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ABSTRACT

The Environmental Inquiry (EI) program (Cornell University and Pennsylvania State University) supports inquiry based, student-centered science teaching on selected topics in the environmental sciences. Texts to support high school student research are published by the National Science Teachers Association (NSTA) in the domains of environmental toxicology, watershed dynamics, biodegradation, and the ecology of invasive species. The first of these publications, "What's the Risk?" was published in 2001 and includes bioassay protocols for assessing the toxicity of substances. Secondary school science students can post the results of their bioassays on a Web server and participate in a process of anonymous peer review and "publication" of their research. Teachers and secondary students who have participated in the process reported finding it interesting and useful; however, we recognized that many teachers are unfamiliar with both the underlying science (toxicology) and the process and importance of peer review in scientific method. In Spring 2001, the protocol and peer review process was pilot tested with prospective science teachers in a secondary science methods course at Penn State, using a companion Web site set up specifically for college-level students. The results of that pilot test suggested that the research and peer review protocols could be adapted for use by introductory level college science students, including prospective science teachers. This paper reports the results of a multi-site expansion and test of that pilot work, undertaken in Fall 2001. (Author)

# Environmental Inquiry by College Students:

# Original Research and Peer Review Using Web-Based Collaborative Tools

## Preliminary Quantitative Data Analysis

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April, 2002



Paper distributed at the annual meeting of the American Educational Research Association, New Orleans, LA, April 1-5, 2002. This paper utilizes data from a project conducted by Eleanor Abrams, University of New Hampshire; Kathryn Ahern, Hofstra University; Mustafa Cakir, Penn State University; William Carlsen, Penn State University; Charles Eick, Auburn University; Francis Gardner, Columbus State University; Nabarun Ghosh, West Texas A & M University; Lisa Kenyon, Texas A&M University at Galveston; John Moore, University of Northern Colorado; Hedy Moscovici, California State University Dominguez Hills; Judy Robb, University of New Hampshire; Mark Thomson, Xavier University of Louisiana; Nancy Trautmann, Cornell University; Sandra West, Southwest Texas State University; and Bugrahan Yalvac, Penn State University

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## Introduction

The Environmental Inquiry (EI) program (Cornell University and Pennsylvania State University) supports inquiry based, student-centered science teaching on selected topics in the environmental sciences. Texts to support high school student research are being published by The National Science Teachers Association (NSTA) in the domains of environmental toxicology, watershed dynamics, biodegradation, and the ecology of invasive species. The first of these publications, What's the Risk?, was published in 2001 and includes bioassay protocols for assessing the toxicity of substances. Secondary school science students can post the results of their bioassays on a web server and participate in a process of anonymous peer review and "publication" of their research. Teachers and secondary students who have participated in the process reported finding it interesting and useful; however, we recognized that many teachers are unfamiliar with both the underlying science (toxicology) and the process and importance of peer review in scientific method.

In Spring 2001, we pilot tested the protocol and peer review process with prospective science teachers in a secondary science methods course at Penn State, using a companion website set up specifically for college-level students. The results of that pilot test suggested that research and peer review protocols could be adapted for use by introductory level college science students, including prospective science teachers. This paper reports the results of a multi-site expansion and test of that pilot work, undertaken in the Fall of 2001.

## Participants and Purpose of the Study

This research involved college students in science courses, pre-service science education courses, and science studies courses at 11 colleges and universities around the United States. The overall goal of the project was to promote science education by engaging students in a sociologically authentic scientific research project including anonymous peer review. The project was designed to enable students to experience science as a mode of inquiry rather than a static collection of facts.

This paper presents some preliminary quantitative data from the 11-campus project, which was carried out in the Fall of 2001. Data are included from 10 campuses (the eleventh yielded only one student's data and is omitted from the analysis). A number

of the faculty participants in the project will meet for the first time at the AERA (American Educational Research Association) and NARST (National Association for Research in Science Teaching) professional meetings in New Orleans in April, 2002; this paper is intended to be used as a resource for discussion of the project and the development of plans for "next steps."

**Research Questions Guiding Initial Analysis**

1. What do students perceive as the strengths and weaknesses of the model, rating the protocol specifications and written materials, the online systems, the quality of the reviews they received, and the extent to which they perceived that their experiences were scientifically "authentic?"
2. How are the final drafts of students' research reports affected by peer reviews?
3. Do reports improve significantly when authors receive detailed, consistent reviews?

**Methods of Data Collection**

All activities were organized to provide an opportunity for students to learn how to frame research questions, design and carry out experiments, critically analyze their results, write a report, and defend their conclusions to their peers. Participating students engaged in original research, computer-mediated collaboration, peer review, and online publishing. They conducted a bioassay experiment, posted their results on a web server, and completed anonymous peer reviews. Peer reviews were submitted using a form that is reproduced in Appendix B. A questionnaire with both fixed-format and open-response questions was administered anonymously at the end of the semester. It is reproduced in Appendix C.

Students worked in pairs to conduct the bioassay experiment and tally their results, but posted individual reports and completed individual peer reviews. The reports followed a common, question-driven format, and quantitative data were entered using a table tool.

After completing their own lab reports, students had about a week to complete online peer reviews of two other students' projects. Students composed their peer reviews using a structured data entry screen with two quantitative items and three essay items.

Peer reviews were anonymous; only report authors and instructors were given access to their contents. The matching of reports and reviewers was nonrandom but anonymous across institutions.[2] User data, reports, and peer reviews were stored in the database in related tables. The final common stage of the project was "publication" of reports after students made revisions using peer review feedback. Since many of the major activities of the project occurred online (report writing, peer review, publication) most of the data were collected automatically.

