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Homework is frequently viewed as a necessary evil—one of the least exciting parts of teaching, but absolutely essential if students are to learn the material. There are many reasons for this attitude. Reusing the same assignments year after year invites cheating (Gehringer 2004) and devising challenging new work is time consuming. Grading is drudgery for faculty or teaching assistants, especially if the class is large. Finally, since each student is given the same assignment, their efforts are largely redundant. Everyone answers the same questions or solves the same problems with negligible long-term benefits. By contrast, assignments such as essays, design projects, or research reports should present an opportunity for individual expression, but evaluation of these kinds of projects must respond personally to each student's work to be effective. In such cases instructors and TAs rarely have enough time to give sufficient feedback.

Peer review offers a solution to some of these problems and promises important advantages for students, whether they are acting as assessors or assessees. As assessors, students spend time reviewing, summarizing, diagnosing misconceived knowledge, and considering deviations from the ideal (Van Lehn et al. 1995). As assessees, students write for an audience where they have the burden of making themselves understood, rather than depending on an expert grader to decipher their intentions. Their peers are likely to give them more feedback than they would receive from an over-worked TA or instructor. Many studies of peer evaluation (Exhibit 1) have found that students regarded peer reviewers as more critical than their instructors, and that consequently students found their work more challenging when assessed by their counterparts (Stefani 1994; Orsmond, Merry, and Reiling 2000). The whole experience encourages students to invest more thought and effort into their work.

A number of commercial software products, such as the Daedalus Integrated Writing Environment (Bowen 1992; Craven 1994), and academic systems, such as Calibrated Peer Review (Chapman and Fiore 2000; Plutsky and Wilson 2004), have been developed to facilitate online peer review in courses across the curriculum. This paper describes a software product called Expertiza, which takes the process a step further—by harnessing computer-mediated peer review to produce reusable learning objects for the course itself, thereby allowing students to learn from those who came before them. While the system itself may be of interest to some readers, its design and associated pedagogical approach may provide a worthy model for others to adapt for their own technological tools and in their own educational settings.

Expertiza: A Brief Introduction

In 1986 at North Carolina State University (NCSU), I started replacing more traditional homework projects with assignments that required my computer science students to create problems like those that might appear on homework or tests. After experimenting with paper-based peer review of these student-created problems, I developed an anonymous e-mail forwarding system to facilitate the reviews. This e-mail system was replaced with a Web-based system in the late 1990s, out of which the Expertiza system eventually evolved in 2005. The development of the Expertiza system was funded by the National Science Foundation's Course, Curriculum, and Laboratory Improvement project.

Expertiza consists of three Web-based applications:

Shimmer, which allows students to sign up for customized assignments and enables teachers to divide tasks into individual parts; Peer Grader (PG), a peer-review system; and Conoscenza, a Web-enabled database that makes selected student work accessible to registered users (with answers to questions provided only to instructors).

PG, a portable Web-based Java application, enables students to submit their work over the Web and allows the instructor to assign reviewers for each submission. Reviewers and authors can communicate in a variety of ways, with the identities of participants either revealed or hidden. Reviewers evaluate submissions on the basis of a rubric composed of several questions, assigning a numeric value to each, and may provide further comments.

The fundamental stages of the peer review process may be grasped as a cyclical sequence of interactions between the instructor, individual students, and groups of student reviewers (Exhibit 2). Our experience with Expertiza, however, has led us to expand this basic model into a seven-phase cycle capable of producing high-quality peer-reviewed work suitable for Web publication:

The *signup* phase. Students are given a list of potential topics and sign up for one of them. To ensure that all topics are chosen, sign-up for any particular topic may be limited. The *submit* phase. Students prepare their work and submit it to PG.The *initial feedback* phase. Students are given a limited time period—usually three to seven days—to make initial comments on their peers' work. Authors may revise and resubmit work for additional comment during this phase, but they are not required to do so. The *resubmission* phase. During the next period—again usually three to seven days—students revise their work in response to reviewers' comments and resubmit it to PG. The *grading* phase. At the end of this give-and-take, reviewers are required to assign a grade, which is one component of the author's final grade.The *review of review* phase. After the review period is over, each student is presented with a set of reviews to assess. The students grade each review on a rubric that asks about the helpfulness of the review. The grades students receive for their reviewing are factored into their final grade for the assignment, with 20%–25% of the grade based on their reviewing.The *publishing* phase. The best-reviewed student work is published to the Conoscenza database, where it is accessible to users around the world.

