AC 2012-5580: WEB 2.0 ETHICS EDUCATION: PATENTS AND COPYRIGHT FOR STEM STUDENTS

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Web 2.0 Ethics Education:
Patents and Copyright for STEM Students

Abstract

Understanding the basics of intellectual property law and the norms of scholarly publishing are essential to ethics education for STEM students. Three factors contribute to its urgency: federal mandates for ethics education for STEM students engaged in funded research; today's "remix culture," which has the potential to violate intellectual property rights; and the burgeoning numbers of international STEM students who may be unfamiliar with U.S. standards. Since 2010, Michigan Technological University has partnered with University of Texas-Pan American to deliver an NSF-funded (award # 0933026) 12-week ethics education program which promotes collaborative learning and offers scheduling flexibility for busy STEM graduate students through the innovative use of educational and communication technologies. Grounded in Pask's model of conversation theory, the program engages student peers as well as patent and copyright experts in conversations using Web 2.0 technologies to encourage and capture group interaction and build critical thinking skills in the intellectual property domains of U.S. patent and copyright law. Student learning and satisfaction were evaluated using pre- and post-tests, rubric-guided expert evaluation of conversation transcripts and problem solutions, focus groups, and feedback forums, all designed to provide guidance for continuous improvement of course delivery and content. Investigators will report lessons learned, student responses, application of the program to an undergraduate NSF-funded REU program, and transition to a sustainable ethics education program for STEM graduate students.

Intellectual Property for STEM Students

Understanding the basics of U. S. intellectual property law and the norms of scholarly publishing – copyright and appropriate attributions, fair use, falsification of data, plagiarism, and patent rights and infringement – are essential to ethics education for STEM students.[1] Three factors contribute to its urgency:

1. Federal mandates for responsible conduct of research (RCR) for students engaged in funded research. Ethics education in intellectual property and scientific publishing is a significant component of RCR. It is not concentrated in any one domain, but rather addressed in various RCR topics, including treatment of data (acquisition, management, sharing, and ownership), conflicts of interest, multi-investigator and multi-institution collaborative science, allocation of credit, publication practices and responsible authorship, ethical standards (legal, institutional, and discipline-based) and societal expectations.
2. Today's "remix culture," which encourages information usage that has the potential—whether intentional or accidental—to violate intellectual property rights. The term "remix culture" was coined by Lawrence Lessig to describe the culture of mixing information with peer-to-peer technologies, open source software, easy and inexpensive editing tools, and digital input devices.[2, 3]

3. Large numbers of international STEM graduate students who may be unfamiliar with U.S. standards for patents and copyright.

According to the United Nations' World Intellectual Property Organization, [4] there is a pressing need to educate the diverse global citizenry about intellectual property. National economies are increasingly based on the production of knowledge-based goods and services, and the international cross-border flow of knowledge-based goods and services is growing dramatically. This is a great challenge, since intellectual property rights around the world reflect diverse cultural norms and varying stages of economic development. Because today's students are tomorrow's policymakers, it is incumbent upon U.S. institutions of higher education engaged in research, which create intellectual property that is subject to U.S. laws, to deliver ethics education on U.S. intellectual property standards as a critical component of STEM graduate programs.

Active Learning and Asynchronous Learning Networks

Understanding intellectual property and scientific publishing is not a simple undertaking. It requires understanding and applying complex concepts to varied situations where the appropriate response is not always clear-cut. For example, one of the significant challenges in understanding copyright is accepting the deliberate ambiguity in concepts such as "fair use" and the need for a user to take personal responsibility in accessing copyrighted materials. While these concepts are difficult and seem ambiguous, they are important for the STEM research community to understand. If graduate students understand the reasonable bounds of fair use, for example, it will help them reduce the perceived ambiguity, decide what information to use and how to use it, and be aware of how copyright holders may assert their rights in ways which inhibit dissemination of scientific knowledge.