**Data Analysis and Discussion**

We began analysis by reorganizing data tables that had been collected by our server using Microsoft Access. Our first task was data cleaning and the creation of one inclusive table by combining a user table, reports table, written reviews table, received reviews table, and final questionnaire table.[3] This was a very complex process, and some of the methodological steps we undertook are summarized in Appendix A. Once a comprehensive clean data table was created in Access, we exported it to statistical software (SPSS) for quantitative analysis.

There were 411 student participants. 341 (83%) gave permission for us to use their responses in research. We did a number of checks of participant-response bias and saw no meaningful differences between permission-granters and others. The following analyses are limited to the 341 individuals who gave consent. However, the peer review scores assigned to consenters by non-consenters are included, without any identifying information about the latter.

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[2] Students at the different universities completed the experiment at different times within an approximately two-month time frame. Instructions to students about how to select reports to review were left to the instructors' discretion. At Penn State, for example, we had our students complete the experiment first, then asked them to hold off on completing reviews until the results had been posted from two other institutions. At least one instructor encouraged his students to try to review another report that assessed the toxicity of the same chemical they had assessed. In most cases, however, students chose reports to review based only on the title of the report, which included the name of the chemical being assessed and an author-determined 5-digit code. Lab partners shared their 5-digit codes with each other so they could avoid reviewing their partner's report, which would have presented a conflict of interest.

[3] The complexity of the source data were functions of the peer review design process and the underlying software infrastructure. For example, most bioassay reports were reviewed by two different reviewers: in database terms, this is a "one-to-many relationship" between report and reviews, and such data are typically stored in separate tables. Furthermore, each author wrote two reviews, and these reviews provide information related to the review author as well as the source report, so there is a second one-to-many relationship between users and reviews.

In the following pages, data are presented as were gathered by the automated system. We provide discussion to address related issues and their relevance where necessary.

**Are you in a teacher education program?**

Although there were teacher education students at most of the participating colleges, they were outnumbered by science majors. 44 participants' major could not identified (this information was provided in the final questionnaire, which not all consenters completed); therefore out of 341 participants, 297 are reported in this table. The following table reports the number of students and whether they are in a teacher education program, by school.

| | Frequency | Percent |
|---|---|---|
| No | 203 | 68.4 |
| Yes | 94 | 31.6 |
| Total | 297 | 100.0 |

| | University | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **School code** | **1** | **3** | **4** | **5** | **6** | **7** | **8** | **10** | **11** | **12** | **Total** |
| | Number of students | | | | | | | | | | |
| Not a teacher ed student | | 20 | | | 1 | 123 | | 1 | 9 | 49 | 203 |
| Teacher ed student | 16 | | 28 | 12 | 2 | 5 | 11 | | 20 | | 94 |
| **Total teacher ed status known** | **16** | **20** | **28** | **12** | **3** | **128** | **11** | **1** | **29** | **49** | **297** |
| **Teacher ed status unknown** | **0** | **0** | **0** | **0** | **3** | **0** | **0** | **9** | **31** | **0** | **43** |

Missing values = 44, 12.9% of the total N of 341 consenters.
One non-consenting participant is omitted, the only student from an 11th university.

**What are your gender and minority group affiliations?**

74 participants (21.7%) were male. Statistical analyses did not yield significant differences on any variables between male and female students. Differences among schools in gender distribution were not statistically significant. With the exception of one school, universities with more than six participants all had female participants outnumbering male participants by at least three to one. This was true among science courses as well as science education courses.

| | Frequency | Percent |
|---|---|---|
| Female | 264 | 78.1 |
| Male | 74 | 21.9 |
| Total | 338 | 100.0 |

17.6% of the students who completed the final questionnaire identified themselves as members of underrepresented minority groups (African-American, Hispanic, Native American). There were no statistically significant differences associated with this response on any measure. 6.2% reported that English was not their first language; no statistically significant differences were detected for this measure either.

**Basic descriptive statistics for the final student questionnaire**

Of the 341 students who submitted reports and gave consent for research, 192 (57% of consenters) completed the final questionnaire. Summary statistics from the questionnaire (reproduced in Appendix C) are reported below. We used Likert-scale items, where 3 = "Neutral," 4 = "Agree somewhat," and 5 = "Strongly agree."

| | Descriptive Statistics | N | **Mean for all students** | Mean for teacher ed students | Mean for other students |
|---|---|---|---|---|---|
| 1 | I learned something by writing peer review comments | 192 | **3.96** | 3.82 | 4.05 |
| 2 | I felt qualified to provide meaningful peer review of other students' reports | 192 | **3.73** | 3.65 | 3.78 |
| 3 | I believe that the peer reviews I wrote should be helpful to the students that received them | 192 | **3.98** | 3.97 | 3.99 |
| 4 | Peer reviewing other students has helped me to think more critically | 193 | **4.10** | 4.08 | 4.11 |
| 5 | Peer reviewing other students has helped me to improve my own scientific writing | 193 | **4.02** | 3.90 | 4.08 |
| 6 | I received useful peer review comments about my own report | 192 | **3.53** | 3.36 | 3.63 |
| 7 | The quantitative scores I received from peer reviewers were fair | 192 | **3.60** | 3.51 | 3.66 |
| 8 | I changed my mind about something in my report because of comments I received through peer review | 192 | **2.99** | 2.94 | 3.02 |

| | | | | | |
|---|---|---|---|---|---|
| 9 | It is easier to say what I really think when I don't have to sign my name or meet in person with the students | 192 | **3.71** | 3.69 | 3.72 |
| 10 | I think that meaningful peer review is a reasonable expectation for college students | 190 | **4.23** | 4.21 | 4.24 |
| 11 | I think that meaningful peer review would be a reasonable expectation for high school students | 190 | **3.88** | 3.96 | 3.84 |

