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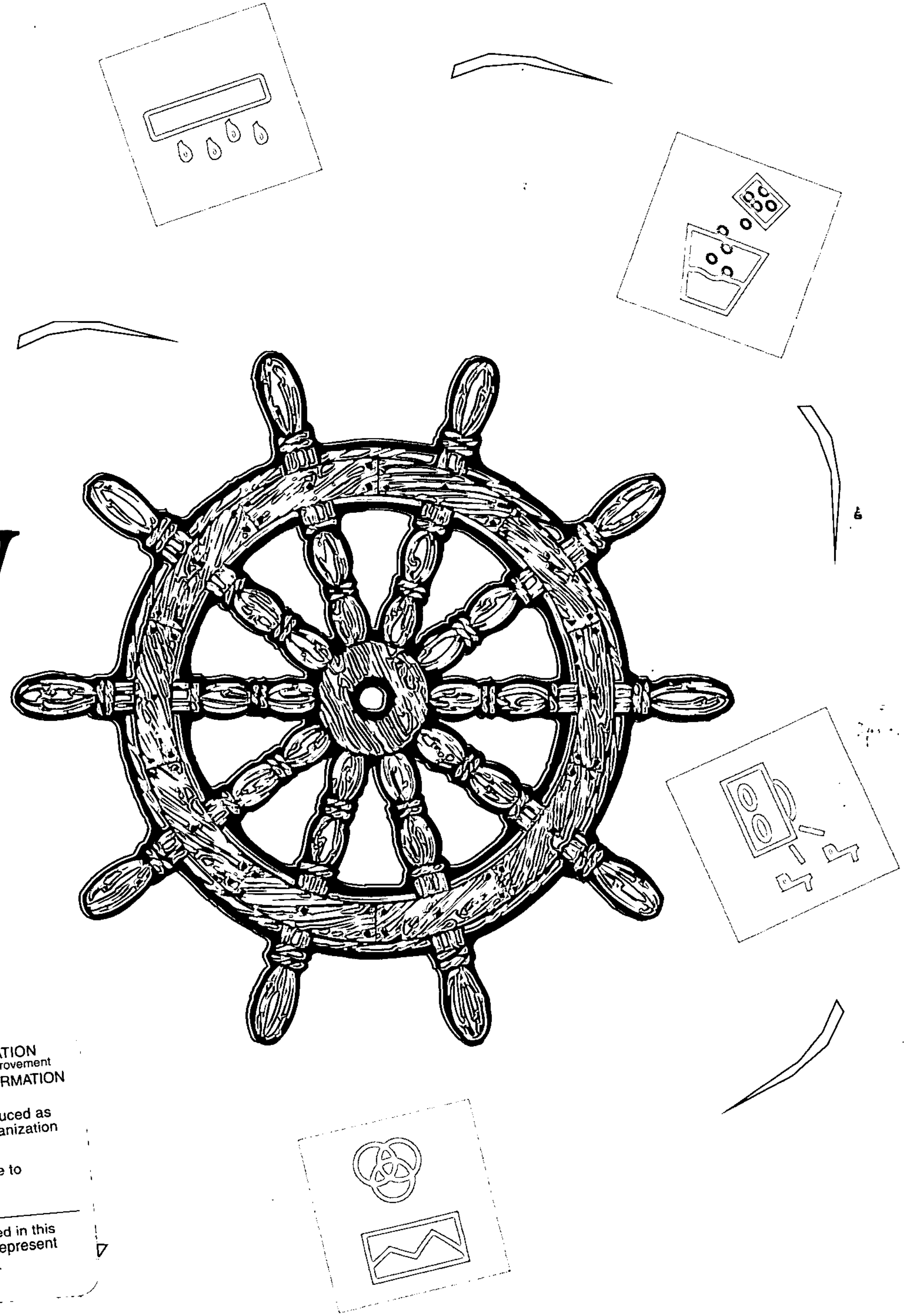
ABSTRACT

Thirty-five Nebraska educators from across the state came together for five Saturday seminars during the 1995-96 school year to collaborate as they conducted classroom investigations. They earned 3 hours of tuition-free graduate credit. Action research was the tool for their investigations, guided by R. Sagor's book "How To Conduct Collaborative Action Research" (1992). This document presents reports on 22 projects conducted by these teachers. Their action research projects involved elementary, secondary, and higher education, and studied many aspects of education, including assessment and the communication of assessment results, performance based assessment, peer mentoring, cooperative learning, science instruction, mathematics instruction, and gender equity. The book is divided into: (1) summaries of the studies, containing the research questions, data analysis, and results of research studies; (2) "Researchers' Journeys," comments from participant journals; and (3) "Close- Ups," sample contents from three researchers' portfolios that provide an in-depth look at their research. (SLD)



CHANGE IN ACTION:

Navigating and Investigating the Classroom using Action Research

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CHANGE IN ACTION:

NAVIGATING AND INVESTIGATING THE CLASSROOM USING ACTION RESEARCH

Reports of Twenty-Two Teacher-Research Projects

edited by

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May, 1997

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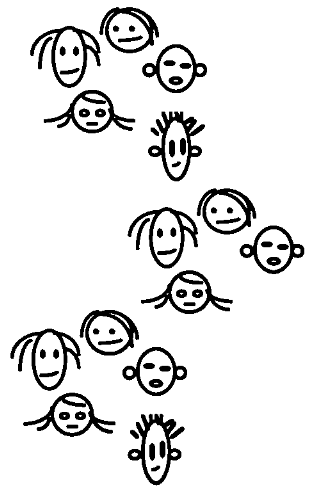

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INTRODUCTION

by De Tonack, Ph.D.
Nebraska Mathematics and Science Initiative
Collaborative Action Research Facilitator

Action Research Guide:

Action research was the tool for the investigations reported in this book. Richard Sagor's work, *How to Conduct Collaborative Action Research* (ASCD, 1992), was the guide book for the research process. Sagor defines research as any effort toward disciplined inquiry, involving a wide array of methods from both the quantitative and qualitative domains. Like any research, action research is a systematic process to acquire valid and reliable data concerning some phenomenon.

Action research involves formulating the problem, collecting data, analyzing data, reporting results, and planning the next steps to put the results into action. Action researchers most often look at what they themselves are or should be doing. In education, action researchers often focus on initiating action, monitoring and adjusting action, or evaluating some action. Generalizability —the applicability of the research findings to other sites and situations—is usually restricted to the immediate context of the researchers. Although the results of the research can provide insight for other individuals and describe procedures that they wish to enact and investigate, the goal of the investigations is to understand what is happening in the researcher's environment and what might improve that environment.

Seminars:

Thirty-five Nebraska educators from across the state came together for five Saturday seminars during the 1995-1996 school year to collaborate, refine, and progress down the paths of their classroom investigations. They were provided with three hours of tuition-free graduate credit from the Curriculum and Instruction Department of the University of Nebraska-Lincoln, five free lunches, a facilitator by the Nebraska

Mathematics and Science Initiative, and the hope of increased insight into what was or was not working in their educational environments.

The first seminar was held September 30, 1995. Facilitator, De Tonack, introduced the procedure and the purpose for the action research. Using Richard Sagor's book (*How to Conduct Collaborative Action Research*) as a reference, participants discussed the definition and purpose of action research for them. Some of the participants had been part of the previous year's action research class, and they shared their experiences with the process. The group then began to search for and refine their own investigation questions for this year. Within a few weeks after this meeting, participants used a form to report their purpose or problem area of investigation, their research question(s), their proposed data collection methods, their proposed calendar, their collaborators within or outside of the immediate group of researchers, and their "critical friend."

Participants chose from October 21 or November 18 for their second seminar. Approximately half came to the first and half to the second session. Much of this seminar was spent examining aspects of action research and planning their methods of collecting data.

All participants came together for the third seminar on January 20, 1996. In large and small groups, they shared their current data and their analysis of that data. They also discussed summaries of other educational research focused on their particular research questions.

The fourth seminar was held in March. At this time participants practiced delivering their tentative research findings in preparation for a mini-conference that was held April 20 for participants and invited guests. The first page of the April conference program is shown on page 3 (Figure 1).

Figure 1.

What's Working in Nebraska Classrooms?
a mini-conference presenting studies in Nebraska classrooms,
using action research as a tool of investigation

April 20, 1996
Southeast High School
2930 South 37th, Lincoln

Agenda

8:30 - 9:00 .... Rolls and coffee, lobby
9:00 - 9:45 .... Session 1
9:50 - 10:35 .... Session 2
10:40 - 11:25 .... Session 3
11:30 - 12:15 .... Lunch
12:15 - 1:00 .... Session 4
1:05 - 1:50 .... Session 5
2:00 - 2:15 .... Action researchers meet in room 208

Course Evaluation Rubric:

An evaluation rubric was developed by Dr. Tonack and refined by the participants for the course credit. The rubric evaluated a portfolio, the presentation, and seminar participation:

I. PORTFOLIO (40%)

Purpose: To provide structure to the investigation and to serve as a display or "scrapbook" for others and for oneself. Portfolio items to include the following:

- Table of Contents
- Rationale for selection of items in portfolio
- Evidence of investigation focused on assessment—
  - Question of investigation
  - Description of data collection techniques
  - Conclusions
- Evidence to support conclusion(s)
  - Description and/or summary of data
  - Description of data analysis process
- Evidence of reflection on the action research process and results
  - Choices may include journal entries, a diary, audio and/or video tapes, recorded conversations with other participants or other educators, flow charts, photos, other
- Evidence of collaboration
  - Choices may include written comments reflecting upon a colleague's investigation, photos, diary of conversations with others, tapes, other
- Evidence of review of outside resources focused on assessment topic

Choices may include abstracts, journal articles, interviews, other

Plan of action after the investigation is completed

Self-designed self assessment of your portfolio

A. Required items are included in the portfolio.

4 All items are included in the portfolio.

3 One item is not included in the portfolio.

2 Two items are not included in the portfolio.

1 More than two items are not included in the portfolio.

B. Effectively uses a variety of methods to display items in the portfolio.

4 Uses several effective methods to present different portfolio items.

3 Uses at least two effective methods to present different portfolio items.

2 Uses only one effective method to present items.

1 Portfolio items are not presented in an effective, communicative manner.

C. Makes and articulates accurate conclusions from the gathered data.

4 Draws conclusions that reflect clear and logical links between the gathered information and the interpretations made from them.

3 Presents conclusions that, with few exceptions, follow logically from the gathered information.

2 Presents some conclusions that reflect erroneous interpretations made from the gathered information.

1 Draws many erroneous conclusions from the selected information and cannot satisfactorily describe the rationale behind the conclusions.

D. Demonstrates an understanding of the action research process.

- 4 Evidence is provided that the action research process was conducted, leading to a conclusion(s) thoroughly supported by the gathered information.
- 3 Evidence is provided that the action research process was conducted, leading to a conclusion(s) adequately supported by the gathered information.
- 2 Adequate evidence is not provided that the action research process was conducted, leading to a conclusion(s) adequately supported by the gathered information.
- 1 Several omissions are made in the action research process.

II. SEMINAR PARTICIPATION (40%)

Purpose: To provide a supportive environment in which all participants assume responsibility for that environment and the professional growth of themselves and the other participants.

A. Participates in seminars.

- 4 Comes to all seminars.
- 3 Misses one seminar or part of a seminar.
- 1 Misses two seminars.

B. Reflects (evaluates the effectiveness of own actions).

- 4 Reviews actions thoroughly and from as many points of view as is useful.
- 3 Reviews actions from both immediate and long-term effects. Finds value in lessons learned from both success and failure.

2 Reviews actions from highly subjective perspective. Rarely considers the effects of actions. Gleans few lessons from the task.

1 Makes no effort to review actions.

C. Contributes to seminar maintenance.

4 Actively helps the group meet agenda and identify changes or modifications necessary in the group process; works toward carrying out those changes.

2 When prompted, helps the group meet the agenda and identify changes or modifications necessary in the group process, or is only minimally involved in carrying out those changes.

1 Does not attempt to identify changes or modifications necessary in the group process, even when prompted, or refuses to work toward carrying out those changes.

D. Works toward the achievement of group goals.

4 Actively helps identify group (interactive small groups and/or collaborative team) goals and works hard to meet them.

3 Communicates commitment to the group goals and effectively carries out various roles.

2 Communicates a commitment to the group goals but does not carry out various roles.

1 Does not work toward group goals or actively works against them.

III. PRESENTATION (20%)

Purpose: To share research findings with colleagues and bring summary and closure to the initial investigations.

A. Uses a variety of methods to present information in an attempt to interest the audience.

4 Uses a variety of methods to present information.

3 Uses more than one method to present information.

2 Uses only one method to present information; it appears to gain attention.

1 Uses only one method to present information; it fails to gain audience attention.

B. Clearly presents the major components of the research.

4 The research question(s), data collection methods, data analysis process, results, and future plan(s) of action are clearly given in the presentation.

3 The research question(s), data collection methods, data analysis process, results, and future plan of action are recognized in the presentation.

2 The research question(s), data collection methods, data analysis process, results, and future plan of action are obscured in the presentation.

1 The research question(s), data collection methods, data analysis process, results, and future plan of action are not each contained in the presentation.

About the Organization of this Book:

This book is divided into three main sections: 1) Summaries of Studies - short summaries of the research question, data analysis, and results of the research studies, 2) Researchers' Journeys - comments from various participants' journals at different points during the course, and 3) Close Ups - sample contents from three researchers' portfolios that provide an in-depth look into their research. The purpose behind this format was to give each researcher the opportunity to share his or her results with a wider audience; to show, through participants' own words, how action research leads to professional growth; and to demonstrate how a portfolio was used by participants to document the research process and their learning. Taken together, these sections honor the work that all participants did and serve as testament to their dedication to understanding and improving teaching and learning.

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I would like to thank the following individuals for their feedback and assistance in evaluating the conference presentations:

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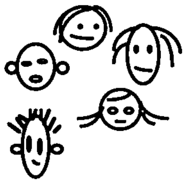
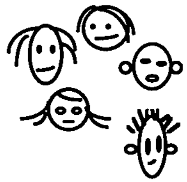


Summaries of Studies



USING SELF-ASSESSMENT TO IMPROVE MOTIVATION FOR LEARNING

Dianne Vorderstrasse
St. Paul Public
St. Paul, Nebraska

Problem:

Both formal and informal assessment of the students in my classroom indicated that some students were gaining little knowledge although daily work and homework grades were exceptional. I was concerned that these students were receiving too much help from classmates, resulting in their having limited knowledge and being totally unprepared. I wanted to make the students aware that this help was having a disastrous effect on them. My investigation was designed to explore whether giving the students time to reflect on how much they had learned would help them to gain insight into their role in the learning process.

Assumptions:

Pressure to receive good grades sometimes inhibits students' acquisition of knowledge. That pressure often leads them to copy the work of others without understanding or to progress to another level without an adequate foundation of knowledge. Self-assessment helps students understand they have a personal responsibility in their own learning and even the right to have input in what they are taught.

The National Council of Teachers of Mathematics Assessment Standards also state the importance of self-assessment: "To function as an independent learner, one must be able to reflect on one's work and progress, to understand what one knows and is able to do, to have confidence in what one does, and to determine what one has yet to learn. When students work as partners with teachers and peers in the assessment process, they learn how to make and use assessment inferences. They learn to value their own judgments and, as they grow in their mathematics power, to rely more and more on those judgments."

Students learn to value their own judgments and, as they grow in their mathematics power, to rely more and more on those judgments.

Study:

Thirty-three Advanced Algebra students were involved in the study. The students were of average or higher ability. I used a blind study in which students drew numbers to identify themselves during the study thereby preserving their anonymity. Students were surveyed at the beginning of the research to determine the amount of classroom work each individual perceived was work that they understood and had completed without "cheating," i.e., directly copying another student's work. The survey asked students to report on the following: how many of their assignments were completed when due; what they did when assignments were not completed on time; what percent of their work was their own and not directly copied; whether they had checked answers with another student, changed their answer to match another student's without finding out their errors, or changed an answer to match another student's after checking to find their errors; on what type of work they had cheated; how many other students in their class they believed had cheated.

Weekly self-assessments were then added to the classroom procedure. These self-reports asked students to rate their understanding of the current topic, the grade they would give themselves, what had helped them make that grade and what they could change to improve it; what they had to do to help themselves understand the current work, and with what they needed additional help. Students were given a homework grade of 100% for each three assessments they completed. After six weeks, the students were given the initial survey again.

Results:

Students indicated that most of the cheating was on homework, some quizzes and none on the tests. This was true both when students were asked about their own cheating and that of their classmates. However, most students believed there was more cheating by other students than by themselves. The reasons students gave for cheating were primarily to finish work and/or for grades.

While there was little change in grades or the amount of work completed, there was a change in the amount of work the students believed was their own and not directly copied. Students were also more aware of what they knew and what they still needed to do. As the teacher, I was more aware of which students were having difficulty with which material, and I made changes to help the students. Students also appreciated the suggestions for improving their study skills and what to review to increase their understanding.

Conclusion:

My results indicated that self-assessment is as important to the success of my students as any other form of assessment. When the students write their current grade average on their self-assessment, they seem to be more aware of how each grade changes that average.

SELF-ASSESSMENT AND PROBLEM SOLVING COOPERATIVELY

Janice McLain
Mickle Middle School
Lincoln, Nebraska

Verla Ringenberg and Lynne Schneider
Morley Elementary
Lincoln, Nebraska

Problem:

Students need to become better problem solvers in mathematics.

Study:

The purpose of this study was to determine if students could become better problem solvers by working cooperatively and by using self-assessment to determine if they had chosen effective problem-solving strategies. This study was conducted in three sixth-grade mathematics classrooms. Two of the classrooms were in the same elementary building; one consisted of a class of 23 average-achieving students and the other, a class of 24 identified-gifted students. The third classroom was a class of 21 low achieving students in a middle school sixth grade setting.

Students were taught ten problem-solving strategies and given sample problems. They were also instructed in how to work in cooperative groups. The problem-solving activities consisted of six different problems. Students worked in groups and were given a self-assessment instrument to help guide them step-by-step through each problem. This instrument listed the ten problem-solving strategies in a checklist at the top of the page. Students were asked to restate the problem in their own words, list the strategies they thought might help them successfully solve the problem, show the procedures for solving the problem, use a strategy to verify their solution, and explain why they thought their solution was correct or incorrect.

Data were collected on the six problem-solving activities that included cooperative groups and student self-assessment. Cooperative group, student rating sheets were used to determine how effective the students viewed working in groups. Self-assessment response questions were used to determine students' perceptions of mathematics, their feelings in math class, and their growth as problem solvers. Students were interviewed individually, and class discussions were held about the experience, as well. A problem-solving process instrument was used to determine how students solved the problem, what strategies they used, and if they were successful in solving the problem.

Results:

Students reported that they worked together cooperatively, that everyone attacked the problem as a group and that they found it helpful to work as a team. They depended on each other and felt confident that the group would help. They reported that they learned problem-solving strategies, how to work in a group, and how to better interpret math problems. They felt they could improve by reading the problem more carefully, developing a better understanding of what they were looking for, using a variety of strategies and working better as a group. Students reported that they were getting better at problem solving and felt more successful than they had in the past.

Conclusions:

All three levels of students reported finding it easier to use problem-solving strategies. The identified gifted evidenced a smaller gain than the other groups possibly because they had been more involved in problem solving strategies previously. We have concluded from this experience that problem-solving strategies need to be overtly taught; that continuous, structured self-assessment by the student promotes metacognition of the problem-solving process; that cooperative groups promote discussion of the strategies thereby increasing awareness and use of a variety of methods.

Problem-solving strategies need to be overtly taught. Continuous, structured self-assessment by the student promotes metacognition of the problem-solving process.

PARTNERS IN ASSESSMENT

Teresa A. Muller
Gibbon High School
Gibbon, Nebraska

Problem:

I was using group work, experiments, hands-on experiences, discovery learning and technology as classroom teaching strategies. However, my assessments were not matching my teaching style and did not seem to tell me what students were learning.

Assumptions:

Assessment should not be the end of an educational experience; instead it should be a means to achieve educational goals. Assessment measures the student's understanding and use of the mathematics being taught. Assessment is a feedback tool for the teacher. Assessment is used for grading purposes and to monitor student growth and achievement. One of the best indications of the mastery of a subject is the student's ability to make significant comments or ask intelligent questions about the subject. Another indication of achievement in a field is interest in that field. Still another indication of achievement is the degree of confidence displayed when work is assigned or undertaken.

Study:

The purpose of this research was to determine which types of assessment give me a better picture of what my students know. I studied my eighth-grade math classes at a rural K-12 school. There were a total of 27 students involved in the research. The gender breakdown was 56% female and 44% male. The control group had 17 students and the experimental group had 10 students. Students were assigned to groups randomly.

The research was conducted by trying several different alternative assessment techniques on the target group while the control group did not experience any change in the way they were assessed. The assessments included the use of group checksheets, rubrics, portfolios, self-assessments, and projects. Data were collected through a student survey, test scores, teacher observations, student portfolios, and photographs. Initially, I used simple rubrics to grade writing assignments and problems of the week. I also used a group checksheet to encourage working together. Soon, the students created their own rubrics to grade their work.

Later, I tried portfolios of student work. The portfolios included a weekly self-evaluation, end-of-term self-assessment, student critique of the portfolio, interview, group evaluation of the individual, journal entries, math autobiography, original work, group work, and several best efforts. The students worked on their portfolios throughout the quarter. During the research, target students did several projects that were evaluated by a rubric.

I gave a survey to each of the eighth-grade math classes to determine the students' perceptions of assessment, what it revealed about their learning, and their improved learning via the assessments. The survey was given at the beginning and at the end of the study. I also kept a personal journal during the study. This journal and the student journals from the portfolios became valuable sources of information.

Results:

The mean test score of the control group was 82%; the mean test score of the experimental group was 94%. The test means for the previous quarter were 85% for the control group and 87% for the experimental group. The students in the target group also had an improved perception about assessment, a higher completion rate of homework, and an increase in their independent learning. The alternative assessments seemed to give a better picture of what the students were learning.

The control group survey scores were 29.3 out of a possible 40 points before the research and 28.3 after the research. The class median was 29 before and after the study. The experimental group survey score before the study was 28.1 and after

The students in the target group also had an improved perception about assessment, a higher completion rate of homework, and an increase in their independent learning.

Assessment became a part of the learning and less of a threat.

the study was 30.8. The class median increased from 28 to 31.

My own journal revealed that the students in the experimental group began to ask fewer questions of me and became more independent.