Educating students about intellectual property thus requires higher order cognitive processes of analysis, synthesis, evaluation, and creating, as well as lower order processes of remembering and understanding.[5, 6] Higher order processes are better developed through active learning strategies which place more emphasis on engagement, participation, and developing a critical understanding of concepts than passive models of content delivery, while also enabling better content retention.[7, 8, 9] Scholars and educators have advocated active learning for decades following the pioneering work of Piaget[10] and Kolb.[11] Active learning consists of four basic elements: 1) talking and listening, 2) writing, 3) reading, and 4) reflecting. Effective strategies also often utilize small groups, cooperative student projects, and case studies that provide opportunities for applying learned content.[12] Similarly, conversation theory suggests that knowledge is created through interaction, and specifically, conversation—it is the "process of knowing and coming to know," not the "storage of representations."[13, 14] Knowledge is acquired through conversation and resource building to create a community of practice and knowledge system or repository.[14, 15] Pask's model of conversation theory has particular relevance for science education: peer learners as well as teacher and learners can engage in conversations which address both "why questions," in which new conceptual knowledge is integrated with existing conceptual knowledge to form a coherent whole, and "how questions" in which new methods are applied to solving problems.[13]

Ethics education is often delivered through self-paced learning that is completed individually. While this method allows training to be implemented within an already full curriculum with few additional required resources, the method precludes the creation of knowledge through conversation. As a result, we believe it also leads to inadequate student learning and discovery. Unfortunately, graduate students' and campus experts in copyright and patents have many obligations during a semester that make it difficult to find time to regularly meet for face-to-face conversations in a traditional classroom setting. One way to remedy this is an asynchronous learning network (ALN) that combines a learning management system (LMS) and Web 2.0 social learning tools to enable conversation while integrating a broad range of resources and engaging the expertise of experts.

Asynchronous learning networks (ALNs) designed for online learning have been the subject of research by the Sloan Consortium for online education.[16] ALNs have potential to scale up and generate discussion that promotes critical thinking and active learning by diverse students at different times and places.[17, 18] The most common second-generation web technologies (Web 2.0) that can be used in ALNs are blogs, discussion boards, RSS feeds, and wikis. Blogs are organized chronologically, can be linked and referenced, and can be tracked with RSS (really simple syndication) feeds; they are increasingly used in educational settings.[19] Electronic discussion boards (EDBs) approximate blogs and have been used successfully to teach RCR, receiving high ratings for student satisfaction, analyzing ethical dilemmas and promoting debate and in-depth discussion.[20] Both allow for relaxed, thoughtful response. A wiki is a web-based software tool that allows users to change content by editing online, making it a simple platform for collaborative writing[21] yet a potent tool for dynamic, collaborative knowledge construction.[22] Called the "architecture of participation" in which knowledge is created through user-generated content ,[23] a wiki is a shared repository of knowledge that can be easily edited, while all content remains visible and traceable to participants, making the process of knowledge construction transparent. Wikis develop advanced-level skills of idea modification, summary, synthesis, and application. Participants' contributions to wikis should be evaluated on contribution to process as well as results, in response to complex problems with no preset solutions, after ample time for development.[24] Wikis are conducive to the formation of communities of practice which serve to expand knowledge and improve professional practice.[25, 14]

Program Design and Assessment

In response to the urgent need for ethics education in intellectual property, and the desire to use a pedagogy of active learning that enables conversation, Michigan Technological University and the University of Texas-Pan American (UTPA) developed a program funded by NSF (award # 0933026) to improve STEM graduate students' understanding of copyrights and patents using web 2.0 tools to enable asynchronous learning. Our focus was not on developing new content, but on delivering access to the best content in the public domain and creating and testing a new infrastructure for conversation.