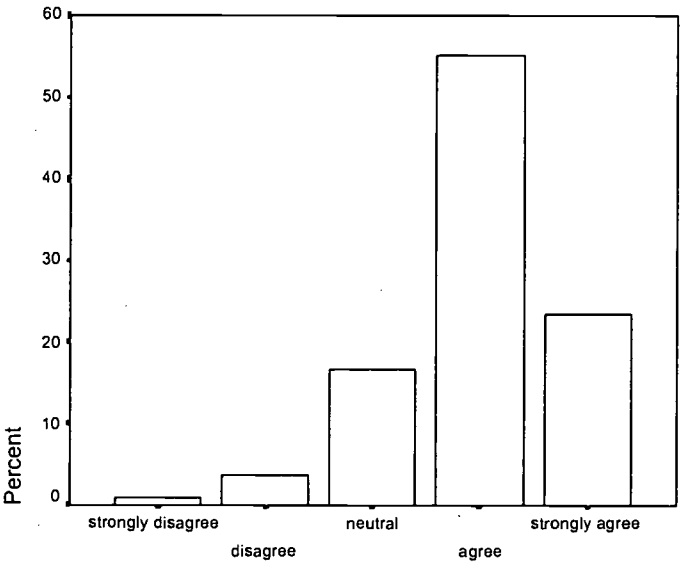
None of the above differences is statistically significant at $p < .05$.

Although teacher education student means were lower for all items except item 11, these differences are not statistically significantly (ANOVA with correction for multiple t-tests). However, it is worth noting that item 11 evaluates high school students' ability to provide sound feedback to each other.

We provide individual descriptive statistics and bar graphs for each final questionnaire item below.

**"I learned something by writing peer review comments."**

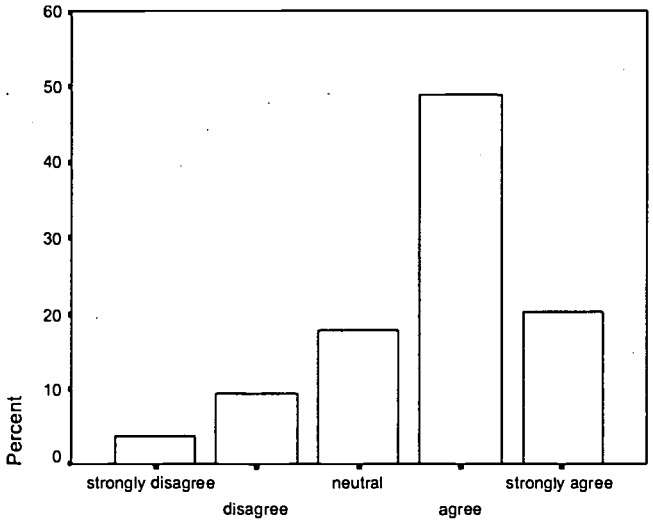
| | Freq. | % |
|---|---|---|
| Strongly disagree | 2 | 1.0 |
| Disagree | 7 | 3.6 |
| Neutral | 32 | 16.7 |
| Agree | 106 | 55.2 |
| Strongly agree | 45 | 23.4 |
| Total | 192 | 100 |




A majority of the respondents (79%) agreed that they learned something by writing peer review comments.

**"I felt qualified to provide meaningful peer review of other students' reports."**

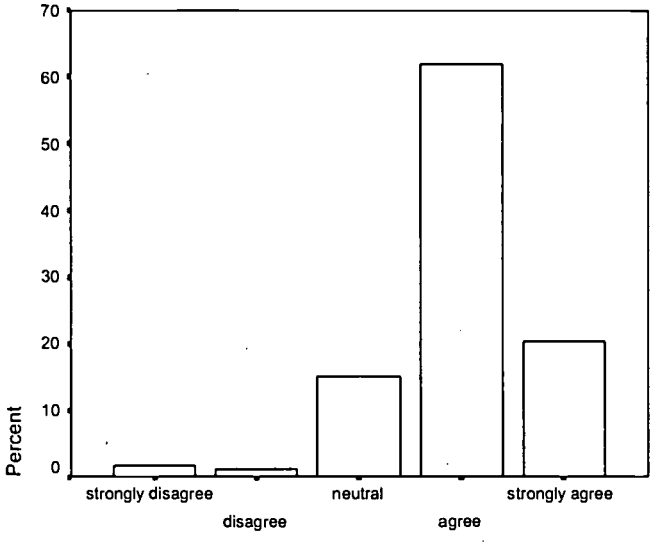
| | Freq. | % |
|---|---|---|
| Strongly disagree | 7 | 3.6 |
| Disagree | 18 | 9.4 |
| Neutral | 34 | 17.7 |
| Agree | 94 | 49.0 |
| Strongly agree | 39 | 20.3 |
| Total | 192 | 100 |




79% of the students reported that they felt qualified to provide meaningful reviews of other students' reports. .