The control group did not make this growth and remained dependent on me. The completion rate of homework was 92% from the experimental group compared to 85% in the control group. Student journal entries from the experimental group included comments such as: "I like the telling us how it's graded before we take the test. You know what to expect. I also like working in groups." "I think this is easier; we know more about it; the grade is fair." "I have learned a lot more about problem-solving. I also got a lot better at solving problems that have to deal with graphs."

Conclusions:

Student performance improved through the use of alternative assessments. I had a better understanding of what my students knew, and the students perceived assessment as more useful. Assessment became a part of the learning and less of a threat. The students became more responsible for their own learning.

Plan of Action:

I plan to use a variety of assessments in my other classes as well. I have kept this year's portfolios to show to next year's students. As a result of my experiences in this research, I now find it easier to create rubrics. I have already begun to work with another mathematics teacher as she works on projects and rubrics. The hurdles to overcome are the organization and summarization of this variety of data. It is also time consuming.

CONTINUING GROWTH THROUGH ASSESSMENT

Sheila Kellenbarger and Karen Ward
Lincoln Southeast High
Lincoln, Nebraska

Problem:

The majority of high school students seem to view tests as the end of a process rather than as an integral part of a learning continuum. Frequently, following a test, we could tell what each student still needed but with the time constraints, unless large numbers missed a concept, we spent only a few minutes in class going over the test and proceeded to the next topic. Students might compare answers for a minute or two to make sure tests were graded correctly, but they did not spend time analyzing errors. This repeated scenario prompted the selection of our research questions.

Study:

Will students understand and retain more if they do a written analysis of each missed test question and have an opportunity to discuss the analysis with their teachers? Do struggling students get so discouraged and bogged down by poor grades that their incentive to keep learning is significantly diminished?

Using the test results as a starting point, we provided students an opportunity to demonstrate continued growth and earn growth points through:

- their written analysis of missed test items;
- a conference with the teacher to discuss the analysis;
- personalized test questions on a maintenance test to demonstrate student retention.

We established guidelines to accomplish these tasks in a manner that would be clear to students and their parents. It was important to make a special effort to explain the process in such a way that students would view it as a way to improve their performance, understanding and

"I really understood this when I wrote it. It's just that now I can't remember what I was thinking."

grade rather than as an additional burden. We did emphasize, however, that to gain the maximum benefit, students would have to make a serious time commitment.

As we proceeded, class instruction was changed very little. When it was time to grade tests, however, everything changed dramatically. To enable students to do a thoughtful written analysis of missed test questions, it was important not to circle errors nor indicate whether wrong answers were the result of major concept errors, procedural errors or minor notation errors. By reviewing missed questions, we assigned test grades more subjectively than in the past. Occasionally, this method of grading was disconcerting to the students because one might miss five answers and receive a "B" while another missed five answers and received a "D." The difference was related to the kinds of errors made by the students.

After receiving their graded tests, students had two weeks to submit a written analysis of all missed test items. They had to follow the provided format. A major objective of the analysis was for students to learn to identify the type of error they had made and to arrive at that conclusion independently. Throughout the process, students were reminded that the correct answer to a problem was not the goal of the analysis; that clarity of thought, detail of the analysis and ability to describe the mathematical concepts verbally were all more important than the answer.

After completing a written analysis of missed test questions, students scheduled a conference with their teacher. Conferences took less than 20 minutes if students were able to express themselves accurately in writing and if they truly understood what they had written. Conferences took far more than 20 minutes if students had difficulty putting mathematical thought into English sentences or if students could not explain what they had written. One student commented, "I really understood this when I wrote it. It's just that now I can't remember what I was thinking."

The conferencing format was enlightening for both students and teachers. The rubric for the conferencing was based on four criteria: student thinking, type of error, correct explanation of process, and correct problem solution. Although a formal rubric was used to evaluate each student conference, some of the most useful communication happened unexpectedly. We learned that students sometimes received the right answers for the wrong reasons. By listening to students, we learned that occasionally we misidentified concept errors as procedural errors and vice versa. Students learned that describing mathematics verbally is not as easy as it first appears, but felt very good about their accomplishments as they became better at it. They realized the benefit of discussing their errors with someone else, whether it was with another student or the teacher. Comparing only answers was no longer important but learning the process was.

An unannounced maintenance test several weeks after the written analyses were completed was given to determine if students maintained the knowledge they acquired sometime during the learning process. Maintenance testing was probably the most difficult part of this project. It was difficult to find time to give the tests, especially as second semester progressed and the end of the year approached. It seemed more important to continue to teach new material than to take time to give maintenance tests.

Conclusions:

Our evaluation of maintenance tests showed that students were able to correctly answer 70% of the questions they had missed on previous tests. While this percent is not significantly different from those who did not provide written analyses, the writers were asked only questions which they had previously missed.

Improved understanding was evident when participating students' test grades improved during the semester. They began to look at test questions differently. They spent more time writing out work that would make their thought processes clearer and consequently would make later analysis easier. Students with high overall grade point averages (GPA) were more likely to participate in the analysis/ conference process than were other

Students with high overall grade point averages (GPA) were more likely to participate in the analysis/ conference process than were other students.

students. Seventy-nine percent of the students whose GPAs were between 3.5 and 4.0 participated in the analysis option but only 56% of those with GPAs between 3.0 and 3.49 did.

A question we answered but did not ask was, "Are females or males more likely to participate in this method of assessment?" We found that through three quarters of classes, 72% of the females participated while only 62.5% of the males participated.

Overall, we thought the research was successful and useful in our classrooms. It changed students, and it changed us. One part of our research plan that did not go as anticipated and needs further development is the maintenance testing for retention. Time became the biggest factor. Teachers in schools with block scheduling may find it easier to incorporate the maintenance portion.

Plan of action:

We plan to use this approach again next year. We think the time constraints are too great to pursue the process with all classes, but some of the ideas can be incorporated on a smaller scale in some classes. Other options for addressing time constraints are meeting with small groups instead of one student at a time for conferencing and making either analysis or conferencing optional.

WHICH ASSESSMENT WORKS BEST IN WHICH LEARNING SITUATION?

Barbara Moran
Cedar Hollow Elementary
Grand Island, Nebraska

Problem:

As I used fewer traditional teaching techniques in my science classrooms, it became more difficult to assess both the educational and behavioral skills that the students were acquiring using only my traditional tests.

Study:

I began by giving an attitude survey to discover student feelings about the classroom atmosphere, group work, subject matter, and support from the staff and fellow students. A second survey was given later to both the students and their parents. It accompanied the student portfolios that included all work from the science class.

I used portfolios, rubrics, student journals, authentic assessments tied to real-life situations, and photographs to assess student learning.

Results:

Authentic assessments were popular with the classes. A student commented, "It is much easier to build an idea into a model than to always write about it." Several students commented that authentic assessments were fun because they allowed choices of projects. The students were motivated by the meaningful situations, but it took good language skills to perform well and that limited a few students.

Rubrics became tedious for me because they seemed to condense topics on which students may have otherwise wanted to elaborate. In building a rubric, it was difficult to decide which areas to highlight. The students felt the rubrics were biased in determining what was important within the content. They felt rubrics limited their parameters of study.

The students were motivated by the meaningful situations, but it took good language skills to perform well and that limited a few students.

I had one student say, "I can hardly wait to journal because the test didn't ask the right questions."

Journaling was the easiest assessment for the students and by far their favorite. It allowed them to express themselves in their own language and with some personal thoughts. When we completed an area of study and our goals and objectives were clearly defined, the students would journal after a traditional test. I encouraged the students to use the terminology and some of the facts and situations that had occurred in our discussions or in the labs. They were encouraged to demonstrate or illustrate with diagrams and show tables and charts to explain the learning that took place. After each traditional test, they looked forward to telling me some things of interest that came up in their discussions that didn't show up on the test. Each student received an "A" for their journal. I had one student say, "I can hardly wait to journal because the test didn't ask the right questions."

Taking photographs during labs, on field trips, and when a guest speaker visited were the best visual aids for the students to use when writing in their journals. The students enjoyed seeing themselves and understanding the steps of the labs.

Conclusions:

There were no significant changes in the student grades, but students were more interested and more motivated as evidenced by the surveys. The new assessment methods also guided my instruction. I did not get as much material covered, but we had a tremendous amount of resources on the material we did cover.

While journaling, portfolios and authentic assessments are useful for all types of instruction, the application of the assessment method may depend more on the skills and the preferences of the teacher than the universal usefulness of the assessment.

Plan of Action:

In the future, I will modify several assessment-related processes to

- determine how often each type of assessment will occur;
- determine who will gather the data;

- develop a timeline for assessments;
- determine scoring procedures;
- score student samples;
- determine learning styles.

COMMUNICATING WITH PARENTS THROUGH THE USE OF PORTFOLIOS

Caroline B. Winchester
Wolbach Public Schools
Wolbach, Nebraska

Assumption:

Parents are essential to any educational reform effort. There is evidence that parents' encouragement and interest in school affect their children's achievement, even after the students' abilities and family socioeconomic status are taken into account.

The Nebraska Mathematics and Science Frameworks is based on the belief that learning is a collaborative responsibility among students, educators, parents, and the community. In addition, communication is vital if a school is to play a leadership role in reform. Thus, communication is a target goal for the school improvement process at our school.

Study:

Seventy-seven students in grades 6-12 and their parents/guardians participated in the research at this rural public school with an enrollment of 143 students. Prior to the first parent/teacher conference, students were asked to select five items from their notebooks and start a portfolio. The portfolio included lab reports, notes, handouts, tests, special research projects, and a journal. The following five questions guided the students' portfolio selections:

- What did you study during this nine week period?
- What was one thing you learned?
- What was one thing you enjoyed or that was easy for you?
- What was one thing that was hard to master?
- Which journal entry is your favorite?

After selecting five items, students took the portfolio home and shared their selections with their parents. A survey for the parents was included in the portfolio, and the survey and portfolio were to be returned at the parent/teacher conference. This procedure was followed at the end of every quarter, with a second survey given at the spring conference.

Results:

After seeing and using portfolios at three intervals during the year, ninety-five percent of the parents requested the continued use of portfolios at parent/teacher conferences and 41% of the respondents felt the portfolios increased communication among students, parents, and the school. Reports indicated the biggest increases in communication involved sharing information about successes, good grades and events that happened in class. Other topics that were discussed more frequently with the use of portfolios included the student's level of understanding, low grades, and problems with assignments.

In addition to this research project, I used portfolios for end-of-semester assessments. The biology and physics classes were to select a portfolio item to expand what they had been learning in class; the portfolio item counted as one-fourth of their semester final. The physiology class selected a larger project which counted as their final. During the second semester, the physiology class worked on a portfolio item after every unit. Each item was accompanied by a student self-reflection on the work.

Conclusions:

Portfolios were successful assessment tools for classes with a wide range of student abilities and interests. When given a choice, students chose to do a portfolio instead of a final exam. Resource students spent considerably more time in preparing their portfolios than they did in studying for a final.

This project has also initiated other portfolio projects in the school. As a result of an article in the student newspaper, the social studies teacher has started using portfolios as part of his assessment.

Plan of Action:

At the end of the year, students selected five items to be placed in a portfolio. Each item was accompanied by a statement explaining why the item was selected. This

When given a choice, students chose to do a portfolio instead of a final exam.

Use of portfolios will continue and expand in the other science classes.

portfolio will follow the students through their years at the school and will be updated annually. It is hoped that, over time, this will give an added assessment of student progress in science. Portfolios will continue to replace the final exam in physiology class. During the next year, rubrics will be developed for many of the portfolio choices so that students may have a clear understanding of what is expected and a high level of quality can be maintained. Use of portfolios will continue and expand in the other science classes. It is hoped that in the future, the portfolio will be digitized using a quicktime camera.

WHAT TYPE OF ASSESSMENT COMMUNICATION IS MOST EFFECTIVE/ BENEFICIAL FOR PARENTS?

Pat Lotspeich, Sue Adamson, and Sue Saalfeld
Hillrise Elementary
Elkhorn, Nebraska

Problem:

Communication to parents about their children's progress can become an overwhelming task, and with a variety of alternative assessments available, reporting progress is more complex than ever before. Often there is a misunderstanding or a misperception of the assessment by the parents or students.

Parents seem to be overly concerned about their children's number grades. Are they interested in other forms of communication? Do they value receiving their children's self-reports of how their school work is progressing, looking at work samples, and talking with the teacher? In previous years, we reported student progress to parents with the quarterly report card and two parent/teacher conferences. The report card used a traditional grading system with number grades indicating progress. We began to question how effective we were in reporting children's progress. Were the number grades enough information to convey an accurate understanding of student progress?

We wondered what type of assessment communication is most effective and beneficial for parents. During the November parent/teacher conference, we surveyed parents of our fifth graders, asking them what current methods of communication provided the most information about their child's progress. Our goal was to find out what types of assessments were most beneficial to parents: number grades, work samples, conversation with the teachers, written comments, or child's reflection on his/her progress. Forty-two percent of the parents responded that they preferred number

We began to question how effective we were in reporting children's progress.

Our action plan began with the belief that part of the mis-communication between school and parents was due to the lack of student ownership of the reporting.

grades to the other choices given. Because a high percentage of the responses matched our current practices of parent communication, no modifications were made in our reporting for the next quarter. The second report card and a parent survey were sent out in January. There was no conference at this time. We were confident about sending this report card home without direct parent-teacher communication because of the responses to the initial survey. There were three questions on this second survey focusing on expectations, grades, and anything that was unclear. Responses were not what we expected. Parents were not happy just seeing number grades. They responded with many questions and comments that they would appreciate a call from the teacher. Because of these responses, we decided to take action.

Study:

We began with our belief that part of the miscommunication between school and parents was due to the lack of student ownership of the reporting. Our plan was to allow students to become more involved with the reporting to parents through a variety of methods. We began by sending a letter home explaining that the initial communication would be a journaling activity. All parents signed an agreement to sign and return these journals each week. While we felt the journaling was valuable, by mid-February the students were getting bored with it. We created an "I can do" grid and introduced it in March. Students were asked to complete these statements in reference to their academic classes: "I can do...; I am working on...; I want to learn more about..."

A different parent reporting plan was used in social studies, also. In March, each student had the opportunity to be involved in a compacting group. For two weeks, the students accelerated through the assigned chapter and then participated in activities that enhanced their studies. At the conclusion of the unit, students filled out the compacting sheet with their parents. The sheet asked students to summarize their activities and to share information and reflection with their parents. Students also were encouraged to facilitate the spring student/parent/teacher conference.

In April, we sent our last parent survey. We restated the rank ordering of five different types of reporting systems that were asked on the initial survey. In addition, we asked for parent opinion of the additional communication efforts that had been enacted the last two months. This survey indicated that over 90% of the parents favored the students' increased participation during the past quarter, saying that it allowed for better communication between them and their child.

Conclusions:

Results indicated that the importance of number grades had decreased from 42% to 33% for the parents. While the importance of talking with the teacher decreased from 33% to 23%, that of student reflection increased from 3% to 10%. It appears that while number grades are still important to parents, their children's reflection on progress is also important.

Our later parent surveys indicated that our procedures were a catalyst for communication between student and parent. When students were more responsible for communication, they were more reflective about their work.

When students were more responsible for communication, they were more reflective about their work.

CALCULATORS IN THE ELEMENTARY CLASSROOM

Janet Stineman
Randolph Elementary
Lincoln, Nebraska

A survey of 45 university students majoring in elementary education revealed they believed that it is not best practice for elementary students to use calculators,

Problem:

Will the self-selected use of calculators enhance exploration and promote self confidence in mathematical problem solving at grade five? As a fifth-grade teacher and a district leader in the implementation of a new math program that promotes student use of the Math Explorer calculator, I believed this was a question I would be faced with from colleagues and parents. Although I have incorporated and encouraged the appropriate use of calculators in my classroom, I felt I would need current data collected from and about the students with whom these educators and parents would be relating.

Study:

I first examined existing information on the use of calculators in the elementary classroom from the National Council of Teachers of Mathematics Curriculum and Evaluation Standards (1989), educational journals, curriculum books, resource books for classroom teachers, mathematics journals, district curriculum consultants and conference programs. The research affirmed my beliefs and suggested ways to collect evidence to support my beliefs.

Next, I assessed the attitudes of educators, parents and students on the use of calculators in elementary classrooms. I surveyed fourth-, fifth-, and sixth-grade teachers. The majority of these teachers had students use the calculator only for checking work already completed. A survey of 45 university students majoring in elementary education revealed they believed that it is not best practice for elementary students to use calculators, although they used a calculator as they participated in hands-on lessons for elementary students. The parent survey indicated that although they value the use of calculators for saving time, they do not want their children using the calculator for similar work in the classroom. Parents felt students should learn how to use calculators, but a majority felt students should not use a calculator in math except to check the work they had already done.

A survey of 100 fifth-grade students in three different classroom settings gave a different viewpoint. A common statement was, "Why should we learn to use the calculator if we cannot use it to do more work or do it better. Parents do not check their work even if they do it with pencil and paper." These classrooms had a Math Explorer calculator available for each student, to be used as directed by the teacher. Students indicated that their mathematical success is enhanced with the use of calculators. They said that their parents do not always share this attitude nor do their teachers, since they do not always have calculators available for solving problems.

As a result of these surveys, I decided to provide opportunities for teachers to assess student work at problem solving. These teachers also had the opportunity to review the comments made by students on how the use of the calculator affected their success and attitude toward extended problem-solving activities. I provided opportunities for students and parents to work together to solve some problems where they could choose to use or not use the calculator. The results were varied, but overall, the parents were willing to consider the fact that a calculator made it possible for the children as well as them to solve more complex problems, create new problem-solving activities, and save time. They were also pleased that students are taught the appropriate use of the calculator. Once parents understand the philosophy behind appropriate calculator use and experience some of the learning activities, they reevaluate their stand on the issue: There is no better teacher than experience.

Conclusions:

In agreement with my investigation of other research, the only true obstacles to the use of calculators are attitudes and beliefs. Throughout my project, students were given problem-solving activities to do in various classrooms. Evidenced by

"Why should we learn to use the calculator if we cannot use it to do more work or do it better. Parents do not check their work even if they do it with pencil and paper."

The only true obstacles to the use of calculators are attitudes and beliefs.

journal entries and interviews with students and teachers, the students did more problem solving and enjoyed the challenge of creating problems of their own if calculators were available for their use.

Students who have access to calculators on a regular basis do more problem solving.

The research and collected data support the use of calculators in the fifth-grade classroom. Students who have access to calculators on a regular basis do more problem solving. They enjoy the challenge of using big numbers, working with multiple functions, finding patterns and creating their own problems for others to solve. Those students who do not have access to calculators do not take the challenge to solve and create problems that require extended time and/or lengthy, routine computations. This is not to say they cannot or do not solve problems with pencil-and-paper, but that they do not enjoy the experiences or extend their learning as often without calculators. Students who discover they can meet the challenge of problem solving develop self confidence in the mathematics classroom.

SO WHAT'S THE PROBLEM?

Dot Snesrud
Osceola Elementary
Osceola, Nebraska

Problem:

So often my students can do the traditional math problems with the basic operations, but when it comes to applying those skills in a story problem, they fail miserably. I began to search for a reason why they could complete algorithms with seemingly little difficulty, but when faced with real world applications, they were unsure of what to do. I suspected that they weren't as clear about number concepts as they were with the steps of doing a number problem. I selected some traditional number problems and had my students write story problems to match them. Were my eyes opened! It became quite clear which students understood the basic operations and which students were shaky. I was especially concerned with four students who struggle in math, but I became aware of some insecurities among even some of the top students.

Assumptions:

- Those who like math can do story problems, solving them as well as writing a story problem to match a number sentence.
- When students can write a story problem to match a number sentence, their attitude about math becomes more positive.
- Writing story problems to match a number sentence is a way to assess mathematical understanding.

Study:

In my math class, at least 60% of class time is spent working on story problems or hands-on activities. Any time my students solve a story problem/real world problem, they are required to write a number sentence to show their thinking. I began using the "match a number sentence to a

Were my eyes opened! It became quite clear which students understood the basic operations and which students were shaky.

Skill in writing story problems comes primarily from the class discussions of the process, not the process itself.

student-written story problem" before Christmas as a fun way to review addition, subtraction, multiplication and division. The National Council of Teachers of Mathematics Curriculum and Evaluation Standards (NCTM, 1989) state, "An inference about learning is a conclusion about a student's cognitive processes that cannot be observed directly. The conclusion has to be based instead on the student's performance." This statement helped me to realize the assessment potential of observing students while they were writing story problems.

I began with a math attitude survey of the students asking them to rate their favorite subject in school, to complete the statement "When I hear the word math, I immediately feel..., " and to rate themselves on the continuum line between "I'm not good at math" and "I'm good at math." I had the students fill out an attitude survey again in the middle of February and again just after the April Easter break. Some attitudes had changed. Most of the improvement in attitude was from those who previously had scored in the middle range on the attitude scale.

Conclusions:

Students had the most difficulty creating accurate story problems for division and fractions. The debating and defending of solutions was a learning experience for all of us. We began to see how we often use our own experience to interpret problems. We also began to see that there were differences in how students approach problems. Although the problems did not always match the original number sentence, my class learned a lot from the experiences.

Writing story problems to match number sentences is a way to assess the mastery of mathematical understanding. I have found it remarkably insightful. I have learned more about how all my students think and approach problems. I see the importance of details in communication and the excitement when there is not always a "simple right or wrong" answer. I now have evidence that skill in writing story problems comes primarily from the class discussions of the process, not the process itself.

THE REFLECTIVE DETECTIVES' MYSTERY

RaNae Adams and Suzanne Oldham
Friend Elementary
Friend, Nebraska

Marla Weber
Exeter Elementary
Exeter, Nebraska

Problem:

A fall outdoor education day with a nature theme was a starting point for our concern. Could we use journals to assess the learning in this kind of activity? But what were we looking for in a journal? We looked at the results of previous student journals, reviewed articles, and then discussed and developed our criteria for quality journaling that would apply to various curricular areas and age groups. Our team derived five components necessary for effective journaling: preparation, explanation, questioning, evaluation, and reflection.

Assumptions:

We have a shared belief in language and literature-based learning through thematic units. We also agree outdoor education is an exciting way to learn.