The core of the infrastructure for active and asynchronous learning was a learning management system (LMS; Blackboard Learning System was the LMS used by both universities). The LMS provided a dedicated website where content experts (librarian experts in copyright and faculty and staff experts in patents) and students interacted asynchronously. Content experts used the LMS in three ways. First, they developed and posted to the LMS a content library of materials in the public domain which students could access at any time through the LMS. These were developed jointly by Michigan Tech and UTPA content experts. Second, they developed and posted to the LMS a series of short case studies or scenarios that posed problems to be solved by students engaging in conversation. The copyright problems were developed jointly by Michigan Tech and UTPA content experts. Case studies are a tested methodology for active learning which develops higher order cognitive processes.[26] By exploring issues directly rather than being presented with "answers," students develop skills for developing and supporting informed positions on issues where right and wrong come in shades of gray, and where statute, case law, ethics, and professionalism are all relevant. Third, content experts monitored student conversation in the LMS and contributed as needed to the conversation to assist student learning; they also conducted optional synchronous chat sessions with students once a week.

Students could access the LMS at any time for content posted by the content experts, but more importantly they used the LMS to engage in asynchronous conversation to solve the problems posed. They began by discussing the problems using a blog linked to the LMS or a discussion board internal to the LMS. After the discussion period, the students then asynchronously wrote team solutions to the problem using a wiki for collaborative writing (at first external and linked to the LMS, then internal to the LMS). The LMS was able to capture each student's contributions both to the discussion and to the wiki, which was critical for evaluation of student learning.

STEM graduate students were recruited through the graduate school. The incentive to participate was learning about intellectual property and a non-credit certificate for successful program completion. Students voluntarily self-selected into the program and a variety of disciplines were represented each semester. Responsible Conduct of Research (RCR) training was not required for all graduate students at the university, and no course credits were able to be allocated to the program.

The program was structured as follows. New students were recruited each semester. Students first participated in a face-to-face orientation in which they practiced using the Web 2.0 tools, met the content experts, and were introduced to the first problem. They were then assigned to small teams of 4-7 students. Each team solved two problems per semester (one copyright problem and one patent problem). To solve the problem, students first engaged in conversation with their team through the LMS, and then proceeded to develop a solution in the wiki linked to or incorporated within the LMS. Students were instructed not to have "offline" conversations, since this was a research project designed to test the effectiveness of online asynchronous learning. Content experts monitored the online conversation and wiki writing and facilitated problem solution by making suggestions about content in the library or lines of inquiry. All teams worked on the same problem concurrently but independently and had five weeks to solve the problem. All team solutions were posted in the LMS after the completion deadline for students to compare.

Federal agencies have indicated a preference for RCR training that has a face-to-face component in addition to online training. For this reason, in addition to the face-to-face orientation, after solving the problem online all students again met face-to-face to discuss the solutions with the content expert and provide feedback on the process. This provided an opportunity for synchronous conversation in which the content expert and students addressed the "why and how questions" to better integrate their new conceptual knowledge about intellectual property with the problem solution.[13] After this meeting, a post-test of content knowledge was administered. While the two face-to-face sessions preferred by the funder departed from the ALN model, both could have been accomplished asynchronously. Since the learning that was evaluated took place primarily during asynchronous mode (the orientation focused on use of the LMS, and the final session focused more on process feedback than problem solution), we do not believe these synchronous sessions had a significant impact on student learning results.

Student problem solutions were evaluated by the content experts using a rubric developed by the content experts and evaluator. The content experts also used a rubric to evaluate the quantity and quality of participation in the conversation that generated the solution (blog and wiki software allowed all student participation to be captured for review). The evaluation of participation was important to counter the phenomenon of "free riders" that can sometimes occur in team-based learning. Students successfully completed the problem if both their team's problem solution and their individual participation were adequate.

Because intellectual property issues are complex, assessment methods focused on students' ability to identify issues and present well-reasoned positions in response to open-ended questions and scenarios. Semi-qualitative measures of learning included tracking of the proportion of issues spotted, occurrence and proportion of properly used terminology, and length of response. In addition to evaluation of student performance, an external evaluator assessed the effectiveness of the program at the end of each semester. Both qualitative and quantitative methods were used to determine the project's success at meeting its intended outcomes. Qualitative data was collected through focus groups led by the evaluator and feedback sessions convened after each problem solution. Quantitative data were collected through pre- and post-program content-area tests that were designed to gauge participants' level of understanding of concepts related to patents and copyright. Together the qualitative and quantitative data[17] were used to determine levels of student engagement and content-area learning outcomes. The results of evaluation were also used to continually improve the project.