**"I believe that the peer reviews I wrote should be helpful to the students that received them."**

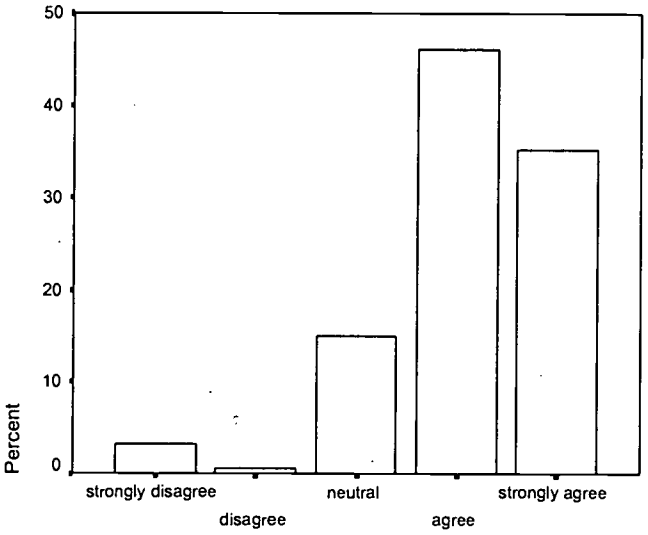
| | Freq. | % |
|---|---|---|
| Strongly disagree | 3 | 1.6 |
| Disagree | 2 | 1.0 |
| Neutral | 29 | 15.1 |
| Agree | 119 | 62.0 |
| Strongly agree | 39 | 20.3 |
| Total | 192 | 100 |




82% of the students thought they provided helpful reviews, and less than 3% anticipated that their review would not be helpful.

**"Peer reviewing other students has helped me to think more critically."**

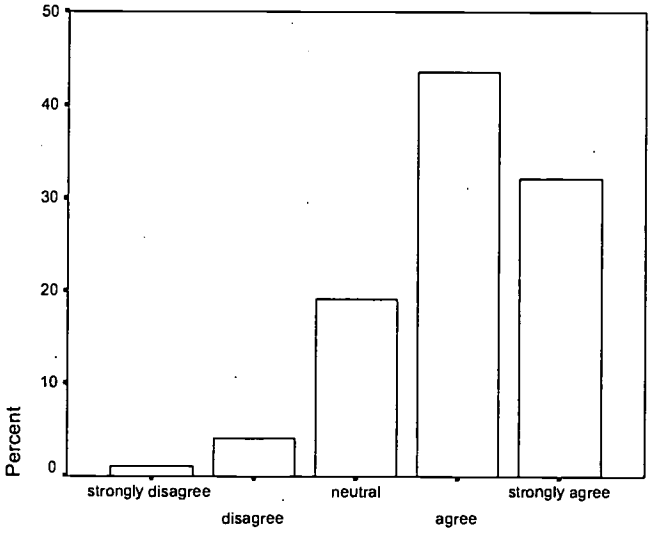
| | Freq. | % |
|---|---|---|
| Strongly disagree | 6 | 3.1 |
| Disagree | 1 | .5 |
| Neutral | 29 | 15.0 |
| Agree | 89 | 46.1 |
| Strongly agree | 68 | 35.2 |
| Total | 193 | 100 |




82% of the students agreed that peer reviewing enabled them to reflect and think about their own and others' research more critically.

**"Peer reviewing other students has helped me to improve my own scientific writing."**

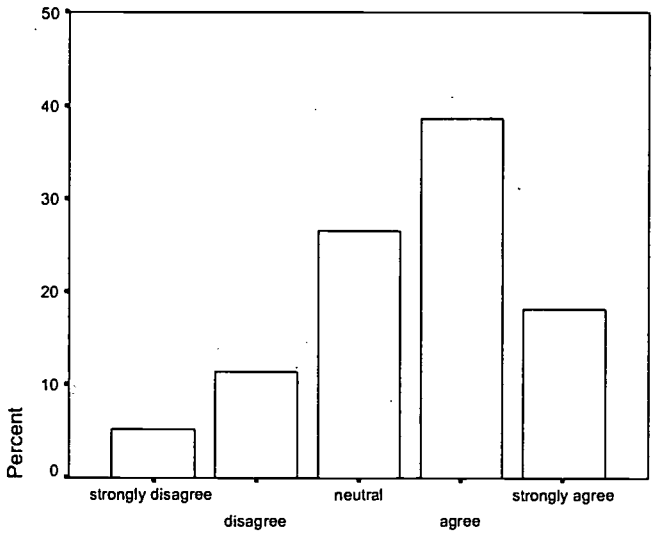
| | Freq. | % |
|---|---|---|
| Strongly disagree | 2 | 1.0 |
| Disagree | 8 | 4.1 |
| Neutral | 37 | 19.2 |
| Agree | 84 | 43.5 |
| Strongly agree | 62 | 32.1 |
| Total | 193 | 100 |




Providing feedback on other students' research reports was perceived beneficial by students. 75% of the respondents agreed that their technical writing improved because of the peer reviewing process.