Study:

A joint effort by Suzanne's sixth-grade class, with the assistance of RaNae, the special education teacher, and Marla's third-graders culminated in an outdoor education learning experience centered around a theme of water. The water curriculum was designed after our participation in the Satellite Education and Environmental Research project sponsored by the Nebraska Mathematics and Science Initiative. Prior to the outdoor experience, students in the Friend Elementary sixth-grade class researched and prepared informational reports related to the learning stations for the upcoming outdoor experience. They videotaped this "sneak preview" and sent the tape to the Exeter third-grade class. The Exeter students returned the video with questions they wanted answered during the event.

As the year progressed, students used more detailed drawings in their journals. More opinions were expressed, and natural reflection and evaluation became intertwined in the journals.

A spring outdoor education day with a water theme was the culminating activity of our joint efforts. The stations at the outdoor site were entitled Water Wonders, Hooked on Water and Fishing, Waves or Whitecaps, Quality Water/Water Uses, Sink or Float, and Orienteering. Third-graders journaled as closure to their visit to each of the stations. They wrote, drew, recorded the concepts they learned, and responded to each station. They self-evaluated their journals using the rubric they had created. Friend's sixth-graders journaled and self-evaluated their science journals after returning to the class.

Does using a self-evaluation tool improve journaling performance? We practiced journaling and self-evaluations on various chapters and units that were taught in science throughout the year. As the students practiced journaling before the outdoor activity, we tried to address areas of concern. Questioning seemed to challenge the students the most. We developed an activity that would encourage questioning as a natural process. With student help, we created a rubric to assist us in articulating our criteria for good journals. Students looked for these criteria in their own journals, using a color code to denote evidence of each of the criteria. The self-assessment tool became an organizer for the journaling. This self-assessment activity allowed students more control in their evaluations. Some of the burden of reteaching and redoing was removed from the teacher and was placed on the student.

We gathered information from the students about their attitudes toward journaling and the activities on Outdoor Education Day.

Conclusions:

As the year progressed, students used more detailed drawings in their journals. More opinions were expressed, and natural reflection and evaluation became intertwined in the journals. In many instances, students would make an explanation and combine that with evaluative thinking and reflection.

All students indicated a very positive response toward learning about a topic related to their environment. The overwhelming majority of the students had a very positive attitude toward the amount of time they were given to journal. Most students expressed that they were more confident in their end product when they self-assessed their journals. This type of assessment created an environment of student ownership. Students realized they are accountable for their learning.

This type of assessment created an environment of student ownership.

THE EFFECTIVENESS OF PEER MENTORING IN IMPROVING ATTITUDES TOWARD SCIENCE AND ACADEMIC PERFORMANCES IN THE SECONDARY SCIENCE CLASSROOM

Steve Ward
Omaha North High School
Omaha, Nebraska

Problem:

I have used cooperative learning for the past several years and have always been impressed with its ability to decrease the disparity in performance between high and low level learners. My attempt was to document some evidence that supports the effectiveness of using a mentor to enhance the performance and attitude of science students.

Study:

In this study, four high-achieving students (mentors) were matched with four low achieving students (mentees). The students were sophomores in a two-year science program integrating biology and chemistry. Students agreed to be involved with the action research. Only hands-on activities and laboratories were used as opposed to written assignments and book work. To assess the effectiveness of this procedure, I used pre/post science attitude scales and pre/post academic performance measures.

Information also was collected from journal entries of the students to obtain their feelings about working with a mentor/mentee and their assessment of their progress during the activities.

In order to find out if peer mentoring had a positive or negative impact on their attitude and/or performance in the classroom, the students were responsible for:

- completion of peer mentoring pre- and post-attitudinal survey;
- completion of post-activity response survey;

- performance of activities according to instructions;
- completion of the attitudinal surveys.

Results:

To my dismay, I found that improvement in attitudes toward science came from the mentors even more than the mentees. They frequently expressed comments with the theme, "I felt like a teacher." The mentors continued with excellent academic performance. The mentees showed increased interest levels by simply being on task and responding positively on their surveys. The low-level learners completed more labs and activities compared to previous quarters.

Before the pairing of students, mentors expressed comments that included the following:

- I don't know if I will be a good mentor.
- I hope that he does his share.
- It should be a good experience. Maybe it will help me understand the mentor things a little better by working with a person whose brain works differently than mine.

The mentees commented:

- I think it will be great. If I don't do my job during a project, then it will hurt my partner's grade and I don't want to do that.
- I hope it helps me pass this course.
- I've always sucked in science class.

After the project, mentors commented:

- I felt like a teacher.
- I had better understanding when I had to explain.
- I understood about increasing surface area but I struggled to explain it to my partner.

The mentees commented:

- Wasn't our brochure sweet! I sure wish I had a computer at home.
- I'm getting better grades but I'm not sure if it's because of my work or my partner's work.

Improvement in attitudes toward science came from the mentors even more than the mentees.

- I thought I screwed up again and my partner couldn't even help me. Then we figured out I was going to grow a bunch and it made sense. That was cool.

Conclusions:

Although peer mentoring can have a positive effect on both the mentor and the mentee, it seemed to be more significant for the mentor than the mentee. I question whether it was the extra attention more than the particular structure that caused the increase in interest and performance.

Plan of action:

What would I change the next time I do this? I would document the learning and attitudes more frequently and instantly. I would focus more on the positive effects toward the mentor rather than the mentee and would select more students from whom to collect data. I would allow more time for students to reflect on their progress or regressions.

DOES COOPERATIVE GROUPING IN MATH HELP BOTH HIGH AND LOW ACHIEVERS?

Daphne Blauser
Saratoga Elementary
Lincoln, Nebraska

Problem:

Our new math program uses more manipulatives than the previous curriculum. I noticed that students were more involved with manipulatives and that those tools lent themselves to more group work. I felt challenged to keep high achievers interested while slowing down for low-functioning students.

Study:

My question was, "Does cooperative grouping in math help both high and low achievers?" I conducted this research in my classroom of thirty-six first graders. The population was mostly from single parent or step-parent families with high mobility. My class had a variety of abilities with several high to several special education and some Chapter 1 students. The Chapter 1 program assists students who are at least one grade level below the norm in reading and math achievement.

Since my research was investigating cooperative math learning, I reviewed literature on cooperative learning. Authors Johnson and Johnson said cooperative learning was not—

- just sitting side by side;
- discussing assignments together and doing it alone;
- doing tasks alone with instructions that the first one done will help the slower workers;
- sharing materials before a competitive test.

Essentially, cooperative learning is assigning a group goal such as producing a single product. The teacher establishes

One difficulty I encountered was finding clearly defined and simple math objectives that the students could accomplish without my constant support and intervention.

a group goal and a criterion-referenced evaluation system.

I continued using the math guide for our curriculum, but I adapted lessons to using pairs or groups whenever possible. I had to spend some time teaching my students about cooperation.

I obtained data in the following ways:

- The media specialist videotaped a session and I videotaped several other class sessions;
- Another teacher observed several math sessions and commented on group dynamics and interactions on a form gleaned from a book on cooperative learning by Johnson and Johnson;
- I wrote my own observations and reflections of math sessions;
- Students completed individual student attitude surveys to assess self-esteem;
- I conducted informal and formal evaluations of students' math concepts.

One difficulty I encountered was finding clearly defined and simple math objectives that the students could accomplish without my constant support and intervention. Of all the data collected, I found the perception surveys the most interesting and useful.

Results and Conclusions:

There were a number of positive changes from using cooperative learning groups in math:

- There was more "on task" behavior indicated by the observations by the outside teacher. She commented, "Several students were off-task when on the rug listening to directions; in small groups, students kept working even when one student misbehaved." I affirmed this observation after I viewed the videotapes.
- There seemed to be higher achievement shown by both the formal and informal evaluations of math concepts. A majority of the students, including those ranking in the lowest quartile from previous tests, achieved better than would be

expected. Some achievement may be attributed to the higher use of manipulatives to teach objectives, but a comparison of last year's class of similar students to this year's showed better achievement with cooperative groupings.

- Another change seemed to be more positive perceptions of math and school. A perception survey was given orally to students. They answered statements with "always true, sometimes true, and never true." First graders had difficulty with these responses. Therefore, I gave the students another survey focusing on peer relations with a yes/no format for the following five questions:
- I think asking other kids about math helps me learn math better.
- I feel good about helping others with problems.
- I try to work with other students on number tasks so we can help each other.

I asked the students two other questions, as well:

- Only smart kids ask questions.
- I don't like to ask for help.

As I analyzed the surveys and grouped questions into three areas (peer relations, school perceptions and self concept), I noted that students seemed to answer positively to those statements that reflected positive interacting behaviors such as "I usually know when people need help and what kind of help to give." On a question asking about their feeling good about helping others, all students answered yes. On a question about helping others in turn helping them learn better, all except one answered yes.

DOES COMPUTER INTEGRATION IN THE SCIENCE CURRICULUM LEAD TO IMPROVED ACADEMIC ACHIEVEMENT?

Tom Gehringer and Elaine Westbrook
Omaha North High School
Omaha, Nebraska

Study:

This investigation examined whether the integration of computer technology enhanced the academic achievement of nine students in our tenth grade integrated science class. The students were selected by their SAT scores taken in the ninth grade. The nine students were placed in three academic groups: high, medium, and low scores. Eleven technology applications were used with the target students.

After selecting the nine students from their SAT scores, we began creating a personal database on each student. A counselor checked the school records of each person. Their previous grades in science were recorded for the seventh, eighth and ninth grades. Individual student profiles also included information about the student's attendance, participation in extracurricular activities, part-time employment and exposure to computer technology, not only in the school environment, but also in the home. Student records were checked to see which junior high they attended and if that facility had advanced computer technology. A questionnaire was given to the students to find out if they had access to computers in their homes and if so, what type. A survey was administered to each of the nine students to assess three things: computer confidence, anxiety, and liking. This instrument allowed us to quantitatively evaluate each student's degree of comfort when working with technology.

Students were allowed to respond to the computer experiences in a variety of ways. Sometimes they were asked to journal and respond to open-ended questions. They were asked to respond to specifics about the technology. In some of the technology labs, students worked individually, and in others they worked cooperatively.

Conclusions:

Data showed little or no improvement of academic grades for the nine students we studied after they used the computer technology . However, some other interesting patterns did emerge. Those patterns appeared to be affected by students' access to computers, both at home and at school. Some students liked structure; others preferred to explore on their own. When learning a new application, students preferred a tutorial before using the application. They wanted to work in pairs, not individually. They enjoyed simulations and images and thought learning was enhanced by their use. All stated that they liked working with the technology.

Plan of Action:

We know that the consistent way in which textbooks are organized helps students use books effectively. Now we need to study how to help students learn when using computer applications. Our study indicated students need time to learn computer applications and need to receive consistent, repeated exposure before learning can be enhanced by technology. It is clear that the use of high-tech applications like computer simulations, visualizations, and virtual reality programs need to be explored more fully so that researchers can understand how students learn best when using technology. Some possible questions for exploration include: What presentation mode is best received by students? What grouping at the computer is most conducive for optimal learning? What presentation sequence helps students learn?

The students enjoyed simulations and images and thought learning was enhanced by their use.

WHO KNOWS? A STUDY OF SELF-ASSESSMENT

Donna Trout and Jackie Thomas
Omaha Bryan High School
Omaha, Nebraska

Problem:

Students seem to have little sense of responsibility for their learning. We wondered if helping them become better self-assessors would help them accept responsibility and improve their study skills, eventually improving their learning in mathematics.

Study:

Our question evolved into, "Can the use of self-assessment activities help students become better, more responsible learners?" This project consisted of four self-assessment activities used in our Algebra 1-2, Honors Algebra 1-2, Geometry, and Pre-Calculus/Trigonometry classes. These were weekly self-assessments generated by the teachers and included notebook checklists, explanations of test errors, journal entries, and group assessments. They were given to all students beginning in the second term of the school year. After approximately nine weeks, students were given a folder with all their weekly self-assessments and asked to choose the one they liked least and the one they liked best and explain why. The following week, they were asked to work in their groups of four to create a "better" self-assessment tool. They were told it should do the following things: 1) allow them to reflect on the work they had done that week and identify their strengths and weaknesses; 2) give the teacher some feedback on how they were doing with the material and feeling about the class; and 3) be easily completed in 5-7 minutes. Student-generated self-assessments were used for the remainder of the term.

Notebook checklists were used and developed through five stages. At the beginning of the term, students in Algebra 1-2 and Geometry were given teacher checklists when they finished a chapter and notebooks were due for a grade. In the second stage of this activity, we added a column for the student to grade his/her own work before turning the notebook in for the teacher to correct. In stage 3, we added a third column so that students checked their own notebook and then checked their partner's notebook before turning it in for the teacher to grade. In the fourth stage, the class created the notebook checklist together as they worked through the chapter. In stage 5, each student was in charge of creating his/her own checklist as part of the notebook grade.

From the beginning of the term, all students had done corrections on tests. Those students in precalculus/trigonometry had been required to write the correct solution, identify their error as "conceptual" or "procedural," and write an explanation of their error and how that differed from the correct solution. Students received a separate grade on these corrections to ensure their taking this activity seriously. These students also were asked to write in their journals immediately after taking the test answering these questions:

1. What grade do you think you will receive?
2. What two questions do you think you did well on?
3. What two questions do you think you had trouble with?

The next day, students were asked to review their journal entry and compare it with the results of the test.

Group assessments were useful since both of us use cooperative groups of four students on a regular basis. Each time those groups were rearranged, a group assessment was administered after the first group activity. Other group assessments were administered as each teacher felt a need to evaluate either particular group combinations that needed further assistance in working together or a need to reinforce a particular social skill for a particular class. The purpose was to remind students that they need to be constantly aware of how they are performing in any situation and that being successful in one setting does not guarantee

The next day, students were asked to review their journal entry and compare it with the results of the test.

Perhaps we have planted a seed that will bear its full fruits in the future.

success in another setting. Sometimes adjustments need to be made in attitudes to assure optimal performance when other students are directly involved.

To study the effects these self-assessments had on students, a baseline attitude survey was administered to students at the beginning and the end of the term. Average test scores and notebook scores were compared whenever comparable between Term 1 (without self-assessment activities) and Term 2 (with self-assessment activities). A student questionnaire was administered four months into the activities to determine student perceptions of the value of these activities. Students were asked to compile a list of things they do to improve their own motivation and do their best in their math class. They were also asked to journal on these two questions: "Who has the most control over your grade? Explain why." and "Who has the most control over your learning? Explain why."

Conclusions:

The attitude survey administered at the beginning and end of each term provided little information. Most of the data was fairly close for both terms. Therefore, we chose to draw no conclusions from the attitude survey. We did, however, find that of the six classes involved in self-assessment, five showed higher results in correctly correlating their perception of math ability to their grades. The one class that did not show higher results had a variety of extenuating circumstances.

The comparison of notebook and test scores between the two terms once again did not yield strong evidence. Notebook grades tended to be more consistent and slightly higher with the use of self-assessment techniques. Test score results proved positive in some classes, neutral in others. At least we know that the self-assessment activities did not negatively affect students. We believe these results would be studied best over a longer period of time. Perhaps we have planted a seed that will bear its full fruits in the future.

The feedback we received from the students seems to be our strongest source of information. We distributed a questionnaire three months into the project.

We were pleasantly surprised, since we had heard some complaints about filling out our weekly assessments. When asked how they thought they would have performed in the class without doing self-assessments, only six out of 106 students (about 6%) felt they would have done better. None of those students was in the precalculus classes, leading us to believe that these students are more mature. Only 18 of 106 students (about 17%) felt they would have done worse. When questioned about the four self-assessment activities they had done, students responded favorably for all categories with many thoughtful comments. The most exciting result was that many students felt that the activities helped them become more responsible for their learning and gave them ideas on how they could improve. These results were confirmed when we asked our students to journal after the final attitude survey about who had the most control over their grade and their learning. Overwhelmingly, students accepted responsibility for both their grades and their learning!

Further support for our conclusion came when we asked groups to make a list of things they could do to motivate themselves to do their best in math class. This activity was conducted both terms. First term students worked for a long time and many groups turned in their sheets with fewer than the ten activities requested. Second term students completed their task in a much shorter time, had better answers, and all groups had the ten activities requested. Some groups indicated they had limited their answers to the best ten.

Overall, we feel these activities are of significance in the quest to help our students become more responsible for their own learning which will enable them to become life-long learners. Referring to the quote we used to open our presentation, we hope to count each student among those who "knows that he knows."

Plan of Action:

We believe that self-assessment must be an integral part of every student's education. It is a basis for our goal of creating life-long learners. Toward this end, we intend to incorporate the following items into our curriculum on a regular basis:

Overwhelmingly, students accepted responsibility for both their grades and their learning!

We hope to count each student among those who "knows that he knows."

Self-assessment must be an integral part of every student's education.

- weekly self-assessment forms that the students have an opportunity to devise;
- notebook checklists in algebra and geometry that students will eventually create on their own;
- correction of mistakes on tests. Students will be required to give the correct solutions and write a brief paragraph about the kinds of errors made on the test. In precalculus/trigonometry, students will continue to write a critical analysis of each problem and an explanation of the correct process;
- group assessment at least once as new groups are formed or as needed.

INCREASING COMPREHENSION LEVELS AND IMPROVING SCORES ON SCIENCE TESTS

Ron Billings
Valentine Middle School
Valentine, Nebraska

Problem:

The purpose of this study was to improve student comprehension levels and raise science test scores for tested objectives. Each science curriculum has its own tests, but it does not usually provide methods to increase comprehension or ways to improve test scores. Other resources I read indicated students need to know what it is they must learn, less material means more likelihood of success, and student participation in selecting the method of evaluation could improve performance levels. My research focused on these ideas.

Study:

The research began by having 54 seventh grade students take two standard curriculum tests following completion of the units. I then selected six student volunteers from the class. The volunteer group consisted of three girls and three boys. One boy and one girl performed very well on the first two tests. One boy and one girl performed moderately well on the first two tests. The last pair of students had very little success on the first two tests. This group of students and I met and discussed objectives to be tested. I solicited their ideas about how each objective needed to be tested. I then constructed the next test based on the group's suggestions. Attached to each test was a separate form for comments from all students concerning how they felt about the test and for any suggestions they might have to improve the tests. I also visited individually with students who had failed tests and asked for their comments concerning why they had failed and asked what could have been

Student participation is important because it may give the students a sense of ownership in the process.

done to make the test easier for them. I considered the student comments when constructing future tests.

I conferred with students for each of the next four tests. The number of tested objectives decreased in each of those tests. I then administered three tests that I had constructed without student input. The number of objectives tested varied on each of these tests. The objectives that were to be tested were given to all students at the beginning of all tests. Following each test, I calculated overall percentage for the entire class by using the number of correct responses and the total number of possible responses. I used Bloom's Taxonomy to guide me in selecting questions that tested comprehension. I measured the comprehension levels for those specific comprehension questions.

Results:

The results indicated that when fewer objectives were tested, better comprehension levels and improved scores occurred. When student participation in the process ended, both comprehension levels and scores declined. I think student participation is important because it may give the students a sense of ownership in the process. I also became a better test maker. There were other results that became more evident during the process: My rapport with students improved, self esteem for many students improved, and failing students became more aware of reasons they failed tests.

Plan of Action:

The results of my study will help me in the future. I believe I can improve comprehension levels for my students and help them achieve more success which in turn will provide them with improved self esteem.

A CONSTRUCTIVE AND METACOGNITIVE APPROACH TO TEACHING AND ASSESSING STUDENTS TO IMPROVE ALL STUDENTS' ACHIEVEMENT IN AN INTEGRATED SCIENCE CLASS

Ginger Hawhee and Deirdra Rochelle
Omaha North High School
Omaha, Nebraska

Study:

During the 1995-1996 school year, we made a method and content transition in our high school biology-chemistry integrated classes. A new science unit was developed: "What's Up Doc? The Politics of Disease." This unit shifted from teacher-based curriculum to student-based curriculum written around students' prior knowledge which drove the direction of the content. This thematic unit included activities that were hands-on, process-oriented, student driven, and relevant. Our assessment changed from traditional testing and presenting to open-ended projects, labs, and products. Group and self-assessments were incorporated on a consistent basis. We began collecting data in the fall of 1995 and continued to collect data through March of 1996.

Teacher transcripts, completed by a colleague on ten different occasions, provided crucial insight to the classroom activities and atmosphere. These transcripts described activities and recorded conversation within the context of the activities.

Data were also collected from student self-evaluations, student journals, and a student survey. The self-evaluation provided students a chance to assess themselves during class activities and prompted students to think about what they accomplished in class every week or two. It also gave them a voice in the direction of their learning. These self-assessments were taken very seriously by students and teachers; grades were posted from their weekly self-assessments. Group

Results and common journal themes from the classroom activities indicated that students were more invested in the activities that they could control and manipulate.

evaluations were given to students only a few times, and therefore did not provide a good source of data. However, we found group assessments were valuable in two ways: they provided a good vehicle to use for assessment, particularly during cooperative learning labs and activities, and they allowed us to observe and compare self-assessment to group assessments.

Results:

Grades improved from first semester to second semester. Common journal remarks included positive statements about the unit. Group members became more communicative. Student responsibility and initiative improved as evidenced by expressed positive attitudes, grades, self-assessment responses and quality of project.

Several themes emerged from our colleague's transcripts. During teacher-directed activities, students tended to show boredom after some time and irrelevant communication occurred. Their lack of interest and motivation did not exhibit the type of classroom we wanted. Involvement in their own learning appeared minimal and only specific students functioned well. During student-driven activities, students showed improved involvement; conversations were enlightening and comfortable. It appeared that student exploration occurred more often.

Students proved that they could be honest in a self-assessment evaluation. In fact, it became clear that some students were harder on themselves than we teachers were. Overall, self-assessing appeared to be a positive evaluation in the Integrated Science 3-4 class. It appeared that when students were given a self-assessment vs. a group assessment, they were more invested in their own "true" evaluations and less focused on others in their group. They appeared less honest in their assessment on group evaluations.

Results and common journal themes from the classroom activities indicated that students were more invested in the activities that they could control and manipulate. The AIDS simulation lab, the "Unknown Expedition" lab, and the Ecological Book Writing activity allowed for this. Students indicated the impact that it had on them personally and how it affected their own lives in positive terms. The "Dance of the Planets" computer simulation was more fact-filled than the latter two activities and was already set up for students to access. Comments on this activity included the need for more time to explore and manipulate the program in order to gain better insight and information. Students did not enjoy it as much as the previously mentioned labs.