An important aspect of this program is that it was designed to test the effectiveness of its approach with more than one student population. At Michigan Tech, the approach was tested with domestic students drawn from a dominantly white, non-Hispanic population, as well as international students, in science and engineering. In contrast, UTPA enrolls the highest percentage of Hispanic students (86%) of any public university in Texas. Both Michigan Tech and UTPA are comprehensive in their graduate program offerings with significant numbers of students enrolled in STEM disciplines. If the program is successful at both Michigan Tech and UTPA, it has the potential to be successful at additional sites and with additional student populations.

Figure 1 displays the logic model for the program, which was designed to produce a tested, replicable model for delivering education that meets federal, state, and university-level regulations regarding the preparation of students to understand complex issues related to patents and copyright.

Program Evaluation

By fall 2011, the program had run for three semesters at Michigan Tech, with 28 students successfully completing the program; a cohort of students started the program at UTPA during the fall 2011 semester. Data regarding the effectiveness of the program was collected in two ways.

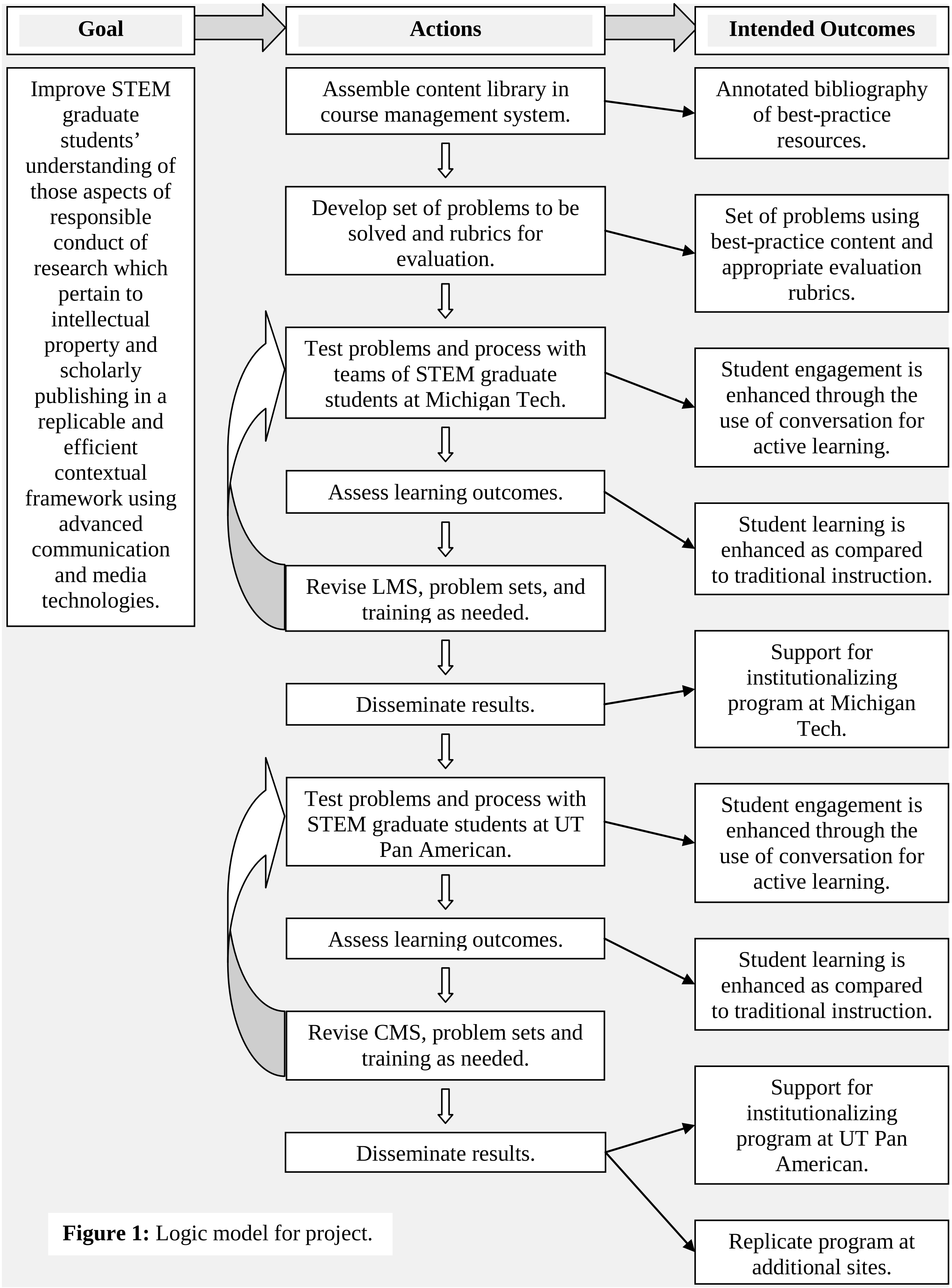

Figure 1: Logic model for project.

First, participants' knowledge regarding patents and copyrights was assessed prior to and following the program using a content-area test administered to the participants via the LMS. The pre/post-test design was used to determine whether the conversation-theory-based design for knowledge construction succeeded in developing the knowledge that students need to acquire.

Once administered, the pre- and post-program tests were forwarded to the external evaluator who coded the tests and forwarded them to the patent and copyright experts for review and scoring. Coding reduced the likelihood that a scorer would know which participant submitted a specific test and whether a specific test was taken before or after the program. Two versions of the content-area test were produced. One-half of the participants took the first version before the program and the second version after the program. The other one-half of the participants took the content-area tests in the opposite order. This was done to reduce the likelihood that participants' post-test scores would be biased due to prior familiarity with questions and to help to correct for any real or perceived differences in difficulty between the two tests. Content-area tests were scored using the rubric shown below.

- 0 points = no response
- 1 point = response demonstrates no understanding of concept
- 2 points = response demonstrates minimal understanding of concept
- 3 points = response demonstrates good understanding of concept