For each stage of the submission and review process, the interface and functionality of the Expertiza system have been designed to facilitate the respective tasks of the students (Exhibit 3) and to allow the instructor convenient control and monitoring of the process as a whole (Exhibit 4). As these selected examples may suggest, the design of Expertiza must accomodate a full range of tasks in order to manage the process on such a large scale; without the capabilities afforded by such technology, a peer review approach to designing learning objects would become too complex to sustain for the duration of a course.

The Rationale

Managing homework as a computer-mediated collaborative undertaking has beneficial consequences across the educational enterprise. For students, it offers better engagement through active learning—learning by *doing* rather than just listening and studying—and cooperative learning—working on projects together under conditions that ensure individual accountability. For faculty, it helps keep courses up to date and provides better resources for helping students.

Hundreds of studies document the impact of active and cooperative learning in the classroom, especially for students who may be overlooked in more traditional systems (Exhibit 5). Notable are the reports of Johnson et al. (1989), which indicate that cooperative learning is markedly more effective than individual learning, and the comprehensive annotated bibliography by Totten et al. (1991), which offers many sources for faculty to consult about ways to integrate cooperative learning into their classes. Expertiza's electronic approach can reproduce this dynamic classroom strategy with the added value of powerful communication tools.

The value of such an approach for extending active learning into homework is undeniable; for distance education students, it is indispensable. All too often, the distance-learning environment does not accommodate the kind of synchronous active-learning exercises that work so well in face-to-face teaching.

Efforts to extend active learning to distance education usually focus on e-mail and message boards (Kochery 1997; Levin and Ben-Jacob 1998; Macdonald and Twining 2002; Phillips 2005). While such forms of interaction are useful, they are unstructured and difficult to assess. By providing a framework for capturing student work, managing peer interaction, and facilitating assessment, Expertiza gives a structure for out-of-class activities that encourages persistence and helps minimize distraction for distance-learning and traditional students alike.

The Expertiza platform also incorporates several strategies that have been shown to diminish the possibility of plagiarism, an increasing concern in an era when complete papers can simply be downloaded from the Internet. The use of multiple deadlines, drafts, and milestones makes it impossible to submit a finished product obtained from an external source (Sterngold 2004), and such processes are inherent in the PG component of Expertiza. The fact that students are doing customized assignments (cf. Clayton and Watkins 2002) makes finding a co-conspirator more difficult, and since the set of potentially identical assignments is small, the same peer reviewers can evaluate most or all submissions for a particular topic, which makes cheating easy to detect. Moreover, when students are asked to improve on a submission from a previous class (cf. Swain 2005), there is minimal risk that they could accomplish the task by Web surfing.

For teachers, Expertiza simplifies formative assessment by increasing the supply of questions for quizzes, as well as by helping to generate a pool of examples and homework problems for students. Formative assessment frequently takes the form of periodic mastery quizzes covering each lecture or each week's work. Quiz results provide feedback to students and the instructor regarding the individual's and the class's progress through the material (Boston 2002). The biggest hurdle facing a program of formative assessment is developing enough questions. Some instructors hesitate to use quizzes because of the burden of reviewing and revising many questions (Haberyan 2003), especially since online testing systems typically require a large pool of machine-scorable questions from which to choose.

Expertiza can engage students in generating these questions. With Expertiza, students can create questions based on lecture material; in turn, those questions can then be filtered and the best ones selected for inclusion in mastery quizzes via a peer-review process. In later semesters, new classes can revisit the questions, fine-tune them, and revise or eliminate the weakest questions (cf. Bangert-Drowns, Kulick, and Morgan 1991). This type of feedback can be especially helpful to lower-achieving students because it allows them to see how to improve and makes them less likely to suspect that poor performance is due to a lack of innate ability (Ames 1992; Vispoel and Austin 1995).