**"I received useful peer review comments about my own report."**

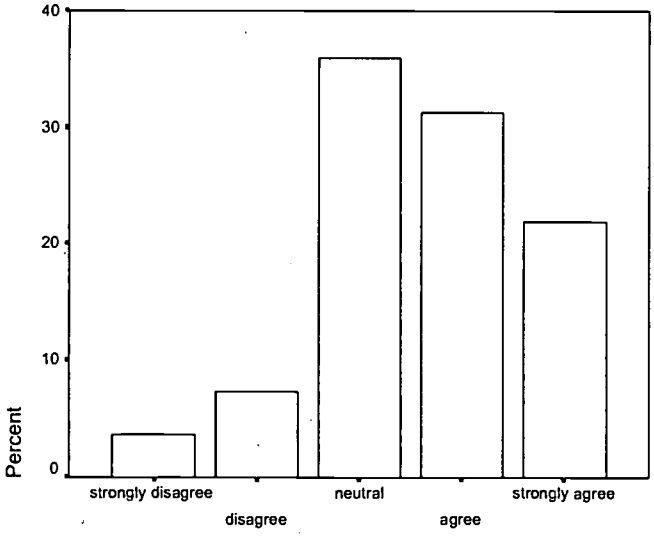
| | Freq. | % |
|---|---|---|
| Strongly disagree | 10 | 5.2 |
| Disagree | 22 | 11.5 |
| Neutral | 51 | 26.6 |
| Agree | 74 | 38.5 |
| Strongly agree | 35 | 18.2 |
| Total | 192 | 100 |




Although 82% of the students thought they provided helpful reviews, only 57% reported that they received helpful reviews. 18% of students reported that peer reviews did not help them to improve their reports.

**"The quantitative scores I received from peer reviewers were fair."**

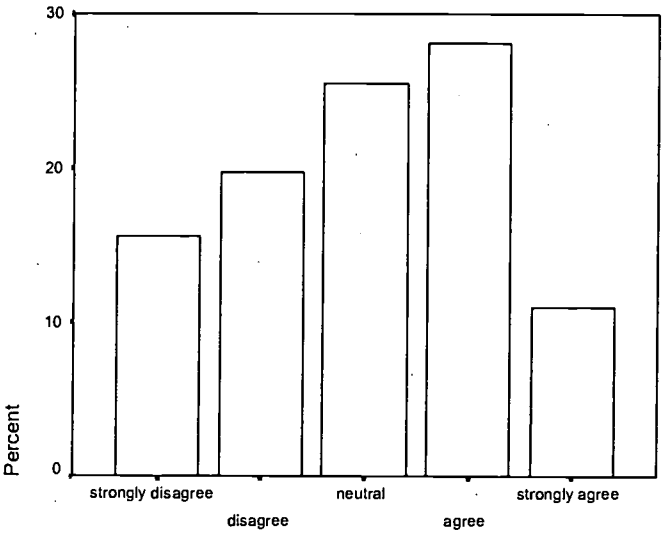
| | Freq. | % |
|---|---|---|
| Strongly disagree | 7 | 3.6 |
| Disagree | 14 | 7.3 |
| Neutral | 69 | 35.9 |
| Agree | 60 | 31.3 |
| Strongly agree | 42 | 21.9 |
| Total | 192 | 100 |




Most of the students thought their peers were fair when they rated the quality of the reports. Previous research has shown that marks given by students can be as reliable as those given by instructors (Orpen, 1982). 11% of the participants reported that their score were "unfair."

**"I changed my mind about something in my report because of comments I received through peer review."**

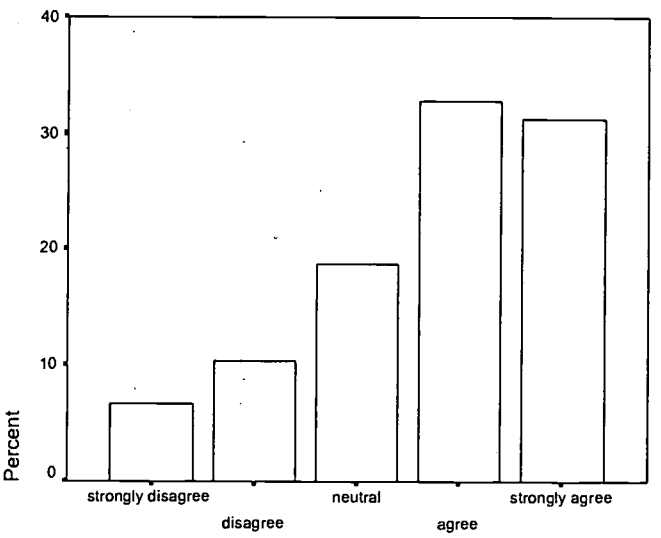
| | Freq. | % |
|---|---|---|
| Strongly disagree | 30 | 15.6 |
| Disagree | 38 | 19.8 |
| Neutral | 49 | 25.5 |
| Agree | 54 | 28.1 |
| Strongly agree | 21 | 10.9 |
| Total | 192 | 100 |




39% of the students agreed that they changed their minds about some aspect of their report because of feedback they received via peer review. This might be attributed in part to the implications of peer evaluation, which involve a different relationship that that between instructors and students. It may contribute to a collaborative role rather than an adversarial one (Billington, 1997).