Plan of Action:

Integrated Science 3-4 for tenth graders will be continued at this high school. Grant money will support curriculum writing for the summer of 1996 to improve the thematic units in the course. Constructive methods will continue to drive the class. Cooperative student learning and collaborative teacher participation will continue at this high school throughout the new year. Alternative and improved student assessments will be used and modified according to student suggestions. Block scheduling will enhance our science curriculum and provide a continuous positive atmosphere and environment for student learning, particularly in the Integrated Science curriculum.

THE SEER WATER PROJECT: A COLLABORATIVE ACTION RESEARCH PERSPECTIVE ON LANGUAGE AND LEARNING IN SCIENCE

Kathyryn A. Ahern
University of Nebraska-Lincoln

Problem:

The connections between and among the sciences and language arts seem ripe for exploration. Interdisciplinary thematic teaching addresses these connections, but the process of developing it is still vague and needs further exploration.

The Satellite Education and Environmental Research (SEER) Water Project offered participating teachers a "supermarket" of curriculum development alternatives. The project included 94 teachers who met weekly at 13 sites located across Nebraska during the fall 1995 semester. Most of the satellite downlink sites were located in the schools of participating teachers; collaboration among teachers was strongly encouraged. The smallest site group had two members, while larger site groups had up to 12 members. The course was prepared by an interdisciplinary collaborative team of university professors, researchers, graduate students and high school teachers.

The purpose of this study was to examine the experiences and concerns of teachers developing and implementing an interdisciplinary thematic teaching unit. The unit involved conducting scientific research in which teachers did the following: identify water experts and form partnerships in order to identify and study local or regional water issues; consult national standards and Nebraska State Frameworks; and develop multicultural activities centered on the theme of water. Teachers were encouraged to use nitrate test kits, fecal coliform test kits, and computer technology– including electronic mail, Internet or Worldwide Web—to innovatively engage their students. I sought to understand issues involved in the development of thematic interdisciplinary science research curriculum among teachers who participated in this science curriculum development course delivered via satellite television.

Study:

I chose to focus on the sense-making aspects of conversation with and among the participants. Through reflection on the conversations, I am continuing to make sense of this experience. Data for this study were collected from a number of sources throughout the action research seminar. The first significant set of data was a collection of anonymous free-write responses to two questions asked of all participants: "How well are we doing in helping you create an innovative, interdisciplinary thematic unit which includes a scientific research project?" and "What will you need from us during the final half of the course in order to complete this unit?" All free writes were transcribed and coded qualitatively using a constant comparative method of analysis, assisted by the hypercard shareware program, Hana's Text Machine. Research memos were kept and showed an evolution in the generated categories using a grounded theory, open-coding strategy.

Secondary data sources included transcriptions of two interviews which were collaborative conversations based loosely on the SEER self-assessment questionnaire.

Results and Conclusions:

The issue of most concern to teachers in the Water Project was the need for sustained periods of time to develop their curriculum units. The teachers valued the time spent with peers in discussion and cited the need for more time to reflect and create through cooperative work time. Through the responses to the anonymous, midterm free write, teachers expressed their need for time to explore thematic interdisciplinary curriculum. Teachers requested time to share ideas as a necessary "stay against the confusion" of this distance learning experience. As one teacher commented, "Time. Time now; we need time!"

The issue of most concern to teachers in the Water Project was the need for sustained periods of time to develop their curriculum units.

The confusion, disarray, and doubt were a developmental stage in the growth and change process.

Making a unit innovative, interdisciplinary, thematic and based on scientific research presented a significant challenge to the science teachers as well as the teachers of other areas. Some people expressed concern about how integrated their units should be and how to go about working with other teachers in their site group and individual teachers at their own schools. The confusion, disarray, and doubt were a developmental stage in the growth and change process. In spite of this confusion, an air of hope and willingness to overcome difficulties prevailed, as illustrated by these comments:

I am still having a little difficulty with the word 'thematic.' I still suspect that I do some thematic work due to the fact that I teach a variety of subjects and often refer to something from one discipline while teaching another. But I don't know if I can come up with what you consider an innovative, interdisciplinary thematic unit. I think as far as the scientific research project is concerned, I could easily handle that. Being innovative is not my strong point.

Is water quality a thematic or topic unit? Can a water quality unit be interdisciplinary within an elementary classroom? Can a topic unit be interdisciplinary that would incorporate math skills, research collections, and journaling exercises within an isolated science class at the high school level?

How do the units begin to develop? Do you start with activities or do you begin with a main topic? What does it look like?

Elementary teachers had a stronger confidence in using a thematic approach. These teachers made a valuable contribution to the groups fortunate enough to have one or more of these teachers in their midst. Elementary teachers generally had a partner in the class when they signed on, or quickly formed collaborative partnerships with others after the first few classes. These teachers enhanced the cooperative nature of their larger site groups. The major concern of this subgroup, as well as the secondary teachers, was time. The elementary teachers second most important concern was their perceived weakness in science experience and knowledge, both for themselves and their students.

Course content and the viability of a thematic approach were issues that seemed more important to some than to others, especially science teachers. Secondary teachers, expecting science as usual, were disconcerted with the interdisciplinary approach to science that the SEER teaching team modeled. SEER challenged teachers to consider new and different ways of teaching science. A number of comments asked questions similar to the following. Some individual comments were quite blunt:

Sometimes I wonder where the science has gone. There are high quality parts to the broadcasts, but they somehow get lost in all of the humanities.

I want more content and less on concepts. We need more time with our groups discussing our unit. The most useful information has been the activities. A lot of us have already taken courses on multiculturalism and interdisciplinary approaches. It seems like less time could be spent on them and more on content.

On teaching strategies—shouldn't we be presenting content or should we be letting students discover everything on their own?

Several people commented that in order to do a new curriculum unit on water, something else would need to be sacrificed. This was a difficult and uncomfortable decision for many.

Teachers expect and do talk a great deal of the time in their classrooms. Generally speaking, learners have less "air time" than teachers. Finding ways to allow individuals to speak freely and perceive that they have been heard was a fundamental aspect of the SEER Program. Distance learning courses have the unfortunate potential to be purely monologues. Creating an atmosphere of dialogue is a challenge in any classroom and an even greater one when transacted via television broadcasts. Many participants commented on the willingness of the SEER teaching team to listen carefully to comments and requests for

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information from the teachers and adjust the program accordingly. The combination of site group discussions, journaling with a SEER staff partner, and giving feedback helped bolster the sense of these participants that their earlier comments and questions were acknowledged in a way that they found satisfying. A number of individuals expressed confidence in their group's ability to overcome difficulties:

The experiments and activities that we have done have provided some ideas for our unit. It seems that each time we do a new activity, we think of a way that we could incorporate it into the unit. We have a pretty good idea of what we will be doing in our unit, but we still need to work out several details like time frame and interdisciplinary teaching. Our theme is pretty well defined. We have decided that education is the key to prevention.

The most important thing the SEER project has done is to place us together as a team. We have a block of time to work on this project, and we have individuals who are committed to accomplishing this project. The ideas seem to blossom and improve as we discuss them.

Just the fact of getting professionals together fosters a think tank for the creation of a thematic unit. We are able to bounce ideas off each other even during the broadcast. We never dare talk or discuss ideas with other students during a professor's imparting wisdom in a lecture hall of 200 students.

The group discussions at the site are probably as valuable or more valuable than the broadcasts themselves. The course does provide the necessary framework to cause those discussions.

Plan of Action:

I offer this action research as a work-in-progress and as a means of deepening my own understanding. Further research is needed to more clearly understand the process of science curriculum development under these distance learning conditions, the role of conversation and reflection in science learning, and the social aspects of learning science in this context.

DEVELOPMENTAL MATHEMATICS AT METROPOLITAN COMMUNITY COLLEGE: DOES IT WORK?

Connie Buller
Metropolitan Community College
Omaha, Nebraska

Problem:

As down-sizing, welfare, and family pressures rise, many people are realizing the need for a college education. However, with the passing of time since high school and possibly high school math courses that were not designed for the college bound, some people find they need to take developmental mathematics to prepare for other classes. Metropolitan Community College of Omaha is an accredited two-year institution serving a four-county area. In the fall of 1995, there were 10,666 students with an average age of 30.1 years attending the campuses of Metro. Mathematics is the largest single prefix offering at Metropolitan Community College, and the majority of the courses we offer lead to other courses that either transfer directly to surrounding schools or fulfill requirements for certificates and degrees at Metro. Mathematics classes have a maximum capacity of 30 but often are smaller. Over half of all mathematics classes are taught by full-time faculty and even the adjunct faculty are expected to have a Master's degree with at least 18 hours in mathematics.

Study:

The purpose of this study was to see if the developmental math classes offered by Metro really do prepare students to achieve success in the other math courses they need for their degrees.

Class surveys were sent to all Metro higher education campuses. Transcript searches were done to track what happened to students taking one or more developmental classes (M095 and M096) at Metro in the fall of 1993 and to find out

Friends were the number one study aid.

what percent of 100-level algebra classes in the fall, 1995, represented students who had previously taken one or both of the developmental math classes. We also looked at students in 100-level classes who attended but did not pass the developmental math classes.

Results:

We found that one-third of all students in Intermediate Algebra and one-half of students in College Algebra had taken a developmental math class. Defining success as a "C" or better, we found that the developmental students had the same chance of success (about 70% of the students) in Intermediate Algebra or College Algebra as those students not needing developmental mathematics. However, the students who attempted to go on to the next mathematics class even though they had a grade of "retake" in the developmental or a "D" or lower in the Intermediate Algebra, had only about a 25% chance of success in a later class. Only 2% of those students who started but did not pass the developmental math class were able to achieve success in the second developmental class.

Conclusions:

It seems that developmental math is successful at Metro. The class surveys showed that friends were the number one study aid and that the only real difference between developmental students and their classmates whose high school background prepared them for Intermediate Algebra and College Algebra was that the developmental students reported studying more outside of class. One individual who had been down-sized after 15 years in his company and had to start with the first developmental class gave this advice: "Take the developmental math and make it a worthwhile trip."

FIRST STEP, SECOND STEP: ACTION RESEARCH

Elaine Specht
Educational Service Unit #10
Kearney, Nebraska

Mike McDonald
Nebraska Wesleyan University
Lincoln, Nebraska

Problem:

The heart of any real school improvement rests in the classroom. Many well-documented best practices for changing instructional practices or learning have little effect because teachers do not fully use them in a sustainable manner. Often changes are only in the realm of verbal innovations. We can talk about it, but we do not really do it.

How do teachers change? Michael Fullan (1991) stated that teachers need knowledge, the will, and the skill. Our study attempted to determine the overall impact of "the will" as we investigated whether action research chosen, implemented, and measured by teachers themselves, had sustainability. We also wanted to know if participating in action research impacted other teaching and learning practices.

Study:

Our mixed-model research study gathered data from twenty, K-12 teachers who originally began action research (AR) in 1994-1995. Demographic, attitudinal, and semi-structured, open-ended questions provided the means for gathering data. The focus of the research questions included:

- Has the work that you did last year for the AR project continued in your classroom this year? Explain your rationale for continuing or not continuing the activity or process.
- Did you change the original AR project in some way this year? Explain.
- Do you expect the change(s) you made in teaching and learning practices last year to continue to influence your class? Explain.

Participating in a collaborative process like action research can lead to change in teaching and learning practices.

- How has the work that you did in last year's AR influenced your present teaching and instructional practices?
- Did doing your AR change your views and practices concerning educational research?

Our questionnaire was sent in February, 1996, to 28 people who initially began AR in 1994-1995. We initiated follow-up through email and phone calls and received complete data from 20 people. Data were analyzed by MYSTAT, Excel, and qualitative domain analysis. Limitations of the study included a narrow range of demographics from our original study pool; a limited review of research questions prior to distribution; a self-selected study population; and an incomplete aligning of attitudinal and qualitative questions.

Analysis of data revealed important, initial findings for the impact of AR on sustaining change in an instructor's teaching and learning practices. Specifically, eleven out of twenty respondents felt AR was being used to sustain their instructional effectiveness. One teacher replied, "The AR process has continued for me because I witnessed first hand the powerful effect it has in motivating and empowering teachers as professionals." Additionally, the majority of beginning to experienced teachers (twelve out of twenty with numbers equally split among demographic choices), felt strongly about AR's role in their sustaining instructional effectiveness.

Conclusions:

General conclusions drawn from qualitative themes indicated:

- The changes in teaching and learning practices that resulted from the AR seminar continued for most of the respondents into the second year.
- Participating in a collaborative process like action research can lead to change in teaching and learning practices.
- Teachers enhanced the 1994-1995 AR project by deleting or leaving out certain aspects of AR if they continued the process into the next

year. A respondent noted, "My AR is not as structured as last year...while still improving the effectiveness of the rubrics for my assessment."

- Some effects beyond the arena of 1994-1995 AR were reported and linked to the AR process. Two individuals reported effects were increased leadership and teacher efficacy.

Comments from AR participants included the following:

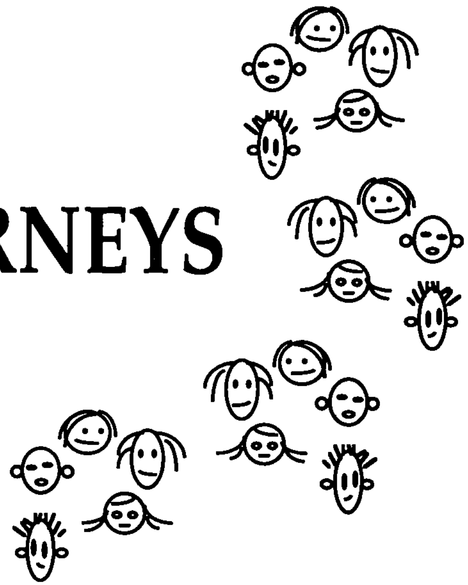
- The idea of research seemed to be theoretical not practical. It didn't affect me or my classroom. This view has changed.
- Doing research in my own classes and interest area is not what I thought research would be.
- Research is something I would avoid like the plague but AR is a rewarding challenge. Educational research doesn't seem to be distantly detached anymore.
- It gives teachers more of a sense of control in improving instruction. It validates the professionalism of each teacher. I now believe that I can evolve my teaching and assessment practices into more effective ones.

Plan of Action:

Grimmett and Neufelt (1994) believe there are three kinds of motivation for teachers to change: traditional-extrinsic rewards, alternative intrinsic for a personally rewarding situation, and authentic motivation which is doing what is good for the learners (moral quest). We recommend that the key for maximizing AR is to explore other elements including motivational factors that sustain longitudinal change in the teaching and learning practice.

Educational research doesn't seem to be distantly detached anymore.

RESEARCHERS' JOURNEYS



The following are comments made in writing by participants throughout the year's experience in action research.

Comments after the first fall meeting:

Sometimes I felt like this would be a daunting/overwhelming task. At other times, I thought this sounds pretty easy! Wonder which it will turn out to be?

. . . .

I like the way you let us make our decisions with help from others and you, but not specific directions.

. . . .

This was cool! I was startled to see how my question began to take shape during the analytic interviews. It just started to appear, like watching a photo appear in the darkroom. The entire day was well-planned and productive.

. . . .

Today? It was interesting, frustrating, reflective, encouraging and the food was great!

. . . .

The day was good because I started to self-reflect about so many issues involved in my teaching and education in general. It was/is good to connect with others with the same agenda.

The small group interaction was very valuable. I got a lot of reassurance and great ideas. Before today, I wasn't real sure my question was small enough, but I think it is and I feel it is a very valuable thing for me to know. I have spent so much time improving my teaching and only a small amount of time on improving my assessment. Teachers are the best resources; it is nice to have the time to interact and "pick their brains."

. . . .

Today was very productive. We came in with our question, then went through frustrations (is this really what we are asking) and returned feeling comfortable with our final(?) question. Discussions are great.

. . . .

Today helped me redefine the question and it served as an encouragement to get started.

It's a tremendous benefit to find out what other participants are doing.

Comments after the second meeting:

I really enjoyed today. It just really hits home how important it is for us, as educators, to collaborate, communicate and receive input. We need to step back more and really listen to others and listen to what we are trying to say as well.

So far the course has been stimulating for me professionally. I feel somewhat frustrated at the spot I am currently in with my own research. I feel that today was good for a refocus and gave me new ideas for further investigation.

I appreciate that this action research class is spread out over several months. I think the reason why I, as a teacher, need three months off in the summer is to give me a chance to stand back and peacefully reflect on the hidden, underlying reasons for observed behavior, rather than taking the observed as fact. I definitely appreciated the lesson on the difference between opinion articles and research-based articles.

These seminar days are really energizing for me although I'm still nervous about the final product. It is really helpful to meet with other teachers interested in changing and bettering the teaching-learning environment.

Powerful sharing experiences today. It's a tremendous benefit to find out what other participants are doing—seeing the list of topics in the last mailing was interesting, but hearing the practical issues through the literature really put it all into perspective. Now it's all becoming exciting; now it's real action.

I enjoy the empowerment that action research gives me. It has strengthened my resolve to meet the new challenges in my classroom.

I thought today went well. I have a tendency to refocus or refine my topic and methods each time we meet. It forces me to get back on task.

Comments after the March meeting:

I learned a lot today and tried to talk to several people to tell them how great I thought their projects were. It's always great to see the enthusiasm of other people as I get in a rut from time to time and bogged down with all the little things in life.

So many practical ideas and positive energy. What we are seeing is not just the requirements for a graduate course, but we are seeing useful solutions that we can use for everyday concerns in education.

This class has been very helpful. It has forced me to organize my thoughts.

It was great to hear others' progress. I also felt I needed the feedback to know I have accomplished what I set out to do, that my conclusions are sensible, and it is important.

I've noticed a wide developmental variation in the researchers. WE are all over the place. Some of us have more data than we know what to do with and others think they need more but don't quite know what to get. Today's discussion helps us all.

Comments after the April presentations:

I like the idea of keeping our presentations informal since some presenters are new. Too much stress is not good. This is a good way for us to get experience.

This course was an "11" out of "10." It was far and beyond a good class; it was far better than I thought it would be in my wildest imaginings. Today's seminars were great.

I was worried during the entire process; the end was great. I was worried for nothing; we were well prepared. It was a great adventure and a tremendous opportunity for me to grow as a teacher.

It was a great adventure and a tremendous opportunity for me to grow as a teacher.

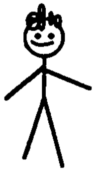
Comments after conducting research:

I was aware before the survey that there was cheating in my mathematics class. Some of the students have been cheating for several years as I have had them in class before and other teachers have indicated there is a problem. The results of this study are even more significant to me when I see that it has made an impact on old habits that are very hard to break. Some of those students would indicate how much trouble they were having, and it made me more aware so I could help them more. At one point, I changed my plans and spent another day reviewing a topic. I have not solved the problem completely but self-assessment makes both the teacher and the student more responsible in the learning process.

The most difficult hurdle to overcome may be tradition; educational assessment procedures have been in place for decades and therefore are difficult to change. I encountered all of these hurdles while doing my research. But these hurdles are no different than the ones my girls run in track.

Mathematics vocabulary is a stumbling block for many students when they try to describe their work and/or their errors. This is true for both written and oral expressions. Students were concerned about their ability to sit down and talk to a math instructor for 20 minutes at a time. Student comments included, "Whew, that wasn't as bad as I thought. This was almost fun if I didn't have to get a grade.

We learned far more that we set out to discover. I learned to know my students better. That's the best part.



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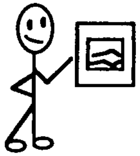

GENDER EQUITY IN HETEROGENEOUS LAB ACTIVITIES

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ABSTRACT:

Problem:

Researchers have found that as students reach middle school, the sexes begin to move apart in interest, participation, and achievement in science. Some people wonder if there is a conflict between the nature of science and the definition of femininity. Others suggest that the problem is actually the nature of masculinity, which intimidates females in the science classroom. While some educators advocate the "masculinization" of female science students in order to raise their level of success, and other authors recommend the "feminization" of science itself in order to reduce the gender gap, some experts are promoting segregation by gender in order to eliminate the male dominance in the science classroom. The purpose of this study was to examine the interactions among students in the mixed-gender science classroom.

Study:

When females and males are lab partners in middle school science classes, does either gender dominate the activity? Three methods were used to collect data. First, open-ended surveys were given to 118 students in this seventh-grade Life Science course. The fourteen questions on this instrument led the respondents to use a variety of perspectives to describe their beliefs and attitudes about science. The second method was the video taping of four students, whom I studied in greater detail, working in female-male pairs during two days of an animal-dissection lab activity. The third source of data was a personal interview with each of the four students after the conclusion of the lab experience. The objectives of the research were to compare the students after the lab experience and to compare the students' beliefs of what actually took place in the laboratory.

Some people wonder if there is a conflict between the nature of science and the definition of femininity.

The greatest difference in attitude was not about science itself, but about the males in the classroom.

The answers on each question of the survey were grouped into categories for comparison. A spreadsheet was used to record the percentage of responses falling into each category, and graphs were created to demonstrate similarities and differences between the genders. In the video tapes, each student was timed according to how many minutes she or he spent in the active process of dissection, as opposed to time spent being a writer or passive observer. The interviews were an opportunity for each student to predict which partner did more of the active dissection. The interview results were compared directly to the data collected from the video tapes.

Results:

The surveys revealed remarkable similarities between the female and male views of science in this seventh-grade classroom. In fact, the greatest difference in attitude was not about science itself, but about the males in the classroom. A higher percentage of females gave negative responses about their male classmates than did males responding negatively about the females. The video tapes and interviews gave an example of how one male student interfered with his partner's lab involvement.

Conclusions:

This study suggests that females and males can work cooperatively without a need for segregation in science. In these heterogeneous situations, however, students and teachers alike must be alerted to the possibility that some individuals have a tendency to dominate activities. Further research could be conducted at the high school or college level to see if more gender differences in science develop as students get older. At the middle level, it appears that the most important follow-up to this study should be methods to detect and correct situations in which female science students are subtly blocked from desired participation.

Section 1: Rationale for Selection of Portfolio Items

One of the great advantages of this action research project has been the opportunity to experience different levels of educational practice. One example of growth comes from the fact that this is my very first portfolio. I have never been required to put together a portfolio as a student. My lack of familiarity with the technique also discouraged me from using portfolios in the classroom with my own students.