A peer-review process can also engage students in producing reusable homework questions, examples to illustrate key concepts, and even assignments. As the review process pushes students to produce publishable materials, Expertiza allows instructors to preserve the best work in Conoscenza to use with future classes, who can then build on the work of those who have gone before them. For students, this means a pool of resources on which they can draw to enhance their understanding of the material covered by the course. For teachers, this means a constantly renewable, adaptable source of materials to enhance instruction and engage students in expanding the horizons of the course.

The results can reach far beyond the bounds of the classroom. In our Ethics in Computing course, students are assigned to research one topic (e.g., netiquette, encryption, Internet filters) in this rapidly changing field and produce a page of Web links and a study guide for the topic. By choosing the "best" page on each topic, we have developed a highly regarded Ethics in Computing Web site covering more than 100 topics and receiving thousands of hits per month. The site was rated a "hot site of the day" for April 5, 2001 by USAToday.com (2002), and for at least two years, it has been Google's top-rated site for "Ethics in Computing."

The Expertiza Approach and Reusable Learning Objects

A substantial benefit of the Expertiza approach is that work by current students can be harnessed to produce better learning materials for future students. The instructor decides what learning objects need to be produced, possibly after consulting with the class, and responsibility for creating them is divided among the members of the class. For instance, instructors could ask students to produce fully developed examples to illustrate difficult concepts from a particular lecture or course unit. The peer-review process pushes students to produce their best work, and more importantly, the scores and feedback provide the instructor with valuable guidance on which student submissions are likely to be useful in future offerings of the class.

In this way, the Expertiza approach gets students working together to improve each others' learning experiences. It helps them learn by making them think through the lecture material and apply it to real-world situations, just as they would in a professional setting. Moreover, in explaining the concepts to their peers, they are gaining valuable writing experience. These learning objects can be improved iteratively; instructors can present examples to new classes using work developed by students from a previous semester and ask current students to identify shortcomings and develop improved examples. This allows each cohort to "stand on the shoulders" of students in earlier classes, with an ever-improving set of materials to help them learn.

Most strikingly, Expertiza can finally make teaching large classes an advantage. Large classes can produce better and more abundant learning objects and thus improve and diversify students' learning experiences. By engaging students with their peers, Expertiza's peer review and Web publishing tools can provide cooperative learning opportunities usually difficult to access in large classes. The usual disadvantages of large classes—lack of engagement, less personal attention—are mitigated not only by the availability of better materials and active learning strategies that engage students in teaching their peers, but also by the increased availability of TA time, released from grading, to give students more individual attention.

Expertiza in Practice

The Expertiza method grew out of a set of class projects. The Ethics in Computing Web site was one of the early experiments in the development of Expertiza (Gehringer 2001); students used a forerunner of Expertiza to review peer submissions and the best reports were added to the site. In late 2005, students in an object-oriented design class used Expertiza to provide feedback to the author of an unpublished textbook (Skrien, forthcoming). Over the course of the semester, each student was assigned three tasks: (a) improve an explanation of some concept covered in the text, (b) develop an example of a concept from the text, and (c) write an end-of-chapter exercise for a chapter from the text. Student submissions were peer reviewed and a score was assigned to each. Based on these reviews, the best eight submissions in each category were selected for a "playoff" round in which a different set of reviewers gave feedback. The authors were encouraged to revise their submissions again in response to the latest review; peer reviewers then assigned a final grade. The "winning" submission received 50% extra credit; the runner-up, 25%; and the other finalists, 10%.

Students reacted quite positively to this experiment. After the end of the semester, they were asked to complete a Web survey that asked ten questions about the textbook and the peer-reviewed assignments. Of the 78 students in the class, 49 responded, a response rate of 63%. Of these 49 students, 29 either agreed or strongly agreed that they learned a lot from doing the peer-reviewed assignments (Gehringer, Ehresman, and Skrien 2006). Twenty-seven said they enjoyed or strongly enjoyed the assignments. Furthermore, Skrien appreciated suggestions from the perspective of students like those who would eventually use the text. The students' work identified potentially confusing concepts and provided alternative ways of explaining them.