**"It is easier to say what I really think when I don't have to sign my name or meet in person with the students."**

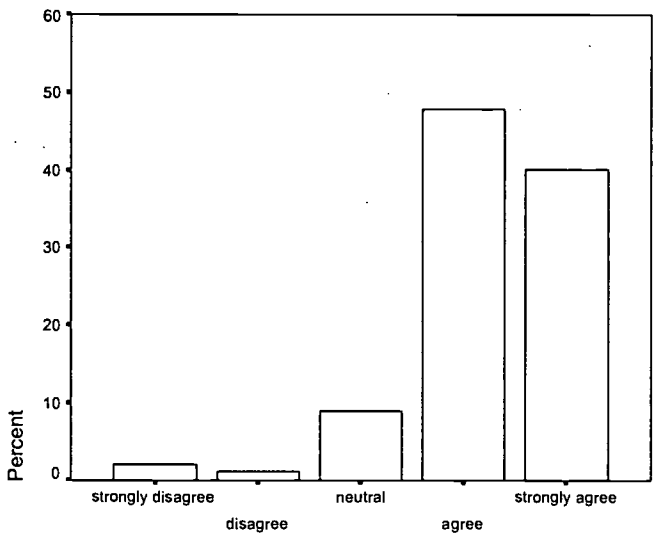
| | Freq. | % |
|---|---|---|
| Strongly disagree | 13 | 6.8 |
| Disagree | 20 | 10.4 |
| Neutral | 36 | 18.8 |
| Agree | 63 | 32.8 |
| Strongly agree | 60 | 31.3 |
| Total | 192 | 100 |



A majority of students felt positive about the anonymity of peer review. This is consistent with what actually happens in scientific community. According to Arnold Relman, the chief editor of the New England Journal of Medicine, about 85% of their reviewers have preferred to remain anonymous, and report that they are more candid and rigorous when they are not required to sign their reviews.

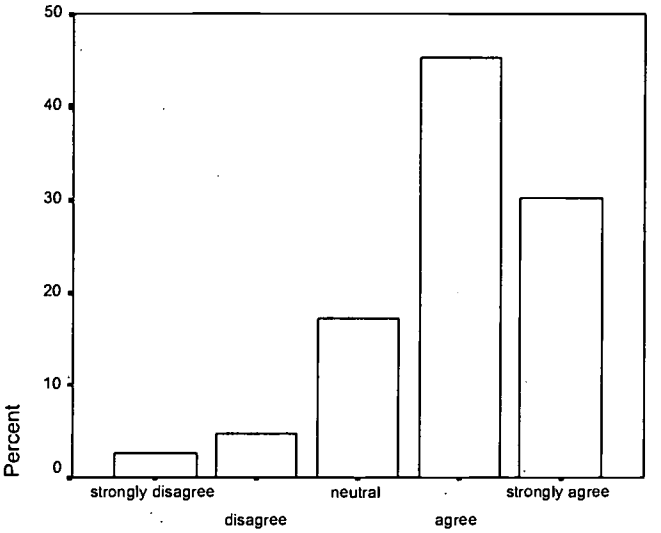
**"I think that meaningful peer review is a reasonable expectation for college students."**

| | Freq. | % |
|---|---|---|
| Strongly disagree | 4 | 2.1 |
| Disagree | 2 | 1.1 |
| Neutral | 17 | 8.9 |
| Agree | 91 | 47.9 |
| Strongly agree | 76 | 40.0 |
| Total | 190 | 100 |



**"I think that meaningful peer review would be a reasonable expectation for high school students."**

| | Freq. | % |
|---|---|---|
| Strongly disagree | 5 | 2.6 |
| Disagree | 9 | 4.7 |
| Neutral | 33 | 17.2 |
| Agree | 87 | 45.3 |
| Strongly agree | 58 | 30.2 |
| Total | 192 | 100 |




Students were consistently positive about their experiences writing and receiving peer reviews. 87% thought college students could provide meaningful and helpful peer reviews. Previous research has suggested that students appreciate the opportunity to comment on each other's work in a constructive manner, and that peer review can instill a sense of community within a class (Hay & Miller, 1992). When students were asked if it was realistic to expect meaningful reviews from high school students, 75% responded positively. There is no significant difference between teacher education students and other students on this measure. However as noted earlier, this item was the sole item on which teacher education students felt more positive than other students.

### School Differences in Quantitative Review Scores

In their peer reviews, students rated the quality of the argument and the quality of authors' technical writing by assigning a score to each. We found some statistically significant differences between schools. An ANOVA procedure was used to detect these differences and then post hoc analyses were done to identify pairwise differences between schools.

The first measure, which we call QScore1, asked reviewers to answer the question, "Did the author address each question fully and provide good support for his or her conclusions?" Responses were reported on a five-point scale ranging from 5 = "Excellent. Exceptionally well done" to 1 = "Failure. Unacceptable responses; report should be restarted from scratch." We call this the "quality of argument" score. Students at School 6 received significantly higher scores on this measure than students at Schools 3, 10, and 12. Because School 6 had a small number of

participants (n=6), this result should be carefully interpreted. There were no other pairwise differences.

**Score 1 (Quality of Argument)**

**One-Way Analysis of Variance**
Dependent Variable: QSCO1RAV (Avg QScore1 RECEIVED)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| SCHOOL | 9 | 11.8739413 | 1.3193268 | 2.53 | 0.0082 |
| Error | 309 | 161.0752053 | 0.5212790 | | |
| Corrected Total | 318 | 172.9491466 | | | |

**Post hoc tests**

| Duncan Grouping | Mean | N | SCHOOL |
|---|---|---|---|
| A | 3.8000 | 5 | 6 |
| B | 2.6973 | 49 | 12 |
| B | 2.5877 | 19 | 3 |
| B | 2.5000 | 9 | 10 |

Significant differences at p<.05. Means with the same letter are not significantly different

ANOVA also revealed a significant school effect on QScore1s written; however, we are still trying to interpret this finding, because we do not see any obvious differences in mean scores.