After all of the instruction about how to do it, the actual work of creating a portfolio should be expected to flow easily. But I find myself wanting to just collect all of the work that I did during this project and file it into a milk crate and call it my portfolio. All of my journal entries, all of the e-mail correspondence, all of the class notes, 118 student surveys, spreadsheets of the survey results, graphs from those spreadsheets, three videotapes, student interviews, and many other pieces of my project would make a nice, big collection. Yet I do not believe that would be the intent of an assessment portfolio. In the end, it would be too burdensome to communicate the project to other people in this way.

My rationale, then, was to follow the outline in the course requirements and provide an example item in each category to represent what actually occurred during my research. I used a variety of methods to do this: narratives, a sample survey, a diagram of videotape patterns, copies of four interview sheets, seventeen graphs, excerpts from journal entries, a commercial brochure to demonstrate gender attitudes in the media, excerpts from e-mail correspondence, a list of literature resources, a self-assessment rubric, an abstract of the project, and exemplars for a summary booklet. My choice of items in each category was based on providing a quick glimpse to the reader regarding the process at that point. In some cases (such as graphs), I felt it necessary to provide enough to support final conclusions. But in other cases (such as videotapes) I felt it more meaningful to provide a diagram that demonstrates the findings of the tapes themselves. In short, the choice of items was an attempt to give assessment information in the most user-friendly way.

Note: Not all items from the portfolio are included in this document.

Section 2: Evidence of Investigation

A. <u>Question of Investigation</u>

In September, at the beginning of the project, our collaborative team began looking at issues of heterogeneous lab groupings in science class. My own part of this investigation was to explore gender equity issues in such settings. My emerging question at that time was:

"In heterogeneous-grouped lab activities, do males and females have equal hands-on involvement in the activity?"

A review of the literature demonstrated a brewing controversy that had various twists. Some educators believe that science is a male activity and that, in order to solve the inequities, female students should be masculinized (e.g., make them more competitive) so that they can carry out these male-oriented tasks. Other researchers countered by concluding that this male-oriented science should be feminized (e.g., move from quantitative to qualitative) to bring success to females (Pollina, 1995). A growing third option puts the burden of inequity not on science itself, but on the presence of males and females in the same class. These educators offer single-sex classrooms for science instruction as an option (Kruschwitz et al., 1995). My question, then, eventually became:

"When females and males are lab partners in middle school science classes, does either gender dominate the activity?"

B. <u>Description of Data Collection Techniques</u>

During our November class session and discussions, our readings from Sagor (1992) helped me to develop the data collection techniques. Seeking effective triangulation, I chose two different "tools for questioning" (written surveys and oral interviews) and one "tool for capturing everyday life" (videotapes).

The written survey was developed with fourteen open-ended questions to collect data about student beliefs and attitudes

A review of the literature demonstrated a brewing controversy that had various twists.

The videotapes gave examples of how some students can dominate a hands-on activity. In some cases, the domination is known and accepted by both parties.

regarding females in science. This survey was administered to 118 students, 63 females and 55 males. The videotapes were made during a laboratory investigation in which dead animals were being dissected. Students were working at tables in groups of four, and they were put into these groups according to their preferences about which kinds of animals they wanted to dissect. Whenever possible, I tried to keep them with their previous lab partners, but they were often rearranged for this dissection activity according to their preferences. The video camera was set up over one lab table to observe hands-on involvement of the participants, and in each class a table was chosen which happened to have two pairs of female-male lab teams. The activity took two days to complete, and the camera ran all day in all class periods during the activity. After the dissection activity had been completed, each of the students who had been videotaped was asked to respond to an oral interview.

The intention of these techniques was to first collect data about student beliefs and attitudes about females in science, then record video observations about what really did occur in one particular lab situation, and finally collect data on student perceptions about what occurred.

C. Conclusions

- The surveys indicated a remarkable conformity between female and males attitudes in this seventh-grade science classroom.
- The videotapes gave examples of how some students can dominate a hands-on activity. In one case, a male dominated. In another case, the female dominated. Sometimes the domination was subtle. In other cases, the person verbally or physically blocked a partner.
- The interviews suggested that in some cases, the domination is known and accepted by both parties, but in other cases the interviews clearly demonstrated how inequities can develop in which the male unwittingly dominates while the female is not even sure whether or not she is being treated unfairly.

- The videotapes and interviews proved to me that I, as the gender inequity researcher, was not even aware of some of the inequities taking place in front of me until I had the opportunity to examine the videotapes and other data at a later time.
- There was not enough evidence to suggest that females and males should be separated for science class at the seventh-grade level, but there was plenty of evidence to suggest that students and teachers should both be given opportunities to become more alert to gender inequities, to recognize those inequities when they do develop, and to practice strategies to remedy the problems.

Section 3: Evidence to Support Conclusions

A. <u>Description and Example of a Survey</u>

After collecting surveys, I read them by studying each question alone on the 118 papers. For example, I read answer #1 on all of the papers and looked for common responses. I then grouped those common responses into categories and proceeded to enter the responses into a spreadsheet. After finishing with #1, I continued by repeating the process for #2. When all of the responses from the surveys were entered into the spreadsheet, I created graphs to show the patterns that developed between responses of girls and responses of boys. See Exhibit A.

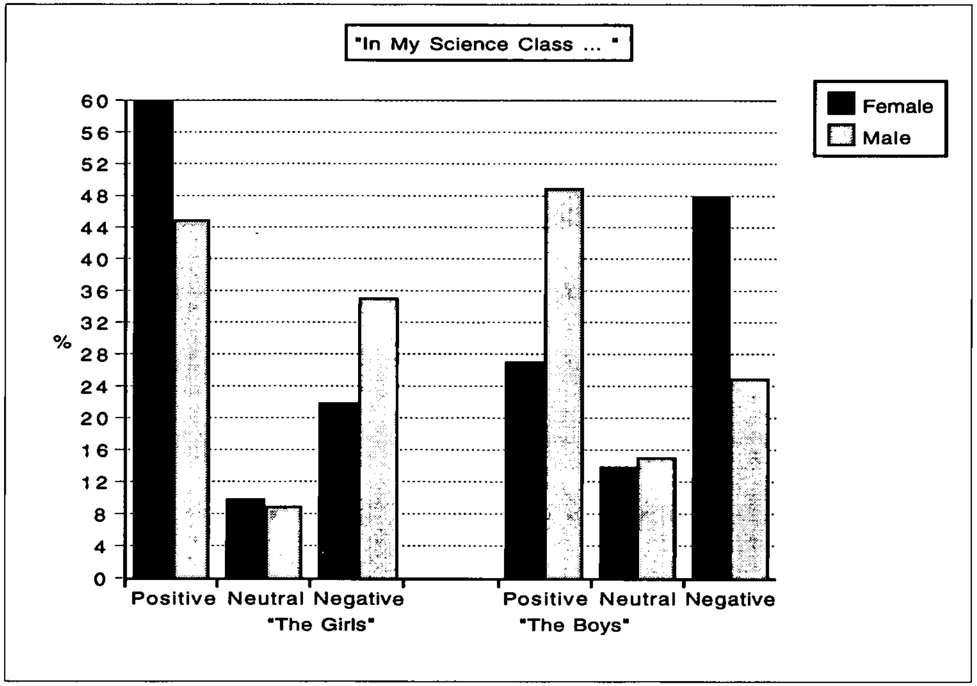
The survey questions included the following: (Surveys of the four particular students studied in detail were included in the original portfolio.)

1. If I told my friends that I wanted to have a career that uses science, they would say…
2. If someone told me that girls cannot have careers that use science, I would tell them…
3. When I get to high school and have a choice about whether or not to learn more science, I will probably decide…
4. If I were a science teacher and I could teach science any way I wanted to, I would probably teach science by…
5. What I want the most from this science class this year is…
6. I wish my science teacher…
7. I would like to learn more about science, because in the future…
8. When I am asked to be the leader in my lab group, I…

9. In some science classes, the teacher makes most of the decisions about what to study and how to learn; in other science classes the students make most of the decisions about what to study and how to learn. In my science class…
10. In my science class, the girls…
11. In my science class, the boys…
12. What I like the most about my science class is…
13. My parents think my science class…
14. My science teacher thinks I…

Exhibit A

Comparison of Survey Answers Regarding Students' Views of Their Classmates by Gender.



However, the questions about classmates pointed out that both boys and girls tended to make more negative comments about students of the opposite gender than they did about their own.

Exhibit A is taken from questions 10 and 11 of the student survey. The darker bars represent the female responses and the lighter bars represent the male responses.

The results from most of the survey questions in this study indicated remarkable similarity between the female and male views of science in this seventh-grade classroom. However, the questions about classmates pointed out that both boys and girls tended to make more negative comments about students of the opposite gender than they did about their own. Combining the student responses, there were fewer positive answers about the boys in science than there were about the girls.

B. Diagram of Videotape Patterns

The videotapes showed lab work and hands, but not faces. To study the tapes I played them at fast-forward speed to watch for patterns of involvement. I used a diagram (Diagram A) that shows three basic patterns of sharing lab equipment. Some pairs of students placed the lab tray equidistant between them for convenient access. Other students passed the tray back and forth periodically. Some students, however, placed the tray directly in front of themselves and used various techniques to "block" the partner from equitable participation. After recording these patterns of tray location, I then viewed the tapes at normal speed and used a stopwatch to time the number of minutes of active hands-on involvement of each partner. I calculated each person's percentage of total participation for that lab team and graphed the results.

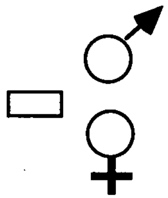
C. Four Interviews

I studied four students in greater detail by asking them six questions:

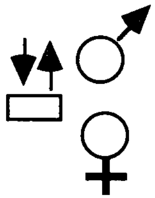
- Tell me about your experience in this lab.
- Who touched the animal more, you or your partner?
- Who did most of the writing on the lab paper?
- Is that the way you really wanted it to be?

DiagramA
Diagram of Patterns of Involvement

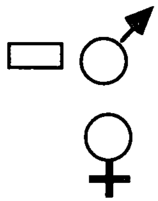
Pattern #1: Tray is equidistant between partners for equal access throughout lab activity.



Pattern #2: Tray is passed back and forth periodically between partners for equal access throughout lab activity.



Pattern #3: Tray is kept directly in front of one of the partners who dominates the hands-on participation throughout lab activity.



- When girls and boys are working together in the lab, does one or the other usually "take control" of the activity against the other's wishes?
- If a lab student would ever feel that his/her partner is not letting him/her do what they want to do, what is the best way to make things better?

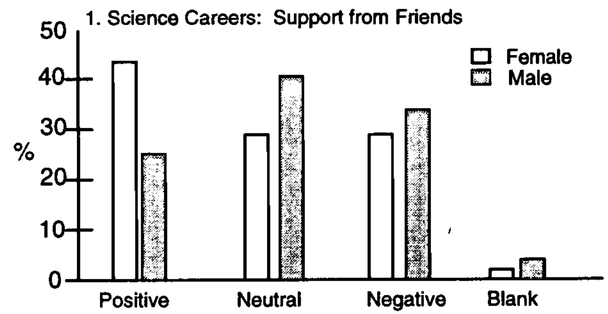
Although graphs are usually associated with quantitative studies, I used this technique qualitatively as a tool for seeing patterns, not statistics.

These interviews demonstrated that inequities do sometimes occur. Moreover, comparing these interviews with the results of the videotape study, it becomes apparent that even when a person is completely aware that they are being blocked out of equal participation, it is possible that the partner and even the teacher are not fully understanding the situation. Even the blocked partner can be unsure of what to do. In other cases, the interviews and video data show that even the victim of the blocking is sometimes unaware of the inequity. See Exhibit B on the following page for an example of comparing interview responses.

D. Data Analysis Process

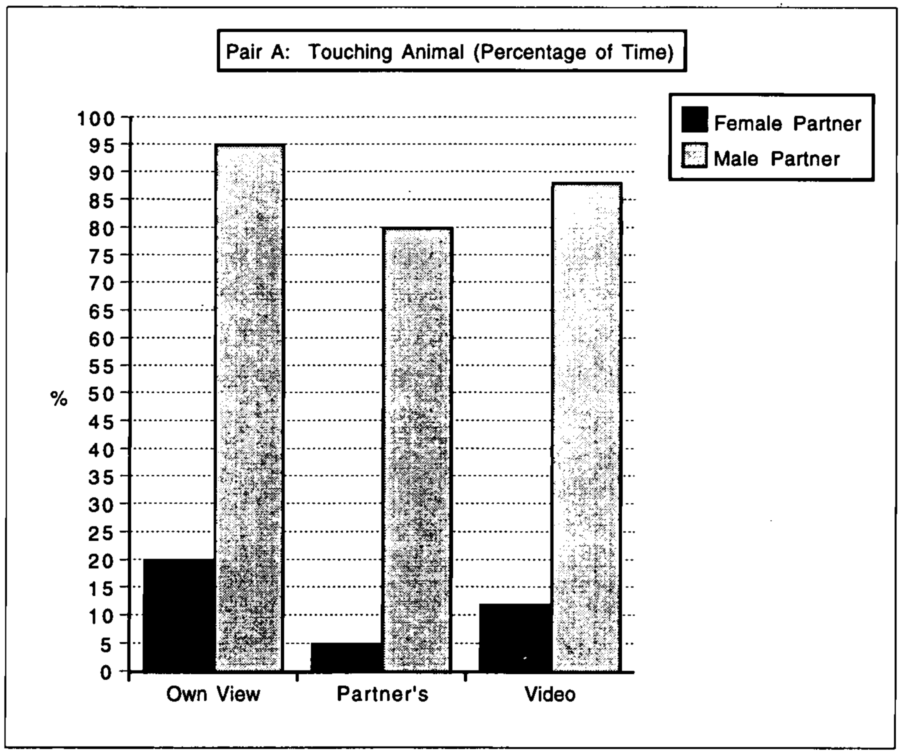
The seventeen graphs included in the portfolio display the patterns that developed during my research. Although graphs are usually associated with quantitative studies, I used this technique qualitatively as a tool for seeing patterns, not statistics. Likewise, the interview and videotapes of four students are not meant to generalize that these results happen all of the time. They are presented here to demonstrate what is possible. When Female "A" talked about being denied access, the video dramatically showed that she really wanted to participate in the dissection, but was verbally and physically blocked by the dominating male partner. Analysis of the situation does not say that this is common, but it is evidence that problems do exist.

Sample graph:



During this activity, both students agreed that the male partner did most of the touching of the specimen. In interviews following the lab, both students indicated that the female partner did not want to touch the dead animal. However, the videotape showed that there were several times when she attempted to take an active role in the dissection, but was verbally rejected or physically blocked.

Exhibit B
Which partner had greater hands-on involvement during this lab activity?



Section 4: Evidence of Reflection

This example shows how journaling and collaboration can allow a person to develop ideas.

A. Gender Equity Issues: Journal Entry and Investment Brochure

It would not be appropriate to try to record here all of the reflection that I did regarding gender equity. Instead, I am providing just one sample to show how "off-the-wall" journal reflection can appear. Yet this example shows how journaling and collaboration can allow a person to develop ideas. Following this page I have inserted a copy of "The Navigator," a newsletter for retirement planning. (When I ran across it at the beginning of this action research project, I'm sure that the terms "equity" and "balanced portfolio" must have caught my attention, although here they were only talking about money.) What really mattered, though, was my reaction to the photographs. This is an excerpt from my journal regarding that investment newsletter:

2/7/96

Back a few months ago when Ginger and I were discussing that investment brochure that had those interesting photos, we were looking at the one on the front that showed what we consider "media bias" that subtly projects the male as the leader, the one who pulls the weight, the active participant, the risk-taker. The female in the photo was the follower, the one who passively is led down the path and protected by the male. On the back of that same newsletter, again the male was the active builder and the female was the encourager. When we went to see the movie "White Man's Burden" last week, a new twist popped into my mind. Role reversal!!! Try to imagine inequitable situations with the roles reversed, and it becomes even clearer how different the genders are portrayed. On the back photo, if the boy had been watching while the girl did the building, how does it make you react? Maybe no different? How about wondering if some people might just assume the passive boy is "lazy" while a passive girl is just "being natural"? How should a boy or girl act in this situation? Are they different by nature? If so, why? If not, then why would role reversal look so uncomfortable?

Or better yet, take a look at the photo again on the front. If you reverse the roles there, suddenly you would see a male with his hand in the back of the shorts of the female. Not at all as acceptable as what we see in the real photo! Just as we might notice a guy pulling on the pants of a young lady, we might just as easily be startled by a photo of the female pulling all of the weight while the guy just rides along. There are some real differences here. Many questions, many issues, many biases, and much to learn about.

B. Reflection on the Action Research Process: Journal Entries

Just as my journal shows mental exploration of gender topics, it also shows an attempt to learn about the action research process itself:

9/30/95

This whole idea of action research is so intimidating to me. But today it started to take focus. The confusion of a new task can make a person feel like such an outsider. My mental state feels similar to how I felt outside the football stadium today. At first, there is simply curiosity. I wondered how the game was going. Then you start to react to the crowd noises. There should be no mistaking a Cornhusker touchdown. But while we were working on the steps, there was a painful absence of home-crowd noise. Then you start to focus in on the loudspeaker announcements after each play. The picture of the game's progress finally takes shape, but you have a long way to go to get the full set of details. Well, that's how my action research project feels right now. I'm an outsider to the process. I'm apprehensive. But information and indicators are beginning to filter in. I'm starting to see something.

11/18/95

I'm still hung up over "sample size." They stressed to us today that we can limit our research to a few individuals in order to make it manageable. I'm not used to that at all. I want to collect data from as many people as possible in order to apply the results. But De keeps pointing out that we are not interested in generalizability. She wants us to realize that we are doing research in the context of our own classroom situations, and we do not have to worry about applying the results

The confusion of a new task can make a person feel like such an outsider.

But the fact is that I cannot use, on a daily basis, all of the great stuff that I have been exposed to over 23 years.

universally. I'm from a traditional science background, so that still feels a bit foreign to me. But it's starting to make sense. So if I give surveys to all of my students, but video only four of them, and then interview them afterward, I can get three different sources of data that will give me valid data, even if not universally applicable.

3/2/96

I was impressed today with the excitement that everyone has about their own research, as well as the interest they show in other people's work. However, there was one striking problem that surfaced again and again. It seems that we simply don't have the time to do what could or should be done for our students. Take assessment issues, for example. How wonderful it would be to have the time to design and use rubrics that we saw today. And open-ended survey questions. And journaling with appropriate feedback. The teachers who do use them are making the time, but usually we find that there is some special factor that allows it. Maybe it's just the extra drive that a person gets when they are taking a course or working on a degree. Or maybe they are working with small class sizes. Or have a special assistant or aide of some type. Or whatever. But the sentiment that came out several times was that as soon as this research project is over, many of the special efforts will cease. Even though it is clear to everyone that those efforts are beneficial to the student.

This reminds me of all the workshops I've attended over 23 years of teaching, all the courses I've taken, all the in-services, conferences, etc. Not to mention all the classroom experiences. You would think that by now I would not be frustrated in the classroom. I should have most of the answers I need. But the fact is that I cannot use, on a daily basis, all of the great stuff that I have been exposed to over 23 years. Time and again, I come across an idea that reminds me that I have been aware of that particular solution for quite some time, but have not been using it. Because it was too draining to continue. Or too time-consuming to set up.

Section 5: Evidence of Collaboration

A. Critical Friend: E-mail Correspondence

At the beginning of this project, my first choice for a critical friend was Patti Severson at Omaha Bryan. I wanted to choose a person who was eager to help and with whom I had a great working relationship. Patti has been so helpful on our PEERS Academy work, and she agreed with enthusiasm to assist me in this project of action research. What I did not anticipate was my own busy teaching schedule. Patti and I did not have an already-established pattern of getting together, and I did not make the effort to set up meeting times.

What evolved naturally was that Sue Koba became my critical friend. Our ongoing communication since our days of working together on the SPARCS Project gave us an ideal mechanism for discussing my research. We communicated by e-mail, telephone, breakfast meetings, dinner meetings and social activities. Sue became a valuable resource for my gender equity research. Collaboration Example 1 on the next page is an excerpt of an e-mail communication that demonstrates the type of sharing relationship this was.

B. Collaborators: Journal Entry and Email Correspondence

My collaborators on this project were the people from Omaha North High. Tom, Ginger, Steve, Elaine and Deirdra were all working on issues of heterogeneous groupings, and our support for each other is shown in the following excerpts:

> 11/18/95 Journal
>
> We learned more about the process today. The amazing fact is that everything becomes richer in understanding when a person has other people to talk with. The carpooling from Omaha to Lincoln is awesome. Talking all the way with Tom and Ginger and Elaine gives us a chance to dig deeper into issues in a way that we cannot seem to accomplish in other settings. There just isn't the time in a regular day to communicate this way.

There just isn't the time in a regular day to communicate this way.

Collaboration Example 1

Date: Mon, 29 Jan 1996 16:59:49 -0600 (CST)
From: Susan Koba <skoba@ops.esu19.k12.ne.us>
To: "Frank A. Tworek" <ftworek@ops.esu19.k12.ne.us>
Subject: Re: movie

Frank,

I find it impossible to respond at length to your last message. There was simply too much there. I will make a hard copy and ponder it at length and then we can talk on Wednesday. Yes, Wednesday sounds good since Kelly and I don't have class. However, I think we have a 4 p.m. meeting in Lincoln. Did you two talk times? The movie, White Man's Burden, has eluded me several times, so I am excited about catching it this time.

Friday is still on, as far as I'm concerned. In terms of bringing stuff, your brain will be good. Mine seems to be draining recently, so I'll depend on you. I have a copy of Grandmother's Nose. I have old copies of Science Scope. I have the Multicultural Journal. I have writing info for Ed Leadership, but I think we should focus toward Middle School...we can look at it though.

As with you, so much has happened, and there is much I'd like to talk to you about. Never enough time. I'll see what I can do about bringing that song on Wed. I did type out the words, so I can bring that. Otherwise, we'll be certain to listen on Friday. See you soon.

Sue

Collaboration Example 2

Date: Wed, 7 Feb 1996 10:25:57 -0600 (CST)
From: Collaborator
To: "Frank A. Tworek" <ftworek@ops.esu19.k12.ne.us>
Subject: Hi

Hi Frank,
My action research is causing me some distress—I just don't know what it is I am trying to find out and therefore I don't know if I am assessing everything correctly. I need help. I want to just drop out. Is this an option? We do need to meet and maybe help each other out before the March 23rd meeting. Could we meet some Sat. at the Radial Cafe or somewhere like that? Maybe we could all meet by the end of this month? Give me some feed back-the others are sitting here and agree that they would like to meet too. WE are all lost!