Qualitative data were also collected to aid in determining the effectiveness of the program and to provide information to the project team that would help the program to better meet participants' needs during future offerings. Qualitative data were collected through focus groups held by the external evaluator. These focus groups were gathered at the beginning and end of each semester and participants were asked a series of questions designed to determine their reasons for taking the course, their prior experience with patents, copyright, and online learning, and their impressions of the course and its impact on their understanding. Participation in the focus groups was optional and all responses were kept strictly confidential by the evaluator. Additional qualitative data was collected through face-to-face feedback sessions convened by the project team at the end of both the patent and copyright sections of the course. The feedback sessions differed from the focus groups in that the project-team knew which participant made specific comments. The focus groups were complementary to the feedback sessions in that they gave participants the opportunity to express their opinions confidentially. Information collected by the evaluator during the feedback sessions and the focus group was aggregated and then reported to the project team through a written annual report.

Results

The first Michigan Tech cohort (spring 2010) was a learning experience for the program team as well as the students. 21 students had expressed interest in participating, but only 5 successfully completed the copyright problem; 2 successfully completed the patent problem. The decline in enrollment resulted primarily from many demands on student time and the fact that the program was not required. Participation declined dramatically when students faced many other deadlines and obligations. Student feedback received after the completion of the patent problem (the first problem) was used to revise program delivery for the copyright problem. The major issue faced by the program team for students who persisted was how to encourage students to work as teams to develop solutions to the problem. Student comments after the first (patent) problem indicated that (1) students wanted information to come from the instructors, (2) they preferred to converse with instructors rather than each other, and (3) they found it difficult to feel like members of a team without having face-to-face interaction. They also tended to procrastinate when faced with a problem solution deadline five weeks in the future. Changes which the program team made to improve the second (copyright) problem were (1) a face-to-face ice-breaker exercise for students to get to know their team members, (2) weekly assignments with requirements for online participation, and (3) a weekly online chat with the instructor after the weekly assignment was completed. For a full ALN design, an online ice-breaker could be developed and pictures of participants could be incorporated to foster relationship-building.