**One-Way Analysis of Variance**
Dependent Variable: QSCO1WAV (Avg QScore1 WRITTEN)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| SCHOOL | 10 | 13.3476149 | 1.3347615 | 3.19 | 0.0006 |
| Error | 366 | 153.1733886 | 0.4185065 | | |
| Corrected Total | 376 | 166.5210035 | | | |

**Score 2 (Quality of Technical Writing)**

There were significant differences among schools in scores received for quality of technical writing (QScore2). One-way ANOVA was performed, followed up with Duncan grouping post hoc analysis for pairwise comparisons. Three groups of schools were identified, as seen in the table below, with statistically different average received mean scores. Schools 6 and 5 comprised two discrete "groups," A and B. Schools 1, 3, 7, and 12 comprise a third group with a significantly different mean score, when compared to Groups A & B. There were no other differences.

**One-Way Analysis of Variance**

Dependent Variable: QSCO2RAV Avg Qscore2 RECEIVED

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| SCHOOL | 9 | 14.9449277 | 1.6605475 | 3.53 | 0.0003 |
| Error | 309 | 145.3587557 | 0.4704167 | | |
| Corrected Total | 318 | 160.3036834 | | | |

**Post hoc tests**

| Duncan Grouping | Mean | N | SCHOOL |
|---|---|---|---|
| A | 3.9000 | 5 | 6 |
| B | 3.2083 | 12 | 5 |
| C | 2.5986 | 49 | 12 |
| C | 2.5767 | 126 | 7 |
| C | 2.5313 | 16 | 1 |
| C | 2.4912 | 19 | 3 |

Significant differences at $p<.05$. Means with the same letter are not significantly different

The following ANOVA table shows that students at School 6 awarded significantly higher scores to others concerning the technical quality of reviewed reports, an interesting phenomenon given that they also received the highest scores. Students School 5 awarded significantly lower scores; however, they received the second highest scores for their reports. (Please note that these are only preliminary analyses; we still need to look at issues like which

schools tended to review which other schools. Again, the matching of reports to reviewers was anonymous but not random, and it is likely that students were most likely to review reports by other students from their own campus, because their reports were most likely to be available for review at the time each campus's reviews were required by the relevant instructor.)

**One-Way Analysis of Variance**

Dependent Variable: QSCO2WAV (Avg QScore2 WRITTEN)

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| SCHOOL | 10 | 13.8479459 | 1.3847946 | 2.91 | 0.0017 |
| Error | 298 | 141.8592512 | 0.4760378 | | |
| Corrected Total | 308 | 155.7071971 | | | |

**Post hoc tests**

| Duncan Grouping | Mean | N | SCHOOL |
|---|---|---|---|
| A | 3.5000 | 4 | 6 |
| B | 2.5656 | 122 | 7 |
| B | 2.4333 | 5 | 10 |
| B | 2.2222 | 12 | 5 |

Significant differences at p<.05. Means with the same letter are not significantly different

## Differences in Quantitative Review Scores for Teacher Education Students

Students in teacher education programs generally received and assigned higher mean scores than non-teacher education students. However, among the differences in mean scores for all four measures, the only statistically significant difference concerned the average score received for the quality of technical writing. Teacher education students were able to articulate their research and communicate results in a more effective way than the students who are majored in sciences or science studies.

**Written and Received Score Differences in Reviews for Teacher Education Majors**

| Teacher Education | Avg QScore1 RECEIVED | Avg QScore2 RECEIVED* | Avg QScore1 WRITTEN | Avg QScore2 WRITTEN |
|---|---|---|---|---|
| No | 2.7508 | 2.60017 | 2.7362 | 2.6503 |
| Yes | 2.9147 | 2.84425 | 2.8653 | 2.7991 |

*Only the received quality of technical writing score (QScore2) is statistically significant at $p<.05$.

**QScore 2 (Quality of Technical Writing) Received**

One-Way Analysis of Variance
Dependent Variable: QSCO2RAV Avg QScore2 RECEIVED

| Source | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| TCHRED | 1 | 3.5135934 | 3.5135934 | 7.08 | 0.0082 |
| Error | 280 | 138.9269355 | 0.4961676 | | |
| Corrected Total | 281 | 142.4405290 | | | |

## Final Comments

As noted at the beginning of this paper, these are preliminary findings from this project, intended as background information to stimulate subsequent discussion and analysis by participating faculty and other interested researchers.

In looking for differences by school and other factors, our primary interest was in developing questions to guide formative evaluation of this project. For example, what are the advantages and disadvantages of restricting participation in a project like this to prospective science teachers? Do between-school differences lead to differences in review-related outcomes? Do positive experiences as a reviewer and as a review-receiver favorably incline preservice teacher participants to consider using peer review with their own students some day?

There are also a number of questions that we have not yet begun to analyze concerning the validity and reliability of evaluations by students in this project. We invite the participation of our CPR collaborators in undertaking these next steps.

**References**

Billington, L. H. (1997). Poster presentations and peer assessment: Novel forms of evaluation and assessment. Journal of Biological Education. 31 (3), 218-220.

Hay, I. & Miller, R. (1992). Application of a poster exercise in an advanced undergraduate geography course. Journal of Geography in Higher Education. 16, 199-215.

Orpen, C. (1982). Students' versus lecturer assessment of learning: a research note. Higher Education, 11, 567-572.