Collaboration Example 3

Date: Wed, 7 Feb 1996 11:48:11 -0600 (CST)
From: "Frank A. Tworek" <ftworek@ops.esu19.k12.ne.us>
To: Collaborator
Subject: Re: Hi

Considering dropping out? No, that option does not exist. In fact, this whole project seems geared toward finding our way in the dark. Discovering new ideas in the unknown. I think we're all lost - and that means we're in the right place. No matter what we end up learning, it will be NEW LEARNING. Even if it's only a tiny bit. Even if it's something we didn't expect. Even if it's something we wish we had never found out. That's REAL LEARNING. Oooo...doesn't this sound great? I must have jumped up on a soapbox just now. Picture me with my right hand pointing to the sky and my left hand tucked inside my vest as golden words spew forth upon the eager minds of my captive audience.

Section 6: Evidence of Review of Outside Resources

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Shakeshaft, Charol (Winter 1995). Reforming Science Education to Include Girls. *Theory Into Practice*, 34(1), 74-79.

Tobias, Sheila (Sep 1994). Keep Culture from Keeping Girls Out of Science. *The Education Digest*, 60(1), 19-20.

Weinburgh, Molly H. and Englehard, George (1994). Gender, Prior Academic Performance and Beliefs as Predictors of Attitudes Toward Biology Laboratory Experiences. *School Science and Mathematics*, 94(3), 118-123.

Baker, Dale and Leary, Rosemary (1993).

Do Teachers Create Gender Differences in Attitude? Presented at the 1993 Annual Meeting of the National Science Teachers Association. April 5, 1993.

The authors of this study used interviews and a Sentence Completion Test instead of forced-choice standardized instruments to examine gender differences in attitude toward science. The study involved 1084 students in grades 2, 5, 8 and 11 from a single middle to upper-middle class predominately white community. They found more similarities than differences between boys and girls. In fact, gender differences which have been observed in other studies using standardized paper and pencil assessments do not occur when boys and girls are allowed to write and talk about science. One disturbing difference did surface, however, regarding the effect of teaching style on attitude. These researchers found that student-centered classrooms appear to be less likely to promote positive attitudes toward science for girls, and teacher-centered classrooms are associated with boys holding negative views about girls in science. They suggest that further research is needed in the area of student perceptions and attitudes toward science.

My reaction to this study centers around this controversy: "Do females have difficulty in science and math because of the teacher, the subject matter, or because of the negative influences of the males in the class?" More and more recent papers praise the benefits of all-female math and science classes. This study hints that student-centered classrooms are dominated by males, causing negative consequences for the females.

Weinburgh, Molly H. and Englehard, George (1994).

Gender, Prior Academic Performance and Beliefs as Predictors of Attitudes Toward Biology Laboratory Experiences. School Science and Mathematics, 94(3), 118-123.

The purpose of this study was to investigate the relationships between gender, prior academic performance, beliefs and student attitudes toward high school biology laboratory experiences. One 11-item scale was created to measure student attitudes toward biology laboratory experiences, and a second 11-item scale was designed to measure student beliefs about the benefits of biology labs. Statistical analysis was done comparing the results of these two scales with each other, with gender, and with GPAs in previous science courses. Gender had a significant effect on attitudes, with females reporting more positive attitudes toward biology lab than did males. Surprisingly, students with lower GPAs in previous science courses reported more positive attitudes toward biology lab than students with higher GPAs. The strongest correlation came with the data indicating that students who believed lab experiences were beneficial had more positive attitudes. The authors suggested that increased hands-on lab involvement is a key in dealing with students having poor prior academic experiences in science. The quality of these lab experiences must be high enough to leave students believing that the time was productive.

Section 7: Plan of Action

What started this year as an action research course for college credit may now become a standard part of my teaching.

1. Continue to use resources that explore gender equity. This is such an important topic that many journals are devoting special attention to these issues. For example, the May 1996 *Educational Leadership* includes five articles on gender equity in its "Contemporary Issues" section. Keeping up on current research opens our eyes to many facets of the problem.
2. In my classes next fall I plan to use special lessons to alert the students to the problems of gender inequity. If that becomes an important focus right at the beginning, we can try to let the students themselves become the classroom observers throughout the year, checking for inequities, and searching for solutions.
3. I hope to develop the videotaping activity again in certain lab situations. Showing the dominance that happened in this year's taping can be a powerful tool, but if the tape is with "current" students next year, it will have a greater impact. This will also give an opportunity for "new" discoveries. In other words, what started this year as an action research course for college credit may now become a standard part of my teaching.
4. Most important will be continued collaboration with the teachers that I worked with on this project. No matter what shape my next year's research takes, I will benefit from their support.
5. Sharing the results of the research will be an additional step. In addition to our course's mini-conference, I already have made a presentation at the NMSI Equity Conference in May. I will be alert to possibilities (such as NATS) where it might be appropriate to give additional presentations.

Section 8: Self-Designed Self-Assessment of Portfolio
Rubric (Three criteria, each with four levels of performance.)

A. Score on the Course Rubric

4 Of the possible 16 points on the predetermined course rubric, earned 13-16 points.

3 Earned 9-12 points.

2 Earned 5-8 points.

1 Earned 1-4 points.

B. User-Friendliness

4 Well-organized and easy to read.

3 Required information is all here, but in some cases is difficult to locate.

2 At least one required item is missing, and portfolio appears difficult to read.

1 Portfolio appears "thrown together" without attention to requirements.

C. Meaningfulness

4 Information in the portfolio is important and makes sense to the reader.

3 The reader can understand what the portfolio is explaining, but is not sure if the research will matter to other people.

2 The information is confusing to the reader.

1 The portfolio cannot be understood.

Using this self-designed rubric, I would score my portfolio as 12 points of a possible 12. I have met the requirements of the course, but more importantly, I have completed some truly exciting and valuable research, and this portfolio is organized well enough to communicate the results.

DO BECKY AND BOB RECEIVE GENDER EQUITABLE MATH/SCIENCE INSTRUCTION AT OUR PUBLIC SCHOOL?

Jim Pfeiffer and Susan Steuer
Friend High School
Friend, Nebraska

Abstract:

The research for this project focused on student/teacher interactions at our school. We chose to look at five independent sources of data that would allow us to determine if the instructional methods currently being used lead to gender equity in the classroom. These data sources were selected to allow us to make direct correlations and form a conclusive statement concerning the state of affairs with respect to gender equity at our school.

Our intent upon inception of the research project was to see if our district followed national trends concerning gender equity. Previous research seemed to indicate that in math/science instruction, gender equity was occurring in the primary grades but declining as students reached the secondary level. To determine if this was occurring at our school, we chose to focus our research on grades 1, 3, 5, 7, 9, and 11. The research consisted of interrelated parts showing trends and disparities in equity.

We made classroom observations at the selected grade levels. These observations were accomplished by each researcher and also a student teacher. Observations were made for thirty minutes with both the number and type of student/teacher interactions being recorded. Next, we chose to survey both the students and the teachers of those classrooms we had observed. These surveys were given at the same time, but without the teacher's presence in the classroom. Questions on the surveys were written in a fashion that allowed the researchers to directly compare student perceptions to teacher perceptions. Another piece of data that was used to make the research more objective was standardized achievement test scores of the observed students. Finally, we conducted a survey of previous graduates of our school. This survey concerned career choices made by past graduates and was used to determine if gender bias had played a significant role in their career selection. We then compiled all of the data to give us a picture of what was occurring in terms of gender issues at our school.

The results of this research project can be used to improve the instructional methods with regard to gender equity at our school. We plan to accomplish this via the use of fall pre-service meetings as well as inservice throughout the school year.

Rationale For Portfolio Items:

The first item we placed in the portfolio was the abstract, which describes our question and entire process of investigation. This is followed by items that were selected as those best showing evidence of our investigation of the question. We felt that the very first page of this section needed to be one which described the question itself in detail. We followed this with an explanation of our data collection techniques and the blank forms used to gather that information. We also chose to include samples of each of the finished forms and of the methods we used to score any of these forms. Also included in this section are the forms that were generated for each observed grade level as well as a compilation of the data representing types of responses and numbers of responses for elementary and secondary.

The second section of the portfolio gives the reader an idea of the data analysis process with a detailed description of the process and the summaries generated for each of the six grades observed. It also displays the data that came from the achievement test scores and the survey of past graduates with respect to career choices. The final document we chose for this section was our conclusion.

Section three of our portfolio contains the diary or journal which was kept throughout the investigation and evaluation process. We made an attempt to write down our thoughts every two

We both found ourselves looking at the world from a different perspective as a result of our research

weeks when we formally met to discuss progress on the project, any questions or observations, and timelines for project section completions. We also met informally on nearly a day-to-day basis, often placing phone calls to one another in the evening after reflecting on an event which happened that day, a news report seen on the television, or an article cut from the paper. We both found ourselves looking at the world from a different perspective as a result of our research and we became empathetic of those who felt cheated by their gender as a result of the system.

The fourth portfolio section is a plan of action that we intend to implement as a result of this research project and our interest in making others aware of our work. It also contains our self assessment of this project as it relates to the standards which had been previously set by the use of the class grading rubric. We felt that the topic of our investigation was quite different from the majority of the rest of the class participants and that due to this, our portfolio does not contain any examples of student work. Nonetheless, we are pleased with the work we did and with the results that we obtained through our observations.

Note: Not all items from the portfolio are included in this document.

Review Of Literature:

Strategies for Equity/Effectiveness

1. Increase wait time.
2. Separate instruction from classroom discipline.
3. Desegregate the class geographically.
4. Use cooperative learning.
5. Alert students to the issue of gender equity.
6. Be self-reflective of your gender interactions in terms of behaviors and expectations.
7. Examine your role model image; use gender neutral language.
8. Use random methods such as poker chips or cards or popsicle sticks to select students to call on.

9. Provide opportunities for students to have individual interactions both within the classroom and outside of class.
10. Encourage active participation by all students.
11. Increase the instructor's mobility during instructional periods.
12. Eliminate the students' use of self-putdowns.
13. Praise females for good work rather than for persistence or appearance or for good behavior.

Gender-Biased Student/Teacher Interactions

1. Questions and answers

- Call on boys more than girls
- Accept boys' called-out answers more than girls'.
- Wait longer for boys' answers than girls'.
- Ask boys more interpretative questions, girls more factual questions.
- Give girls more neutral responses ("Okay") and boys more complex responses, both positive and negative.
- Allow boys more talking time than girls.

2. Praise, Criticism, and Feedback

- Praise girls for the form or appearance of their work; praise boys for the content of their work.
- Tell boys how to solve problems, but solve the problems for girls: learned helplessness.
- Discipline boys more than girls, even when they misbehave equally.
- Give boys more criticism and corrective feedback.

3. Physical Movement

- Position your body toward boys more than girls.
- Circulate more to boys' seats than to girls' seats.

4. Other

- Fail to challenge students' gender-biased behaviors or comments.
- Allow students to self-segregate by sex.
- Give girls fewer experiences with science equipment.
- Assign different classroom tasks on the basis of gender.

(Research by the "Gender Equity Program, Center for Advanced Study in Education and the City University of New York Graduate Center" describes unequal treatment for girls and boys in the classrooms both by female and male teachers.)

The observations looked at both the number and type of interactions each student received from the teacher.

Data Collection:

During this research project, we gathered five independent forms of data from dissimilar methods to help us answer our proposed question. The first three of these were designed to complement one another and were developed in such a way that the data could be triangulated. These pieces of data allowed us to arrive at a hypothesis that was further supported by the fourth and fifth pieces of data, standardized test scores and past student career selections.

Initially, we made three observations of the grades 1, 3, 5, 7, 9, and 11 classrooms targeted for the research project. Our observations were made independently by three individuals, including each of us as researchers and a math student teacher from Doane College who was recruited to assist with the process and provide us with a potentially less-biased set of observations than could be obtained from any other school personnel. To make the observations, the classrooms were mapped and the students were located with respect to the location of the teacher. Each observation was thirty minutes in length, and the activity of that day was noted. Neither the teacher nor the students were aware of our purpose at the time of these observations. The observations looked at both the number and type of interactions each student received from the teacher. These interactions were categorized into four types: positive, negative, neutral, and remediation. We knew that the category placements could be viewed as being subjective, but by discussing the focus of our research before beginning, we felt that we were collecting data that could be compared and triangulated among the three observers.

In addition to the observations, we also generated two surveys to be completed by the students we observed and the individual teachers of those classes. The surveys were designed to have significant correlation between student and teacher responses. The student surveys were introduced with a description of why we were in the class observing and an appeal for the students' honest responses to the individual survey questionnaire. Although the surveys read as though they were directed only toward math and science instruction, students in health classes were instructed to answer the questions for that class and that teacher. While the students were completing their surveys, the teacher was sent from the room to complete the teacher survey. The surveys were then tallied and student-teacher discrepancies were noted in the summary of our data.

Another purpose of the teacher survey was to give us a better idea of the way each individual teacher normally conducted class. A number of the questions were related primarily to classroom procedures of a daily nature. For example, "Do you use a random method for calling on students?" By asking such questions, we hoped to be able to make suggestions to each teacher concerning his/her level of gender equity and possible improvements.

After putting together the observational data, we felt we needed to look at information that was more objective. We chose to look at the achievement test scores for the students we observed. In order to do this, we had to use the students' previous year test scores. This portion of the research was conducted with the assistance of the high school guidance counselor. While we had hoped for objectivity that would support our subjective observational phase of the study and our hypothesized conclusion, we found that the interpretation of the data was for the most part very subjective in nature. We were able to make what we feel to be relatively significant connections to the observational phase of the project.

Finally, we were interested in how gender equity/inequity at our high school was impacting our graduates in their college major/career choices. For this final phase of the data collection process, we listed all graduates from the past seven years and then researched their college choices and fields of study. We also looked at those careers that our graduates were pursuing. We believed that this data would provide some insight in gender trends from a long term perspective.

Teacher Survey:

Responses were: *Always; Sometimes; Rarely; Never*

1. I expect similar levels of academic performance from both female and male students.
2. I treat both male and female students equally in terms of classroom discipline.
3. I assign specific tasks in math and science instruction based on the student's sex (i.e., cooperative group roles).
4. I randomize selection of students to respond to questions.
5. My classroom seating arrangement integrates female and male students.
6. I allow my students to group themselves for activities.
7. In my class, I teach from more than one place in the classroom.
8. I ask questions requiring the same cognitive ability of all students.
9. I praise boys and girls equally for similar behaviors.
10. I believe that boys and girls can achieve at the same level in science and math.
11. I give equal amounts of wait time to both girls and boys.
12. I provide equal remedial help to both girls and boys.
13. I use he/she interchangeably in my communication to students.
14. I call equally on boys and girls in class.

15. I believe boys are able to do better in math and science than girls.
16. I provide quick, positive reinforcement for all correct student responses.
17. My classroom atmosphere is positive and exciting for all students.
18. I believe my classroom is gender equitable.

Student Survey:

Please check the box which best expresses your opinion about this teacher during this class period.

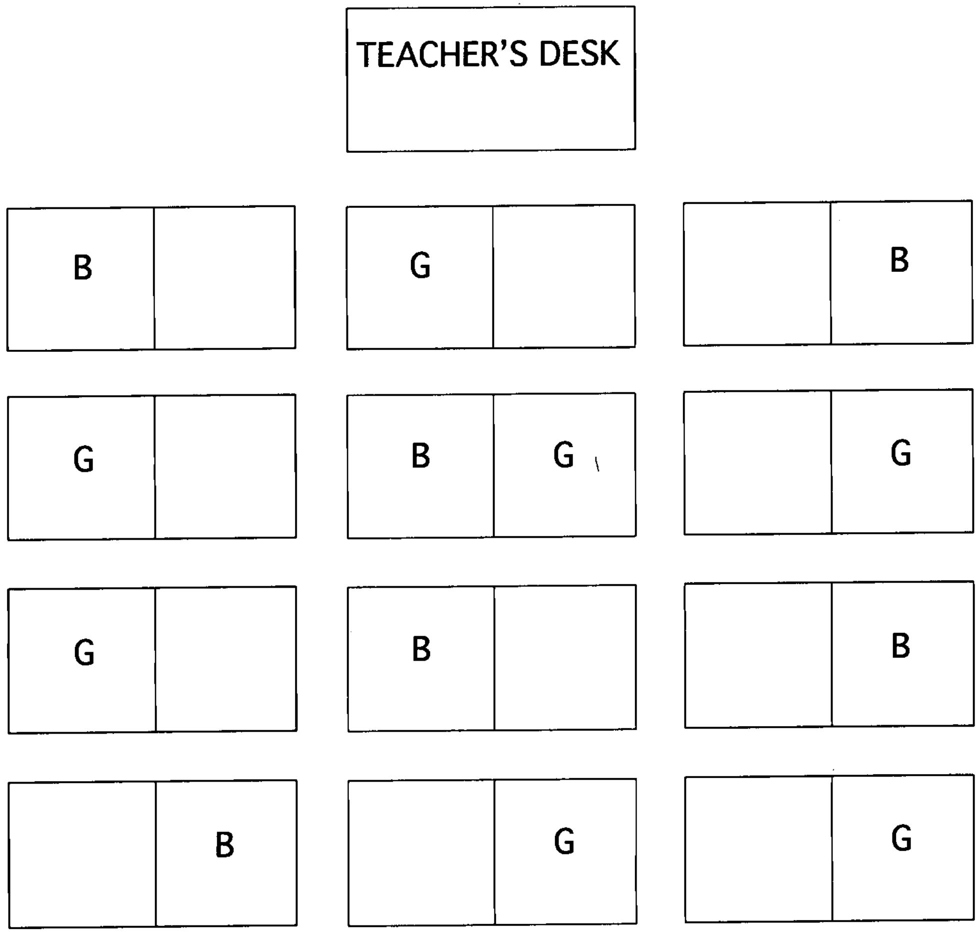
Choices were: *boys; girls; the same*

1. Who does your teacher treat better during math class?
2. Who does your teacher treat better during science class?
3. Who gets called on more often to answer questions during math and science class?
4. Who gets in trouble with the teacher more often in your class?
5. Who gets asked harder questions during math and science classes?
6. Who needs more help from the teacher during math and science classes?
7. Who gets asked to clean up more often?
8. Who does the teacher spend more time helping during math and science class?
9. In your class, who do you think gets better grades in math and science?
10. Who does your teacher expect more from in math and science classes?
11. Who does the teacher spend more social time with?
12. Who do you think the teacher likes better?
13. I am in grade (circle one) 1 3 5 7 9 11
14. I am a (circle one) FEMALE MALE

Classroom Observation Tally Sheet:

Grade Level Observed:____________ Date:____________________

Start Time:__________ End Time:___________ Subject and Lesson:_____________________



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Data Analysis Process:

The research on this project was set up to allow the researchers to take independent pieces of data gathered by dissimilar methods and compare and compile these distinct data sets. The first three pieces of data collected—the classroom observations, the teacher surveys and the student surveys—were then compared and contrasted to suggest patterns or discrepancies.

In order to organize the classroom observation results, we made a chart noting the number of boys and girls present and the activity. This chart summarized the total number of teacher responses of each type. Also tallied were the number of children by gender who received one or fewer teacher interactions in each thirty minute observation. We then totaled all of these to create a similar set of data for the school as a whole. Important to analyzing this data was the creation of a summary showing, by grade level and by elementary and secondary classes, the number of interactions per boy or girl per observational period.

All School Summary/Teacher Responses Per Student By Grade And Gender:

Grade 11
88 responses per 20 boys = 4.4 responses/boy
76 responses per 19 girls = 4.2 responses/girl

Grade 9
112 responses per 25 boys = 4.5 responses/boy
62 responses per 16 girls = 3.9 responses/girl

Grade 7
96 responses per 36 boys = 2.7 responses/boy
71 responses per 39 girls = 1.8 responses/girl

Grade 5
83 responses per 43 boys = 1.9 responses/boy
98 responses per 36 girls = 2.7 responses/girl

Grade 3
50 responses per 39 boys = 1.3 responses/boy
47 responses per 28 girls = 1.6 responses/girl

Grade 1
158 responses per 34 boys = 4.6 responses/boy
38 responses per 9 girls = 4.2 responses/girl

Types Of Teacher Responses By Grade Level

RESPONSE TYPE: Number of Students	POSITIVE #B	POSITIVE #G	NEUTRAL #B	NEUTRAL #G	NEGATIVE #B	NEGATIVE #G	REMEDIAL #B	REMEDIAL #G
First Grade Boys 34 79% Girls 9 21%								
Third Grade Boys 39 58% Girls 28 42%	5 56%	4 44%	33 54%	28 46%	4 67%	2 33%	8 38%	13 62%
Fifth Grade Boys 43 54% Girls 36 46%	17 45%	21 55%	46 51%	45 49%	11 48%	12 52%	9 31%	20 69%
Seventh Grade Boys 36 48% Girls 39 52%	14 70%	6 30%	57 53%	50 47%	13 72%	5 28%	12 55%	10 45%
Ninth Grade Boys 25 61% Girls 16 39%	19 63%	11 37%	55 65%	30 35%	17 61%	11 39%	21 68%	10 32%
Eleventh Grade Boys 20 51% Girls 19 49%	12 60%	8 40%	56 54%	47 46%	9 43%	12 57%	11 55%	9 45%
Elementary Grade Boys 116 61% Girls 73 39%	53 65%	28 35%	164 62%	101 38%	35 69%	16 31%	38 50%	38 50%
Secondary Grade Boys 81 52% Girls 74 48%	45 63%	27 37%	168 57%	127 43%	39 58%	28 42%	44 60%	29 40%

We summarized the student surveys by tallying the responses of each class in a manner that allowed us to distinguish between the responses the girls gave versus those of the boys. By summarizing the data in this way, we were able to locate distinct differences in how the girls perceived the teacher's actions when compared to the boys' perception of the teacher's actions.

We then turned our attention to writing and scoring a teacher questionnaire that we could directly compare with the student questionnaire. We found it challenging to write the questions in this manner. We also added some questions on general classroom behaviors of the teacher in order that these behaviors could be compared with what was shown by the three observations. This second type of question was designed to give us a clearer picture of what happens in the classrooms on a daily basis so that we could accurately make suggestions for improvement in instruction with respect to the issue of gender bias.

When these three pieces of data had been collected, tallied and organized, we compared each set from each classroom to look for issues that were either agreed upon by all involved or greatly disagreed upon. We took into consideration those questions that were answered differently by the boys and the girls and any discrepancies occurring between the student responses and those of the teacher.