These changes had a positive impact on students' perceptions of the program, and fewer recommendations were made at the conclusion of the second (copyright) problem. Students' comments indicated that they were initially interested in the topics and that they increased both their interest in and understanding of the topics as a result of the program. The program was clearly successful in delivering content to the participants who completed it.

The program team continued to address student concerns in 2010-11 by building more student-requested structure into the program, and increasing the amount of interaction required. Building on feedback from students, the following changes were made for 2010-11:

- Started the semester with the copyright problem, and then moved on to the patent problem. Students could identify more easily with copyright issues because they faced these issues in coursework papers and thesis or dissertation writing. Patents were considered more difficult by the students, in part because of the legal language and system, and in part because the patent examples were not always immediately applicable to their own fields of study.
- Included team-building exercises during orientation and posted pictures of group members. This allowed students to get to know each other, build an identity as a team and develop a commitment to working with each other.
- Moved all tools to a single LMS to make communication and learning easier for students. Students had some difficulty negotiating between external blogs and wikis and LMS content.
- Incorporated more structure into the problem-solving process. This helped to reduce procrastination, to lead the students toward the problem solution by directed use of the LMS library content, and to encourage team interaction.
    - Gave the students the final problem assignment (copyright challenge and patent challenge) at the launch of each module.
    - Broke down each copyright and patent problem into 5 weekly assignments, which included dictionary terms and a weekly team wiki challenge. The final assignment was the wiki response to the challenge posed at the launch.
    - Established a regular weekly schedule: assign problem, review all team wikis and participate in online class chat on Monday, post to group discussion board by Wednesday, reply to two group posts by Friday, complete group wiki by Sunday.
    - Provided students with direction for composing acceptable discussion board entries.
- Provided more cues and reminders to keep students engaged in the program.
    - Provided regular notifications of upcoming due dates.

    - Provided notification to group members when something was posted to their group discussion board.
- Used the weekly chat with the content expert for clarification, redirection and sharing perspectives.
    - Asked students to supply a question to the content expert before the chat.
    - Provided new weekly assignment and copies of all group weekly wikis to all teams before the chat so these could be discussed.
    - Provided feedback about past week's wikis during the chat to instill a level of competition.
    - Provided a chat log to students.

Retention in the program during the second (2010-2011) year was much higher than during the first semester the program was offered; 14 of 18 students completed the program in fall, and 12 of 17 completed in spring. The evaluator attributed the improved retention to the fact that the project team incorporated the results of the formative assessments to make changes to the program so that it was better for students who have many other demands on their time. Nonetheless, competing demands on time again appeared to be the primary reason for students leaving the program.

Analysis of the quantitative data indicates that the program was effective in helping students to learn the intended content (Figure 2). The gain scores (Figure 3) for both the patent and copyright components of the project showed that the program was effective in imparting content-area knowledge to participants as measured by the pre- and post-program content-area tests. As shown in the figure captions, the number of participants in the program each semester was relatively small. The largest group to complete the program consisted of 14 individuals (fall, 2010). Therefore the semester-to-semester variations shown in Figures 2 and 3 should not be considered significant. Of the three semesters, the group that participated in fall, 2010 had the highest mean scores at the beginning and end of the program. The variability shown in the data most likely reflect the varying interests of the different groups of students who participated in the program during the different semesters. The program requires extensive group work and students with strong opinions and/or interests certainly influenced the emphasis placed on different topics each semester. The ability to tailor instruction and focus to meet the needs and interests of the participants was a key element of the program's design, but it probably is responsible for the variations shown in Figures 2 and 3.

To test the effectiveness of the program at improving content-area understanding among participants in the areas of patent and copyrights, gain scores (figure 3) were aggregated for spring 2010, fall 2010, and spring 2011. This aggregate dataset was then tested using a t-test to determine if the mean of the distribution was different from a value of zero. The results of the t-testing indicate that the results are statistically significant with $p<0.01$. This result indicates that the program had a significant positive impact on participants' level of understanding of patents and copyrights.