## Appendix A: Methodological Notes on Data Analysis

In MS Access:

1. We removed duplicate records from the Final Questionnaire using the following rules: (a) Delete incomplete entries, (b) Delete older entries when multiple complete entries exist.
2. We assigned dummy user names to anonymous entries (anon1, anon2, etc.).
3. We ran a "find duplicates query" on Peer Reviewed Report and found many unsubmitted duplicates. These were all deleted.
4. We had nine students who double-posted their reports and got reviews for both versions. We pooled all reviews for these nine people by deleting one copy each and pointing the original reviews to the remaining duplicate.
5. We also deleted duplicate peer reviews only if it would be clear to the report author that a duplicate had been submitted. There were three pairs of duplicates where the wording and/or scores were different and we judged that an author might have concluded that they came from different reviewers.
6. There were a number of duplicate records in the User table identified by running a "find duplicates query" on password.
7. There were 23 pairs of reports with identical titles. Only one pair was completely identical, submitted by UIDs 620 and 629.
8. There were four users who did not submit reports but submitted peer reviews. There were 34 users who submitted reports but not peer reviews.
9. Seven reports that were not submitted are removed to the PRReport deleted table.
10. Before removing non-consenters there were 411 reports. We omitted people who did not give their consent to use their data for research, resulting in 341 participants.

**Appendix B: Web-Based Form Used for Student Peer Reviews**

(The following content comprises the web-based form used by students to complete peer reviews).

1. Did the author address each question fully and provide good support for his or her conclusions?

- Excellent. (Exceptionally well done).
- Good. (Very well done).
- Satisfactory. (Acceptable response to all questions).
- Poor. (Minimal attention to the questions and/or serious technical problems with one or more responses).
- Failure. Unacceptable responses; report should be restarted from scratch.

2. Please rate the overall quality of the writing in this report for clarity, readability, and technical accuracy (spelling errors, run-on sentences, etc.).

- Excellent. (Exceptionally well done).
- Good. (Very well done).
- Satisfactory. (Acceptable response to all questions).
- Poor. (Minimal attention to the questions and/or serious technical problems with one or more responses).
- Failure. (Unacceptable responses; report should be restarted from scratch).

3. What was a particular strength in this experimental design? (Scrolling text box)

4. Do you agree with the conclusions? Do they appear to be supported by the results of the experiment? (Scrolling text box)

5. What suggestions can you make for improving the experimental design? (Scrolling text box)

## Appendix C: Final Questionnaire

### *Final Questionnaire: College Peer Review Project*

You were asked earlier to help us evaluate the College Peer Review project by completing a questionnaire about your experience. If you are willing to complete this optional step, **thank you!** Evaluation will help us determine the value of the project and will guide the project's future development. If you would like to see the original consent form in a new window, click here. Otherwise, simply fill in the information below.

Top of Form

| **Demographic Questions** (Who participated) | Please note that if you wish to not respond to any question, you may leave it blank. |
|---|---|
| Your User ID (e.g., jas21) | |
| Your 4-digit password | |
| Your student status | ○ Undergraduate ○ Graduate ○ Other (e.g., non-degree) |
| What is your current major field of study? | |
| If you have a dual major, what is your second major field of study? | |
| Are you in a teacher education program? | ○ Yes ○ No |
| When do you plan to complete your current degree? | 2001 |
| What is your gender? | ○ Male ○ Female |
| Do you consider yourself a member of one or more of the following minority groups: African-American, Hispanic, Native American? | ○ Yes ○ No |
| Was English your first language? | ○ Yes ○ No |
| Have you ever done scientific research in a setting other than a conventional college class? | ○ Yes ○ No |
| If you answered "yes" to the previous question, please describe the research, the setting, and the length of time you were involved | |

Please continue below:

| | Please make one choice in each row | | | | |
|---|---|---|---|---|---|
| **Process/Outcome Questions** (5-point scale) | Strongly disagree | Disagree somewhat | Neutral | Agree somewhat | Strongly agree |
| I learned something by writing peer review comments. | ○ | ○ | ○ | ○ | ○ |
| I felt qualified to provide meaningful peer review of other students' reports. | ○ | ○ | ○ | ○ | ○ |
| I believe that the peer reviews I wrote should be helpful to the students that received them. | ○ | ○ | ○ | ○ | ○ |
| Peer reviewing other students has helped me to think more critically. | ○ | ○ | ○ | ○ | ○ |
| Peer reviewing other students has helped me to improve my own scientific writing. | ○ | ○ | ○ | ○ | ○ |
| I received useful peer review comments about my own report. | ○ | ○ | ○ | ○ | ○ |
| The quantitative scores I received from peer reviewers were fair. | ○ | ○ | ○ | ○ | ○ |

| Continuation of above table: | Strongly disagree | Disagree somewhat | Neutral | Agree somewhat | Strongly agree |
|---|---|---|---|---|---|
| I changed my mind about something in my report because of comments I received through peer review. | ○ | ○ | ○ | ○ | ○ |
| It is easier to say what I really think when I don't have to sign my name or meet in person with the students who wrote the research reports. | ○ | ○ | ○ | ○ | ○ |
| I think that meaningful peer review is a reasonable expectation for **college** students. | ○ | ○ | ○ | ○ | ○ |
| I think that meaningful peer review would be a reasonable expectation for high school students. | ○ | ○ | ○ | ○ | ○ |
| If I taught science, I would like to use some type of formal student peer review. | ○ | ○ | ○ | ○ | ○ |

Please continue:

| **Process/Outcome Questions** (Open-ended) | Please write as much as you wish. |
|---|---|
| What do you believe students can learn about the nature of science by participating in projects like this? | |
| Any other comments for us? Feel free to offer suggestions for improving the project. | |

When you finish, press the "Submit Questionnaire" button.

Submit Questionnaire

Bottom of Form

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