We then created, for each of the classroom teachers we observed, a summary of these results. Included in the summary were a general recap of our findings and suggestions for each teacher to better make his/her classroom more gender equitable.

First Grade Summary:

In writing the student survey, we tried to take into consideration the maturity level of first graders. We felt that if we read the questions to them, they would be able to answer them accurately. However, even with explanation, the students had a difficult time marking only one box in any one row and as a result, five of the fourteen surveys had to be disqualified. We considered a repeat visit to the classroom in which we would read the questions to each student individually, ask for a verbal response, and then mark the responses ourselves. After filling out the questionnaire once and hearing the questions read numerous times, we felt that the validity of the survey would be challenged by asking for a repeat performance. We did tally up the responses of the nine remaining students who completed the first survey correctly, only one of which was female. This class has only three girls and on this day, only two of the three were present.

We were anticipating that the responses might be evenly distributed as if random selections had been made. However, a remarkable number of the responses were heavily selected as either nearly all boys or all girls. For this reason, we have chosen to make some comparisons using the student survey results, but we warn that they should perhaps be taken with a "grain of salt."

The first discrepancy in the surveys is in the area of expected performance. The teacher feels that she always expects similar levels of performance in both math and science classes from both boys and girls. The students reported that although this was true in math class, the science class was different. Three of the nine students felt that the boys were treated better in science class, while another five students reported that it was the girls. Only one student felt that in science the boys and girls were treated equally. Questions five and six also showed discrepancies. These questions deal with who is asked harder questions and who needs more help in math and science. The students reported that the boys are asked harder questions on six of nine surveys, while the teacher indicated that she always asks questions requiring the same cognitive abilities of all students. On question six, girls were reported to need help more than boys in math and science on seven of the nine surveys. In this class, the students felt that both boys and girls were disciplined equally. This is the only class we surveyed that reported in this manner. The teacher also responded that she disciplined the students the same.

Our observations of this class do not correlate well with the survey data. Our observations show that this class has lots of teacher-boy interactions but very few teacher-girl interactions. In three observations, the girls received three positive responses while the boys received thirty-one. In terms of total responses, the boys received almost four times as much feedback as the girls.

Suggestions:

Some sort of randomized drawing of names to call on the students might move the class closer to being gender equitable. In addition, it is important to note that during all three observations the seating arrangement was such that the three girls in the class were seated in the rear of the room at the far left side, and while two of them were at the same table, the third girl sat diagonally from them with a boy. The teacher seldom walked to that corner of the room because she was so often distracted by tables of boys nearer to her proximity. A suggestion for improving this problem might be to spread the girls out around the room. This could also help with curbing the behavior of the boys. Recall that although the data for this class is triangulated, it may be unreliable due to the factors previously mentioned .

Third Grade Summary:

The third grade data shows many of the same patterns that we observed in the other classes. The teacher said she "always" treats boys and girls equally in terms of classroom discipline, yet the student survey responses do not support this position. On the student surveys, 21 of 28 students marked that the boys get into more trouble than the girls. When asked about calling on the students, the teacher said she "sometimes" called equally on girls and boys, and she responded in the same manner in reference to asking students of both sexes questions at the same cognitive level. In looking at the student surveys, it is noted that the students feel that it is the girls who get called on more often by the teacher than the boys. It is interesting that 14 students reported that to be true, while only two students, both females, reported that it was the boys who were called upon more often.

The teacher responded that she "always" believes that girls and boys are equally able to achieve at the same level in math and science. The student surveys did support

In terms of total responses, the boys received almost four times as much feedback as the girls.

this position in that six students reported girls doing better, while the remainder of the students, fourteen total, reported that achievement of girls and boys is equal. When asked about assigning specific tasks based upon gender during math and science instruction, this teacher reported that is "always" a consideration. Later in the survey, however, she reported that her classroom is gender equitable. We believe this teacher misunderstood the survey question on the assignment of specific tasks by sex, based upon the remainder of the survey responses.

The three observations for this class did not reveal anything particular in terms of gender equitability. In all categories of responses, the number of responses for both boys and girls were nearly the same. However, this class did show one significant concern. A large number of students of both genders received minimal feedback of any type. On two of the observation days, more than 70% of all students in this class received no more than one comment. While this is not a specific concern in this project, we believe this a significant issue.

Suggestions:

It does appear that this particular teacher is somewhat aware of gender bias. However, due to the general lack of student/teacher interaction at any level, we may not have a large enough pool of observational information to make a statistically relevant statement concerning this teacher's gender equitability. We are concerned about the number of students who, in a thirty minute observation, are not being called upon and allowed to interact as individuals with the teacher. We believe that this teacher would be well-served to employ a randomized method of selecting students for responses, as opposed to beaming both questions and responses to the group as a whole.

Fifth Grade Summary:

A marked difference is seen between the way the teacher feels she treats students in terms of discipline. Although the teacher said she sometimes treated both boys and girls equally, 24 of 28 students marked that boys got in trouble with the teacher more often. When asked about calling on students, the teacher said she sometimes calls equally on boys and girls in class discussions and that she sometimes asks questions at the same cognitive level for both sexes. Fourteen of the students answered that boys were called on more often than girls, while the remainder of the class answered that they were called upon equally. It is important to note that no students answered that girls were called on more frequently than boys. In addition, 10 of 28 student surveys reported that the boys get called on to answer the tougher questions in math and science, while no respondent felt that way about the girls. The teacher believes that girls and boys are equally able to achieve in her classroom while the class felt that boys received higher grades than girls in math and science classes with 15 of 28 responding this way, while only 2 students felt that girls received the better grades. The teacher states that she sometimes provides equal remedial help to both girls and boys. The students, on the other hand, feel that the girls receive more help than the boys with 10 of 28 responding in this manner. Our observations in this class do not show the remarkable differences reflected in the teacher-student surveys, but they do show some interesting discrepancies. For example, in this particular class, the number of students receiving one or fewer responses during three, thirty-minute observations was 52%. Many of the students making up that 52% were the same in each observation, which would lead us to believe that the geographical placement of students may be a factor as to how often you are called upon in class. This could be explained by the fact that the teacher stated she rarely or never moves around the room while instructing.

We were led to believe that the geographical placement of students may be a factor as to how often you are called upon in class.

Suggestions:

We feel that through our data we have shown that this teacher is aware of gender bias and works hard to overcome the differences in class instructional periods. One suggestion we would make to this teacher would be to circulate throughout the room or to employ the use of popsicle sticks and other random methods to call upon her students.

Seventh Grade Summary:

In this particular class, the student surveys and the teacher survey were nearly in direct correlation to one another. The only question which could possibly be construed as a discrepancy would be concerned with discipline. The teacher feels that he sometimes disciplines students equally, while the students answered overwhelmingly, 25 to 0, that the boys get in trouble more often than the girls. However, in retrospect, this question can be taken out of context. The teacher could still be treating the boys / girls equally when it comes to discipline, but perhaps in this class the girls simply do not cause behavioral problems as often. If we consider this as a possible scenario, then there are virtually no discrepancies in the surveys. In comparing the survey results with what was observed in the classroom, the teacher's perceptions of what is happening in the classroom tend to correspond with the student's views and for the most part this classroom appears to be gender equitable.

Suggestions:

This teacher uses random methods for calling on students at least some of the time. During our observations, we noted that this teacher could improve this class by becoming more geographically aware. It appears that students seated in the front two corners of the room and approximately two seats deep receive a disproportionate number of responses. In terms of the types of teacher comments, it was observed that only about 12% of all comments given were positive with about the same being negative or remediation statements. We also noted that the positive statements were given in favor of the boys 2 to 1. The negative statements also appeared to be close to that ratio. Perhaps this teacher could work at varying his neutral comments to include more praise for correct responses and appropriate behavior, but as a whole, this class appears to be as gender equitable as any other which we observed.

Ninth Grade Summary:

The ninth grade data is going to be difficult to report in a fashion similar to that used in the other classes that were observed during this research project. It was our objective to observe three math or science classes at each of the six grade levels selected for the observation phase of this project. Unfortunately, we are the teachers responsible for the majority of those classes offered at our school. We felt strongly that we could not be a part of the research data, which greatly diminished our ability to select classes for observations at the secondary level. We were somewhat relieved when we realized that we could observe my student teacher in the first semester of the school year and include her performance in our data. However, the surveys were not prepared until the second semester. We felt it unfair to ask students to fill out a questionnaire concerning the teaching of someone who hadn't been actively teaching the class for more than two months. Adding to this dilemma was the fact that we had observed the student teacher and the student teacher was doing the third observation for this project. Therefore, we found it unfair to give any teacher or student surveys in grade nine. Subsequently, the only data that we have to report for this level is our classroom observations.

It is difficult to draw any conclusions from the observations of the ninth grade. Two of the three observations were completed in a geometry class, while the third was an ecology class which was having a lab on observation day. During the lab, there were two different settings, the classroom and the lab. Since the observer did not note which girl/boy in the lab corresponded with which student in the classroom, the data is inconsistent as far as the number of students receiving one comment or less during the class period and should be disregarded. There were only 10 students in the ecology class, which complicates the data or lack of it even further. The geometry classes were taught by the student teacher and the ecology class was taught by the same teacher in each of the eleventh grade observations.

Some of the same conclusions that apply for most grade levels can be transferred to

The majority of teachers feel that they make a large number of positive comments to students throughout the day, when in reality the number of negative and positive interactions seems to be very close in number.

this situation. Boys tend to get more remediation than girls as a whole, nearly two comments to the girls' one. Also, we continue to notice a general lack of positive comments to either gender, as opposed to a large number of neutral responses. It seems that the majority of teachers feel that they make a large number of positive comments to students during the course of a teaching day and very few negative statements, when in reality the number of negative and positive interactions seems to be very close in number. The remainder of the observed behaviors in these three observations appear to show that the classrooms being observed are relatively gender equitable, but without further study, we can not be certain of that statement.

Eleventh Grade Summary:

All eleventh grade observations were completed in a health class, taught by one instructor. The student surveys and the teacher survey were closely correlated on many of the questions. The teacher reported "always" expecting the same performance from both boys and girls and the students mostly agreed with 73 % making that statement. Of those who did not agree, it appears that nearly 20% felt that this teacher expects more from females than males. When asked about calling upon students to answer questions, the teacher responded that he "always" randomizes selection of students. The class reported (23 of 26) that indeed this teacher does call on both males and females the same. It is interesting to note that in at least one classroom observation this was true for the first four questions, but then the random drawing of names was abandoned. In terms of the cognitive level of the questions, 20 of 26 students felt that it was the same for each gender, but it is interesting to note that all of the remaining six students felt that the boys were asked the tougher questions by this instructor. On the teacher questionnaire it was reported that students are "sometimes" asked questions at the same cognitive level. Although the responses by both parties correlated quite closely, if there is any inequity in the class, it favors being a girl. However, the majority of all students in the class felt that this teacher tries to treat both males and females alike.

During the classroom observations, it was clear that in this particular class, there are a lot of teacher/student interactions. Two of the observed lessons dealt with feelings and self-concept. The students shared experiences and were asked to give their opinions on numerous occasions which would rarely happen in a typical college-prep math or science class. This subject area in science lends itself much better to appearing gender equitable than perhaps a traditional class would. Again, the observation of those classes could not be accomplished by these researchers in this district.

The observed health class is held in sections meeting every other day. Two of the three observations were with a single section, while the second observation was the other half of the class. In the two observations of the same class, a distinct geographical difference was noted between the right and left side of the classroom. When a diagonal is placed from the front right corner of the class to the back left corner an interesting phenomenon occurs. If you are a student seated on the left side of that diagonal, you are likely to receive four times as many responses as your classmates seated to the right of the diagonal.

In this class it appears to the researchers that gender inequity is not an apparent problem. The data that we collected in all three modes is nicely correlated and shows very little, if any, gender bias. As noted earlier, if any bias is occurring, it favors the girls. This small portion of the data is quite interesting, but it is not possible for the researchers to further investigate this phenomenon at the present time without changing the focus of the research question.

Suggestions:

The class did not show significant examples of gender bias, but it did show some classroom dynamics problems. If we were to make any suggestions to this teacher, they would be with respect to geography. The geography of the classroom has a serious impact on whether or not students are selected to interact with the teacher. By being more geographically aware, this instructor could be more inclusive of all students. The instructor did use random selection part of the time, but it was discontinued part way into the lesson during one observation. We feel that this instructor could eliminate the geographical bias by selecting students by drawing cards as was demonstrated at least temporarily. Overall, in terms of gender bias, we feel that this instructor has done a reasonable job of avoiding gender discrimination in his instructional methods.

Standardized Test Scores:

The next data we collected in this project were standardized test scores. We felt that the objectivity of the numbers would create a data set that would allow us to validate the subjective observations we made. For the standardized test score portion of the research project, we looked only at grades 4,6,8 and 10. These grade levels were chosen in order for us to compare our observational data to the test scores. We threw out the kindergarten and second grade achievement test scores as it was suggested to us that those scores do not carry much validity. When we looked at the test scores, we initially noted what we thought to be significant trends. However, the objectivity of this portion of the research project also became subjective in that interpretation of the data, especially when the standard error of the test was taken into consideration, showed little of significant value. This data did not, however, discredit our conclusion that was derived using the observational and survey portions of the research. In reality, it seemed to confirm what we now believe to be true.

Initially, when looking at the statistics for the 1995 Achievement Tests in math and science, we felt we had found a general trend. It appeared that students in math from our school did not conform to the same trends that occur nationally when comparing boy/girl test scores. Girls in the grade levels we observed were statistically in higher percentiles than were the boys. Only in grade four did boys score in a much higher percentile than girls. In the other grades, girls were between 2 and 17 percentile points better than the boys. However, we need to qualify this statement somewhat, as two of the three grade level percentile scores are within the statistical error of the test, meaning that in those grades the boys/girls are statistically equivalent in achievement.

In looking at the science portion of the achievement test, we did not find quite the same pattern. Initially, it appears that boys scored in higher percentiles in all grade levels. However, once again the statistical error of these tests at two of the grade levels indicates that both the boys and girls are achieving at or near the same level.

While comparing scores in each grade from subject to subject, some interesting patterns appear. Grade four was the only level at which, in both tests, a single gender, the boys, disproportionately outscored their counterparts. In grade eight, the math scores were statistically within standard error for the two genders, while in science, the scores show the boys nineteen percentile points ahead of the girls. In grade six, the science scores were statistically even while the math scores show the girls seventeen percentile points ahead of the boys.

Gender Analysis of 1995 Achievement Tests In Math And Science

Achievement test scores were gathered for the students' previous year. For example, with the fifth grade class we observed, we looked at their achievement test scores from the fourth grade.

	Math		**Science**	
Grade	*Males Percentile*	*Females Percentile*	*Males Percentile*	*Females Percentile*
4	90	60	76	50
6	68	85	75	71
8	69	75	87	68
10	86	84	86	80

Career And College Major Choices:

We analyzed the career and college major choices of our graduates from the past seven years. We chose to disregard all students who had entered the military or the work force and concentrated on those students who were currently attending postsecondary school or had graduated. We chose only to accept as math and science related fields those majors that required an extensive study of mathematics or science courses. The following majors were included:

- Health related professions which required a four-year college;
- All business related professions acquired via a four-year college;
- Actuarial science majors;
- Engineering majors;
- Pure mathematics or science majors;
- Computer science majors;
- All math or science education majors.

This portion of the research was found to be somewhat depressing to us. In a small school such as ours, where it is not uncommon to have a student for five or six consecutive years, we become quite attached to our pupils. As graduation approaches and we are asked to write numerous recommendations for these students, we spend a great deal of time listening to and discussing their hopes and dreams. It always appears as if they leave us with very worthy aspirations, yet when we looked at where they had traveled over the past years, we found many unable to reach their goals due to a variety of reasons and circumstances. It was disheartening to see what some of our students had not accomplished since leaving our doorways.

On the other hand, we were also pleasantly surprised by the nearly 30% average of both boys and girls entering what we had categorized as math / science related fields. Also interesting to us was the fact that we had two males who chose to become registered nurses, a predominately female career domain, while two girls had chosen actuarial science careers, a heavily male-dominated career.

Post-Secondary Education

H.S. Grad. Year	Total Students	Boys	Girls	Total in Math/Science Boys	Total in Math/Science Girls	Percent in Math/Science Boys	Percent in Math/Science Girls
1995	16	6	10	2	3	33%	30%
1994	26	17	9	7	6	41%	67%
1993	22	10	12	0	6	0%	50%
1992	15	8	7	2	2	25%	29%
1991	18	11	7	5	4	45%	57%
1990	17	10	7	2	0	20%	0%
1989	19	10	9	2	2	20%	22%

Conclusions:

With our variety of data, we feel comfortable that our conclusion is accurate for our public school. After considering all of the data collected, it appears that there is a wide range of gender equitable interactions that occur between teachers and students on a daily basis during math and science instruction at our school. As expected, it appears that the teacher and his/her instructional methods largely determine whether the students perceive the class as one in which both sexes are treated equally. The students' perceptions of the gender equitability in classroom instruction, for the most part, fit the observational data collected. It also appears that the gender of the faculty personnel does not determine how gender equitable that teacher is, nor does the grade level being taught seem to affect the observational or survey portion of the research.

It does appear that those teachers who have had some training in gender equity issues

It does appear that those teachers who have had some training in gender equity issues are more equitable in their interactions with students.

are more equitable in their interactions with students. In addition, it appears that if certain techniques such as the random drawing of names to answer questions is employed, even occasionally, by an instructor, the students perceive that instructor to be more gender equitable. While the use of random drawing was at best "random" during the observations, its use had a dramatic impact on the student survey responses.

Plan of Action:

We intend to introduce the findings of our gender research to the faculty and staff at our school during the teacher inservice days in August of 1996. We hope to help our colleagues with techniques they can use to balance the gender equation and create an informed staff who can create a gender equitable environment for every student. It is our intention to share the results in a fashion that does not single out the participants of our research. We believe that by presenting our findings and the information we have obtained from the literature, we can make our staff more aware of how much influence each of us has on the choices that both girls and boys make in terms of both classes selected and careers chosen.

Once we have done our initial presentation to the staff and hopefully raised their awareness of gender issues that are affecting our students, we intend to follow up with a survey. This survey will indicate whether the teachers are using any of the methods we have suggested. It is our hope that we can encourage our staff to record specific successes and problems which they encounter while trying to implement suggestions for a more gender equitable school system.

INNOVATIVE TEACHING STRATEGIES IN AN INTRODUCTORY LEVEL GEOLOGY CLASS, UNIVERSITY OF NEBRASKA-LINCOLN

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Problem:

Many of today's undergraduate students—including science and non-science majors, pre-service teachers, and non-traditional students—come to college with an inadequate understanding of science. Overemphasis seems to have been placed on maximizing student exposure to vocabulary and facts rather than examining the broad concepts of science. High school teachers may do this in an effort to adequately prepare their students for college-level classes. Beardsley (1992) states that there is a "a widespread conviction that pre-college mathematics and science education in the U.S. is in such a grim state that radical reforms are urgent." For example, biology is a common course offering in many high schools across the U.S. Leary (1990) reports that the National Research Council has found that "Biology is so poorly taught that the experience seems designed to snuff out interest."

Beardsley (1992) reports that the number of students between grades 4 and 12 answering "No" to the question "Do you like science?" increases between these grades from 20 to 35 percent. As a result of fact-oriented exposures to science in primary and secondary schools, undergraduate students come to college with no real understanding of the process of science, poor preparation to participate in science classes, and an attitude that the experience will be inevitably painful. They know from experience that science (1) is full of disjointed facts, (2) contains a difficult-to-understand jargon combined with over-dependence on complicated mathematics, and, most threateningly, (3) lacks a

Students often graduate from college without a knowledge of what science is, how it operates, what it constitutes, and how it affects modern civilization.

mission—that all the good science has already been done and there is little more to find out about the world around us. Most importantly, undergraduate students do not view science as a process and have a poor understanding of what separates "science" from "non-science."

At the undergraduate level, many students are unwilling to consider a field of science as a potential major or career option as a consequence of these experiences. These students will take only the bare minimum of science courses required for graduation. Students who declare themselves interested in a science major are often overwhelmed by the vast amount of factual knowledge presented in a typical introductory-level science course and focus only on the courses they need to master in order to graduate in their chosen field of science. The result of all this is that students often graduate from college without a knowledge of what science is, how it operates, what it constitutes, and how it affects modern civilization. Even if they successfully navigate their way through existing introductory-level science classes, many students graduating from our colleges today are, at best, fact-rich but concept-poor. Pool (1990) neatly summarizes the end-result of many introductory-level college science classes by stating that "Introductory courses may give majors everything they need to continue on to more advanced classes, but a student who is only going to take a physics (or chemistry or biology or geology) course needs both much less and much more."

I would have to characterize my own traditional, lecture-only style geology course, "Life of the Past" (LOP), typical of this introductory-level course genre. My objective for the course was to cover the course texts (Richard Cowen, *History of Life*, 1995, and Stephen Jay Gould, *Wonderful Life*, 1989) completely and present as much content as possible.

The Challenge:

Two events significantly impacted my decision to implement some innovative teaching strategies in my Spring, 1995-96 LOP class: my participation in a workshop concerned with training pre-service science teachers and my role as project coordinator for the SEER Water Project.

The workshop was sponsored by the Center for Science, Math, and Computer Education at University of Nebraska-Lincoln (UNL) and supported by the Howard Hughes Medical Institute Biological Sciences Grant. The workshop focused on examining current course offerings for pre-service science teachers at UNL and other schools, evaluating how these courses assess learning, and demonstrating some innovative teaching strategies for presenting these classes. Interestingly, the workshop itself involved numerous work-sessions in which the participants evaluated issues using the pedagogical techniques being examined in the workshop.

In January, 1995, I became the Project Coordinator for the Satellite Education and Environmental Research (SEER) Water Project. The SEER Water Project consisted of a series of 15 weekly, two-hour Tuesday broadcasts televised via satellite to 15 downlink sites across Nebraska during Fall, 1995. The downlink site groups ranged in size from 3 to 12 teachers, and included a mix of large, urban and suburban schools, and several small, rural schools with total student enrollments (K-12) of less than 350 students. Using the theme of "Water," each broadcast included the following elements:

- providing new science content in the areas of biology, chemistry, and geology;
- encouraging incorporation of scientific research in Nebraska schools;
- introducing teachers to new pedagogical models;
- including cooperative learning and group work;
- journaling and the use of computer technology;
- illustrating the relationship between science and public policy;
- examining the cultural and multicultural issues in water practices.