In Fall 2006, we used Expertiza for peer review of the source code of Expertiza itself. This experiment was intended as a "proof of concept" that production-quality code can be written in a computer science course. The peer-review process helped students identify flaws in their design and in their program code. During the review process, students were forced to scrutinize code and, in so doing, we hoped they would learn to write better code themselves. The results of this experiment were mixed. Students were mildly positive on the quality of code produced. They were asked to rate, on a scale of 1 (much worse) to 5 (much better), whether their refactored code was better than code they would have written "from scratch." The mean of their responses was 3.47. However, they felt that they spent too much time reading poor code and too little time improving it. Another experiment in an English course on computer documentation produced user documentation for Expertiza. Students in this course used the Expertiza system to document itself—submitting their "manual pages" to PG for review by other class members (Exhibit 6). We are excited about having an expertly written set of user documentation, as it will aid us in attracting other users.

There are many other ways the system might be used (Gehringer et al. 2006). Students in a service-learning course could submit reports on their experiences, which peer reviewers would compare with their own experiences. Descriptions of common problems and how they were resolved could be collected into an FAQ for the use of future courses. Alternatively, students assigned to read papers about a specific aspect of the course material could produce a topic map for which the peer review would serve as a quality-control mechanism. When the contributions are linked together, students will have built a topic map of the entire course—a resource of use to anyone wanting an overview of the topic.

Since its inception, the Expertiza project has been awarded an honorable mention for the Gertrude Cox Award, NCSU's program for recognizing work in teaching and learning with technology. Currently the Expertiza system resides on NCSU's server; future development plans include a downloadable version for local use. Those interested in acquiring more information about Expertiza or in using it in their own classes should register here. A list of published papers about Expertiza may be found here.

Conclusion

Peer review is an active-learning technique that gives students the opportunity to interact with and learn from each other. Instructors are increasingly employing Web-based systems to manage the process. This opens wide new vistas for creating learning objects to enhance the educational experience. Expertiza expands these possibilities even further by allowing instructors to manage individuals or teams of students, each working on a different aspect of the problem. The peer review process encourages students to continually improve their work, resulting both in a better product and in more learning. Successive classes can improve and extend the resources created in this way. Not only are these objects produced through active learning, but they offer active learning experiences to those who use them later. By allowing students to create learning objects for those who follow them, Expertiza leverages the full power of peer review.

References

Ames, C. 1992. Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology* 84 (3): 261-271. http://eric.ed.gov/ (accession no. EJ452395; accessed May 25, 2007).

Bangert-Drowns, R. L., J. A. Kulick, and M. T. Morgan. 1991. The instructional effect of feedback in test-like events. *Review of Educational Research* 61 (2): 213-238.

Boston, C. 2002. The concept of formative assessment. *Practical Assessment, Research, and Evaluation* 8:9. http://PAREonline.net/getvn.asp?v=8&n=9 (accessed February 28, 2007).

Bowen, L. F. 1992. The Daedalus Integrated Writing Environment. *Computers and Composition* 10 (November): 77–88.

Chapman, O. L., and M. A. Fiore. 2000. Calibrated peer review. *Journal of Interactive Instruction Development* 12 (3): 11–15.

Clayton, M., and A. Watkins. 2002. Assessment and integrity in the digital arts. *Syllabus* 15 (April): 31-34. http://eric.ed.gov/ (accession no. EJ654044; accessed May 25, 2007).

Craven, J. 1994. A new model for teaching literature classes. *T.H.E. Journal* 22 (August): 55–57.

Gehringer, E. F. 2001. Building an Ethics in Computing Website using peer review. Paper presented at the

American Society for Engineering Education 2001 Annual Conference and Exposition, Albuquerque, NM, June. http://research.csc.ncsu.edu/efg/ethics/papers/ASEE01.pdf (accessed May 25, 2007).

Gehringer, E. F. 2004. Reuse of homework and test questions: When, why, and how to maintain security? Paper presented at Frontiers in Education 2004, Savannah, GA, October. http://fie.engrng.pitt.edu/fie2004/papers/1630.pdf (accessed May 25, 2007).

