gehringer, “Expertiza: Reusable Learning Objects Through Peer Review,” Duke University Center for Instructional Technology, May 30, 2007
- Edward F. Gehringer, “Expertiza: Reusable Learning Objects Through Peer Review,” UNC-Wilmington Masters in Instructional Technology program, May 11, 2007
- Edward F. Gehringer, Ravi Wesley, and David Edelman, “Collaborative Learning Through Online Peer Review,” UNC Teaching and Learning with Technology conference, Raleigh, NC, March 22, 2007.

- Edward F. Gehringer, “Expertiza: Reusable learning objects through peer review,” 12th Sloan-C International Conference on Asynchronous Learning Networks, Orlando, FL, November 10, 2006.
- Edward F. Gehringer, “Work in progress — Reusable learning objects through peer review: The Expertiza approach,” 36th Annual Frontiers in Education Conference, San Diego, October 31, 2006.
- Edward F. Gehringer and Dale J. Skrien, “Expertiza: Students helping to write an OOD text,” OOPSLA 2006: ACM SIGPLAN International Conference on Object-Oriented Programming Systems, Languages, and Applications, Portland, OR, October 23, 2006.
- Edward F. Gehringer and David Edelman, “Expertiza: Reusable Learning Objects and Active Learning for Distance Education,” NCSU Faculty Center for Teaching and Learning, August 18, 2006.
- Edward F. Gehringer and Luke Ehresman, “Expertiza: Reusable Learning Objects and Active Learning for Distance Education,” UNC Teaching and Learning with Technology conference, March 17, 2006.
- Edward F. Gehringer and Luke Ehresman, “Expertiza: Reusable Learning Objects through Peer Review,” SIGCSE 2006: Thirty-Seventh Technical Symposium on Computer Science Education, Houston, March 2, 2006, poster presentation.