The issues identified as areas of concern during fall 2010 appear to have been successfully addressed during the 2010-11 year. Students reported that there were good discussions and chats, and that most people participated in those. Also there were no complaints this year about having to work as a team.

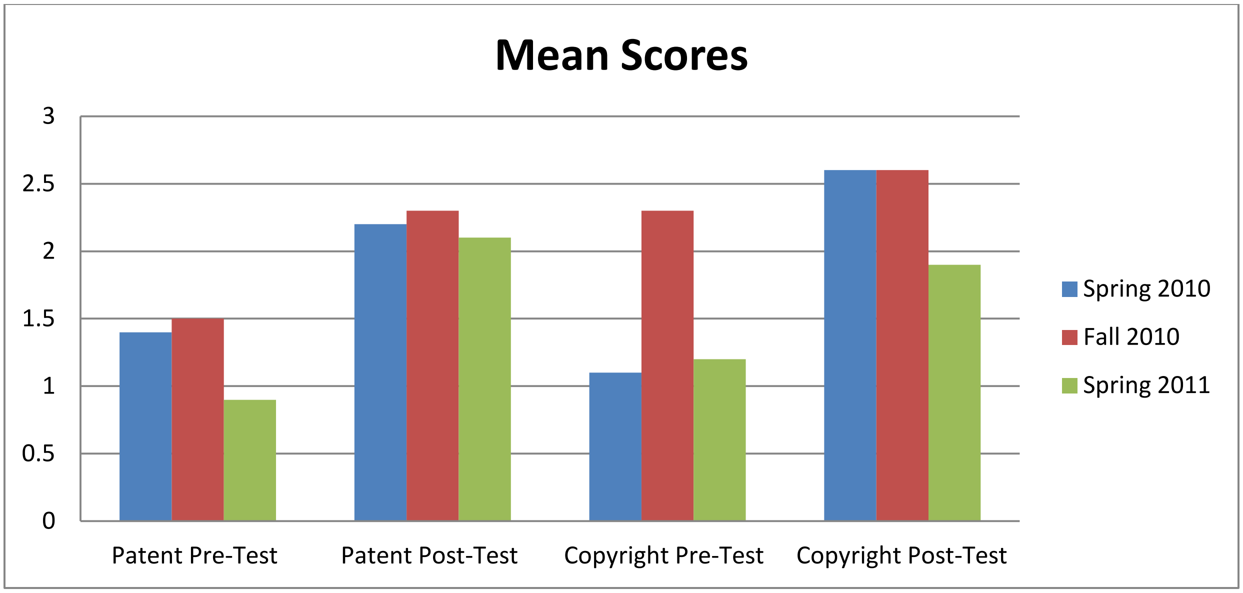

Figure 2: Mean scores on pre- and post-program content area exams. Mean scores shown in this chart are the numerical average of the scores received by participants in the program. Participants were tested on both patent concepts and copyright concepts on both the pre- and post-program tests. The ranges in scores (minimum to maximum) are listed here in the following order: Spring 2010, fall 2010, and spring 2011. Patent pre-test: 0-3, 0-3, and 0-3. Patent post-test: 1-3, 1-3, and 0-3. Copyright pre-test: 0-2, 1-3, and 0-2. Copyright post-test: 2-3, 1-3, and 0-3. The numbers of students who took the pre- and post-program tests, respectively, by semester are: Spring 2010, 16 and 5; fall 2010, 18 and 14, and spring 2011, 17 and 12.