Gehringer, E. F., L. M. Ehresman, and D. J. Skrien. 2006. Expertiza: Students helping to write an OOD text. Paper presented at OOPSLA 2006 (Object-Oriented Programming Systems, Languages, and Applications) Educators' Symposium, Portland, OR, October. http://research.csc.ncsu.edu/efg/expertiza/papers/oopslaes06.pdf (accessed May 25, 2007).

Gehringer, E. F., L. M. Ehresman, S. G. Conger, and P. A. Wagle. 2006. Reusable learning objects through peer review: The Expertiza approach. Paper presented at Frontiers in Education 2006, San Diego, CA, October. http://fie.engrng.pitt.edu/fie2006/papers/1523.pdf (accessed May 25, 2007).

Haberyan, K. 2003. Do weekly quizzes improve student performance on general biology exams? *The American Biology Teacher* 65 (2): 110-14. http://www.eric.ed.gov/ (accession no. EJ665339; accessed May 25, 2007).

Johnson, D. W., G. Maruyama, R. T. Johnson, D. Nelson, and L. Skon. 1989. Effects of cooperative, competitive and individualistic goal structures on achievement: A meta-analysis. *Psychological Bulletin* 89:47-62. http://www.eric.ed.gov/ (accession no. EJ254134; accessed May 25, 2007).

Kochery, T. 1997. Distance education: A delivery system in need of cooperative learning. Paper presented at the 1997 National Convention of the Association for Educational Communications and Technology, Albuquerque, NM, February. http://www.eric.ed.gov/ (accession no. ED409847; accessed May 25, 2007).

Levin, D. S., and M. G. Ben-Jacob. 1998. Using collaboration in support of distance learning. Paper presented at the 3rd WebNet 98 World Conference of the WWW, Internet and Intranet, Orlando, FL, November. http://www.eric.ed.gov/ (accession no. ED427716; accessed May 25, 2007).

Macdonald, J., and P. Twining. 2002. Assessing activity-based learning for a networked course. *British Journal of Educational Technology* 33 (5): 603-619. http://www.eric.ed.gov/ (accession no. EJ657891; accessed May 25, 2007).

Orsmond, P., S. Merry, and K. Reiling. 2000. The use of student derived marking criteria in peer and self-assessment. *Assessment and Evaluation in Higher Education* 25 (1): 23-38. http://www.mah.se/upload/Bolognaprocessen/Orsmond%201%20Assessment%20in%20Biology.pdf (accessed May 25, 2007).

Phillips, J. M. 2005. Strategies for active learning in online continuing education. *The Journal of Continuing Education in Nursing* 36 (2): 77-83.

Plutsky, S., and B. A. Wilson. 2004. A comparison of three methods of teaching and evaluating writing: A quasi-experimental study. *Delta Pi Epsilon Journal* 46 (1): 50–61.

Skrien, D. J. Forthcoming. *An introduction to object-oriented design and design patterns using Java.* New York: McGraw-Hill.

Stefani, L. A. J. 1994. Peer, self, and tutor assessment: Relative reliabilities. *Studies in Higher Education* 19:69-75.

Sterngold, A. 2004. Confronting plagiarism: How conventional teaching invites cyber-cheating. *Change* 36 (3): 16-21. http://findarticles.com/p/articles/mi_m1254/is_3_36/ai_n6153014 (accessed May 25, 2007).

Swain, H. 2005. Nip double trouble in the bud. *The Times Higher Education Supplement* 1676 (January 28): 58.

Totten, S., T. Sills, A. Digby, and P. Russ. 1991. *Cooperative learning: A guide to research*. New York: Garland.

Van Lehn, K. A., M. T. H. Chi, W. Baggett, and R. C. Murray. 1995. *Progress report: Towards a theory of learning during tutoring*. Pittsburgh, PA: Learning Research and Development Center, University of Pittsburgh.

USAToday.com. 2002. Hot sites. February 6. http://www.usatoday.com/tech/2001-04-05-hotsites.htm (accessed May 25, 2007).

Vispoel, W. P., and J. R. Austin. 1995. Success and failure in junior high school: A critical incident approach to understanding students' attributional beliefs. *American Educational Research Journal* 32 (2): 377-412. http://www.eric.ed.gov/ (accession no. EJ511006; accessed May 25, 2007).

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