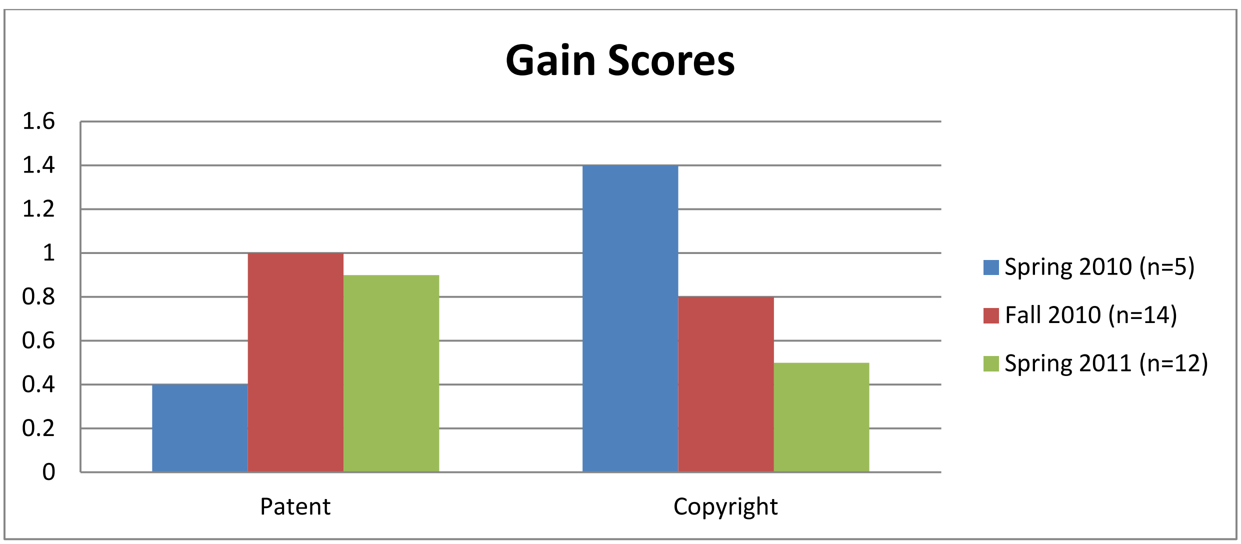

Figure 3: Gain Scores for the pre- and post-program content-area tests in the areas of patents and copyrights. Gain scores are calculated for individual participant as that individual's post-test score minus their pre-test score. Gain scores are only calculated for individuals that completed both the pre-test and the post-test. The ranges in gain scores (minimum to maximum) are listed here in the following order: Spring 2010 (N=5), fall 2010 (N=14), and spring 2011 (N=12). Patent: (-1) to 2, 0 to 2, and (-1) to 3. Copyright: 1 to 2, (-1) to 2, and (-1) to 2. A negative gain score indicates that an individual received a lower score on the post-test than that individual received on the pre-test. N refers to the number of

individuals who completed both the pre- and post-program tests and for which gain scores were calculated.

Students in the post-course focus groups reported that they felt that online learning could be as effective as face-to-face. This is a positive achievement for the project. Their comments indicated that they felt the online approach was more engaging than face-to-face lecture courses, more efficient, and more flexible; they felt more relaxed and had more time to think about responses; and they probably learned more than in a traditional course because they had to put together their own responses without being told exactly what to do. They reported that the whole-group chats were “fun” and that the chats worked really well when the instructor asked for questions ahead of time and then restated them and answered them so it was clear what was being talked about. They would have liked the instructors to comment on each group’s work in order to provide more feedback.

The biggest issue in 2010-11 was student frustration with the LMS software. The graduate student who assisted with the program also found the software difficult to use. The evaluation data clearly indicate that the software is a problem and a different package should be used. In summer 2011 an NSF-funded undergraduate research (REU) program was delivered with an ethics component using a similar Web 2.0 design, but with content more aligned with the needs and interests of undergraduate researchers; a new LMS was tested which was significantly easier to use, and this LMS has been adopted by the university as whole for 2012.

Next Steps

The program is being piloted for students at UTPA during the 2011-2012 academic year and continued at Michigan Tech during spring semester 2012. The program team at Michigan Tech is carefully evaluating required elements of Responsible Conduct of Research (RCR) training and working to ensure that future offerings of the intellectual property/ethics education program satisfy those requirements and provide an alternative to conventional RCR training opportunities. If this program can be used to complete required RCR training for graduate students engaged in research, it may encourage more graduate students facing multiple demands on their time to learn about the increasingly important concepts of copyright and patents.

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