Activities to achieve these objectives included interactive experiments, demonstrations, panel discussions, and interviews with various experts and public officials. A unique aspect of the SEER Water Project broadcast series was its emphasis on teacher participation during the television broadcasts. Educators learn by doing. They conducted experiments, participated in group discussions, practiced cooperative learning, and reflected on their experiences.

As a participating member of the team which prepared each broadcast and presented it to teacher audiences, I became aware of how these new pedagogical models worked. I recognized that these techniques could be used in a variety of settings, although the participating SEER audience was a select group of teachers who were not representative of the average student population in the UNL classes.

I cannot recall when I made the decision to revamp the structure of LOP, but I remember that we had already completed several of the SEER Water Project Broadcasts before I seriously entertained the notion of revising my syllabus. I was encouraged to do so by several of my co-workers. Dr. Betsy Kean, a Principal Investigator for the SEER Project and a member of the UNL Department of Curriculum and Instruction, informed me that there was an action research class forming in which I could explore the implementation of these pedagogical techniques in my class. I think that it was my scientific curiosity more than anything which prompted me to revise my course. I decided that I would conduct an experiment to see if these pedagogical techniques had an impact on the way my students learned the material in LOP. I enrolled in the action research class offered by Dr. De Tonack and soon discovered that many of the teachers participating in the SEER Water Project were also taking the action research class with me! It was a surprise (and a source of encouragement) to be able to work so closely with these professionals who knew me far better than I knew them at the start of the class!

Many people encouraged me to gradually introduce new teaching strategies into my class over the course of several semesters, so that I could evaluate different techniques to see which would work and which might not be as successful. Disregarding all this advice, however, I decided to completely revise my class using as many new techniques as possible. I believed that doing so would enable me to better determine the outcome of my experiment.

The Experiment:

A proper scientific experiment requires some control data against which to compare the results of the experiment. This was lacking; I had never previously envisioned revising my LOP class in this way and had never systematically evaluated the pedagogical style of the previous classes I had offered. Complicating this picture was the fact that the enrollment in LOP varies from semester to semester. When it is offered in the fall semester, LOP usually fills the auditorium in Bessey Hall (about 190 students). When offered in the spring semester, I limit enrollment to 70 students and hold the class in a smaller lecture room in Bessey Hall. Even using my traditional lecture format, I always enjoyed the more intimate surroundings of the smaller classroom since it enabled me to get to know my students a little better. However, I had no data on what students learned in my previous classes. While students at UNL are asked to fill out course evaluation forms at the end of each semester, many students choose not to do so, and of those who do, many address issues related to the professor's expertise, style, and class management. To rectify this gap in my data base, I prepared a questionnaire which I asked former students to complete. The sample population was limited to those students I could find around campus, and I collected only 12 questionnaires prior to the start of the spring semester. The questionnaire asked students four items: (1) to list some things/concepts they remembered from class and to indicate how long it had been since they were in my class, (2) to describe any controversial issues that were considered in their LOP class, (3) to mention some ways in which they thought the class could be improved, and (4) "Other comments" were solicited. Those who filled out the questionnaire were also asked some basic demographic information, such as their name, address, and a contact phone number.

This led me to think that perhaps I was asking my students to remember too many things, and that the key concepts were being diluted with lots of interesting, but not highly important, information.

The responses to the questionnaires revealed some surprising results. I had been convinced that I was managing to communicate key ideas to students, including the concepts of evolution, science versus non-science, geologic time, and the role of geologic history in interpreting past life. I was surprised to discover that of the 12 responses received, only six mentioned "evolution" as an important concept remembered. Similarly, only four respondents mentioned geologic time, two mentioned extinction, and three mentioned changes in life over geologic time. Several students did not remember much. After reading one questionnaire given to me by a student, I asked him if the concept of evolution stuck with him at all, and his response was "not much." Another respondent stated that he "didn't remember very much."

I was also surprised by the responses to the next question which asked students "What were the controversial issues you considered in class, if any?" Several students reported "none," or "can't remember any offhand." Several mentioned some appropriate topics, including the Big Bang Theory, the concept of evolution, and the "distinction" (spelling) of the dinosaurs. Reading the questionnaires made me realize that in some cases I was reaching some students with what I considered to be the key issues in LOP, while I was not making very much of an impression on others. This led me to think that perhaps I was asking my students to remember too many things, and that the key concepts were being diluted with lots of interesting, but not highly important, information. This, to me, is the crux of the matter: If LOP is supposed to be an introductory-level science class for primarily, non-science majors, what am I supposed to be "giving" the students as they pass through my class? Results of this questionnaire are summarized in Table 1.

After reflecting about this for some time, examining some of the concepts behind the SEER program, and talking with other teaching professionals in my action research class, I began to realize that in an introductory-level class such as LOP, I can reasonably expect the students to remember only four, or at most five, key concepts or ideas. What were these four

Table 1

1. After ____ years, list some things or concepts that you remember:

   DNA
   Evolution of plants/animals
   Extinction
   Geologic time (age of the earth)
   Plate tectonics
   Fossil evidence for plant life began in water
   Tectonics
   Atmospheric changes
   Linnaean classification scheme
   Pangea I and II
   Climate change over geologic time
   Dinosaurs
   "Life began as clay" theory
   Burgess shale
   Don't remember much

2. What were the controversial issues you considered in class, if any?

   Mass extinctions
   Evolution
   First living organisms
   Origin of earth and planets
   Big Bang Theory
   Evolution of humans
   Don't remember any

3. Can you think of ways you would have improved the class?

   Slides/pictures
   Provide more handouts
   Field trips
   Museum tour
   Smaller class size

4. Other Comments:

   Good use of "Farside" cartoons
   Have class on a different night
   Enjoyed the class
   Fun
   Questions in class were always welcome

The underlying importance of the "less is more" concept is that if students are asked to remember "less," but the "less" includes the distillation of several truly important ideas, they will come away from a class with "more."

or five issues going to be in my next class? How was I going to present them? It took a long time for me to finalize my list of ideas for my last LOP class. I began to wonder how many times teachers at both the K-12 and college level really take the time to think about what they want their students to get out of the courses they offer. A phrase frequently heard at SEER Project script-preparation meetings was "less is more." The significance of this idea finally dawned on me only when I considered how to narrow my number of key concepts down to four or five ideas. I believe that the underlying importance of this concept is that if students are asked to remember "less," but the "less" includes the distillation of several truly important ideas, they will come away from a class with "more." They will be able to use the ideas they have more thoroughly learned in an appropriate manner both in later courses and in their future life.

My "Top 5" list:

- What is science and how is it different from other world-views? (science versus non-science);
- The theory of evolution;
- Geologic time;
- Extinction;
- How different sciences interact to answer important questions.

The Revised Structure Of LOP - Spring Semester, 1995-96:

The LOP course was presented in the spring as a three hour course offered on Thursday evenings. Anticipated enrollment was 70 students. The class started with 70 students in attendance, and due to normal attrition and late registrations, the number of students in the course at the end of the semester was 66.

Journaling:

Based upon the successful use of journaling in the SEER Project, I decided to incorporate journaling into my LOP class. The biggest drawback to this was the amount of time it would take to journal with up to 70 students. Good fortune provided a solution to this problem in the month before the start of last semester's LOP class in January, 1996. Two former LOP students, Aimee Krabbe and Donald

Fisher, approached me and asked if they could somehow obtain a few extra credits in a geology course. The Geology Department at UNL offers an undergraduate research course to students in which, under the supervision of a faculty member, they conduct some geologic research. Since both students had previously taken LOP, I asked them if they would be willing to help me present the course. They would simultaneously be investigating the efficacy of the innovative pedagogical techniques being used in LOP. Since they had taken the course under the traditional format, they would be in a unique position to observe how the course affected students. The course requirement I gave them was to present their results at the undergraduate research symposium, held in the spring of every year. Both students would be assigned approximately 23 journaling partners, and between the three of us we would more or less be able to cover the students in the class.

Following the lead of the SEER Project, journaling was to be conducted via e-mail. Plans were included in the syllabus to take the students over to the nearest UNL computer laboratory the first night of class to instruct those students unfamiliar with e-mail on how to use this technology. I was amazed to discover on the first night of class that of the 70 students in the class, over 50% had never used e-mail before, and that nearly 35% had never used a computer to any great extent! Arranging the e-mail class turned out to be a "good thing." Many students who said they were somewhat familiar with e-mail were asked to help those who were not familiar with it at all, and in the process sharpened their own e-mail skills. Only 15% of the class reported any real familiarity with e-mail on the first night of class. One of the most interesting comments I received back from students came from one of the them who e-mailed directly to say thanks for making him learn how to use e-mail!

Group Work and Cooperative Learning:

Another task accomplished during the first night of class was to arrange the students in groups. Group work and cooperative learning were going to be important elements in the class structure, and since the class met only one night per week,

Of the 70 students in the class, over 50% had never used e-mail before, and nearly 35% had never used a computer to any great extent!

getting the groups established early was critical. Students were asked to line up in the hallway by birthdate, with January 1 at the head of the line, and December 31 at the rear of the line. Students counted off up to 18, and then the process was repeated. All of the "ones" formed Group 1, and so on. We finalized on 18 groups recognizing that some groups would have three people in them and others would have four. The students found this exercise interesting and fun on the first night of class. Groups were asked to decorate the folders they were given in any way they chose; some of their creations were quite elaborate and artistic. The folders were used to receive and return papers, provide topic lists for each class meeting, and provide storage for some reference papers the students might want to use during the class.

Group work was defined as those assignments in which groups were asked to work together to answer a question with usually one correct response. These items could be found in their notes or supporting text materials, or the students could discover the answer for themselves by considering the possible answers and selecting the "most appropriate" response. Cooperative learning involved questions in which more than one right answer existed. These questions tended to be more general and emphasized considering some of the controversial ideas presented in the class in which there is no right answer. Each class night, the students were provided, via their group folders, a list of topics for that night. These questions would be assigned during the class and considered during either "Group Work" or "Cooperative Learning" periods. In general, the group work and cooperative learning activities followed models discussed in Foster (1993) and Math Vantage (1996).

On occasion, groups were requested to turn-in their group work notes for evaluation. These notes would be evaluated and returned to them via their group folders. In addition to this method of evaluation, both my student assistants and I would visit the groups during their deliberations and occasionally participate in their conversations. Group work time was also meant to provide students with a few minutes break during the class. An important part of the group work process was "reporting out." At the beginning of the semester, I asked each group to report out the results of their efforts by designating a group spokesperson. I would call upon these spokespeople to report the results of their group work following its conclusion.

Group Presentations:

Each group was assigned a topic for which they had to prepare and present a "Group Presentation" on an assigned class meeting night. The first night of class the students viewed videotapes of several presentations prepared by teachers in the SEER Program. The students were told that these presentations were models, but their group's creativity would be an important element in a successful presentation. The list of presentation topics was prepared prior to the first class meeting and groups were assigned their topics randomly at the end of the e-mail training session in the computer lab. The topics were keyed to the course syllabus and were designed to amplify or present new information not provided in the reduced lecture.

Another important aspect of the group presentations was that the class groups would evaluate each presentation. Each group was provided an evaluation form to be filled out during or after a group presentation in which they assessed the quality of the presentation. These forms were to be returned in their group folders and were then averaged together to come up with a grade for each presentation. The forms, once tallied, were provided to the group that was evaluated. Comments were solicited on the evaluation form and space was provided for their inclusion.

Self-Assessment:

Groups were provided a preliminary self-assessment rubric the first night of class. They were requested to consider the rubric, and provide any desired changes/additions/deletions by returning their form to me via their group folders during course week six. After the editing process, the rubrics would be provided to each student who would then complete a self-assessment and get it back to me during week 14.

Lecture:

In the traditional lecture format, students would sit through a three-hour lecture, with usually two to three breaks provided at appropriate moments in the presentation. In the new class structure, lecture would be reduced to only 45-50 minutes out of a total of 180 minutes per class. The lecture would usually be presented near the start of class, and the group work, cooperative learning, and student presentations would follow the initial lecture. It was initially planned to provide a few minutes at the end of class for a closing lecture in which I would have the opportunity to wrap-up or bring closure to the class activities for the evening.

Assessment:

One of the hardest parts of this entire process for me was revising my method of assessing student performance in the class. In the traditional lecture format, assessment was a relatively simple affair and consisted of giving the students a series of quizzes and hourly exams culminating in a final. For the last several semesters, I have offered the students the opportunity to help write questions for the hourly exams. The questions, without provided answers, were bound in a packet that was then placed on reserve in the library the week before a given exam date. The students could go to the library and study the questions they would be seeing on the exam. The packet also contained some of my own questions, and the total number of questions in the packet far exceeded the number appearing on the exam. Students who submitted questions received extra credit, and students who had questions accepted for inclusion on the exam received some additional extra credit for each question that was selected.

With the revision of class structure, the role of the exams in assessing student performance was, like the lecture, reduced in emphasis. Tests of various types, including the final exam, would now count for only 44% of student's grade. Tests would consist of 11 "Readings Quizzes" (short, multiple-choice tests covering the highlights of a given week's reading assignment, worth one point), two hourly exams (multiple-choice tests, worth 10 points each), and a final exam (a multiple-choice test worth 13 points). There would be no Readings Quizzes the first and last night of class, or those nights on which hourly exams were to be given. I have found Readings Quizzes to be a useful tool for helping students remember to look at the text before coming to class. I was concerned that the group work would never achieve its goal if some students in a group were totally unprepared to discuss the topics provided for that evening, and therefore decided to retain this assessment tool in my new course structure.

In addition to the assessment points outlined on the syllabus, students would be provided the opportunity to earn some extra credit points over the course of the semester. These extra credit points would be given for submitting questions for the hourly exams (on a group basis), visiting the State Museum (natural history), bringing in a current news clipping pertaining to some aspect of LOP. The final breakdown of assessment points in the restructured LOP class is indicated in Table 2.

Table 2: Student assessment in "Life of the Past" class

Self Assessment	25
Group Work	13
Group Presentation	18
Reading Quizzes	11
Hourlies	20
Final	13
Total:	100

Less Is More? - Try A 10-Page Syllabus:

In my previous classes, both LOP and other classes I have taught at UNL, my syllabus usually consists of four pages: two pages provide an introduction to the class, and the last two pages include a detailed course schedule. The initial syllabus prepared for the revised LOP class consisted of 13 pages, with nine pages devoted to a discussion of the structure of the class, two pages for the class schedule, one page for a sample group presentation evaluation form, and one page for a list of presentation topics. Reviews of the revised syllabus were requested from several sources including my action research critical friend, other SEER staff members, my wife (a licensed secondary school teacher), and some participating teachers in the SEER program. Some reviewers felt the extra length was mandated by the use of unfamiliar pedagogical techniques in the syllabus, while others believed that no one would read a 13 page syllabus! I edited the syllabus down as far as I felt comfortable, and the final syllabus I gave to the LOP students consisted of six pages describing the course structure, the class schedule, sample group presentation evaluation form, and presentation topics.

The Mid-Semester Evaluation:

As I have done several times with previous classes, I asked the students in last semester's LOP to evaluate the course approximately half-way through the semester. I was especially anxious to gauge the students' feelings about some of the innovative techniques we were using in the class. By this time, the class size had stabilized at 66 students. Of these 66 students, 39 returned evaluations. Table 3 lists the questions asked in the questionnaire and provides some grouped responses to the questions asked. It is important to note that the totals provided for each question may include more than one response per student since several students wrote more than one comment in response to a question; if this was the case, all their responses were recorded and tallied. What really impressed me initially was the response to the evaluation. The students took the time to write detailed answers to the questions. They were involved in the process and were interested in assisting me to determine the success and problems associated with the new class structure.

When I got my first look at the mid-semester evaluations, I felt stung by the criticism I saw in the comments. I anticipated that the reaction to the group work and cooperative learning would be far more positive. I reviewed the evaluations with both my critical friend and the action research instructor, Dr. De Tonack. They helped me to see past the apparent criticism and recognize that most

Table 3: Mid-Semester Course Evaluation Results

1. What are you learning in this class?

Quite a bit	6
Stephen J. Gould - Wonderful Life	5
Origins of life	8
Evolution	10
Biology/geology connections	4
How to e-mail/use WWW	3
Geology/geologic time periods	2
Very little	2
Nothing	1
Scientific thought process	2
Total:	43

Several comments relating to class management were also provided in response to this question. They are:

Class moves too fast	3
Textbook is too hard	1

2. Compared to other classes I have had at UNL, I rate this class…

One of the best courses/best I have taken	4
Excellent, outstanding, pretty cool, better than I thought	11
Unique	2
Average/good	5
Mediocre, difficult, confusing, not very good	10
Intense/involved	4
High energy	1
Chaotic	2

Do not like reporting out 1
Has potential 1
Total: 41

3. What do you think about the group work that we are doing? Is it helping you learn material?

Helps 16
Does not help 2
Need better system of sharing answers 12
Frustrating 1
Too large a class for group work 3
Chaotic/noisy 1
Helps a student understand material 1
Not spending enough time in groups 2
Individual groups learn material 4
Total: 42

4. The lectures are worthwhile/not worthwhile. Why?

Worthwhile 32
Too short 4
Enthusiastic, teacher loves material 12
Best part of class 1
Hard-to-follow, too broad, goes off on tangents, confusing, too fast 6
Total: 55

5. Do you like the group presentations?

Like 25
Fun 4
OK 3
No 5

Pain-in-the-butt	1
Useful learning tool	1
All look the same	3
Best part of the class	1
Total:	43

6. What would you do to improve the course?

Eliminate some group work	3
More lecture	4
Reduce the size of the class	4
Total:	11

importantly, the students were involved in the class. As I read and re-read the evaluations, I began to see several interesting patterns emerging which led to some modifications in the course format. A common thread in many of the evaluations was that the class size was too large. There is little that can be done about that in a university setting. The spring LOP class is actually one of the smaller introductory-level courses offered by the Geology Department. Many respondents felt that the existing reporting out process took too much class time. As a result, I reduced the amount of reporting out by having groups initially work through a discussion topic and then coalesce in larger groups to compare their notes with other groups. One spokesperson would then speak for the larger group reducing the amount of reporting out by approximately 75% (four oral reports versus 18 oral reports). I realized also that although I had intended to provide a closing lecture which brought closure to each class, it was never happening. The reporting out and the student presentations were taking so much class time that there was no way to provide closure at the end of the class period. I resolved to keep a stricter control on time in the classroom and make sure that the reporting out allowed enough time in the class for the student presentations and a closing lecture. One student also

I incorporated this additional "wait time" into my lectures and was surprised to see that if I waited long enough, the class would answer my questions!

commented that I was not providing enough "wait time" between asking the class a question and going on to answer it myself. This student referred to "wait time" as "that painful pause between a question to the class and the class response." I incorporated this additional "wait time" into my lectures and was surprised to see that if I waited long enough, the class would answer my questions!

Other students commented that they enjoyed not being treated like a high school student in the LOP class. I found this comment very interesting. Having participated in the SEER Project and working with many K-12 teachers in their classrooms and in my action research class, I recognized that many of these innovative pedagogical techniques I was trying out for the first time in my college-level class were already in wide-spread use in K-12 schools across Nebraska! I believe that the current college students and non-traditional students in my last LOP class were still ahead of the cusp and had not been exposed to these pedagogical techniques in their primary and secondary school years. I think that is one reason why so many students were resistant to these techniques in LOP. Furthermore, these techniques required more work on the part of the student. They had to actively participate in their learning, and this style of learning did not suit all the students in my class. Many students can learn successfully through a traditional lecture format; why should they change, especially when the class apparently enjoyed the lectures they were being provided in LOP. One student commented that the lectures were excellent—why change a successful teaching tool? I have come to believe through my experiences in the SEER Program that not all of us learn in the same way. I always "sort of" knew this; I think that all of us do. Yet, at least at the university level, we still teach using the basic lecture format. We are afraid that our students will lose content if we don't provide them with it!

The mid-semester evaluation proved to be an important element in my experiment. The modified class tried to incorporate those positive suggestions which came from LOP students via their comments on the evaluation. I had to wait until the end of the semester, however, to see how the students formally responded to the slightly modified class format.

Final Class Evaluation:

As is typical of most college level classes today, the Geology Department requires instructors to provide students the opportunity to evaluate a class at its conclusion. The Geology Department uses a standard form which asks four specific questions (Part 1) and then presents a series of short statements about the class and asks the student to indicate a response on a 1 to 5 scale. The instructor cannot see these anonymous evaluations until after all grades have been submitted. Most students choose to remain anonymous, although several do put their names on their evaluation forms. I provided the students with the evaluation forms during week 14 and asked them to bring the completed forms to class for the final class meeting at which time they were collected by a student in the class and inserted into an envelope which the student delivered to the departmental secretary. A few evaluation forms were delivered to the secretary by individual students who did not attend the final class. Table 4 provides a synopsis of the results of the final evaluation.

They had to actively participate in their learning, and this style of learning did not suit all the students in my class.

Table 4: Final End-Of-Semester Course Evaluation Results

32 student evaluations received out of 66 enrolled students in the class.

Part 1

1. What, if anything, did you like about the course?

community/groups	15
fun	3
presentations	7
journal/e-mail	3
inventive class	1
no boring lectures	2
extra credit	1
respectful learning environment	2
inst. is excited about subject	3
freedom	1
test packet	1
evolution	1
style	1
Gould book	1

Quotes for Question #1: "I really liked the groups. Since I am a non-traditional student, it really helped me get to know the people in class."

2. What, if anything, did you like about the instructor?

enthusiasm/passion	10
contagious energy	2
dynamic/awesome	2

knows/loves subject	8
inspiring	2
people oriented	10
excitement	2
motivation	1
easy to approach	5
gifted/brilliant lecturer	3
fun	1
humor	1
brought subject to life	1
learned most names	1

3. What suggestions, if any, do you have to improve the instructor's teaching effectiveness?

eliminate lecture entirely	1
keep better control of class	2
more time for group work	1
ask more questions	1
distribute work better within groups	1
keep group work	1
only provide lecture/eliminate groups	1
vary format of each class	1
none/nothing to improve	8
more disciplined schedule	3
keep working on wait time	1
better preparation	1
more openness to other evolution theories	1

4. What suggestions, if any, do you have to improve the course?

smaller class size/larger classroom	3
offer course during the day	1
none	2
fieldwork/hands-on experiences	1
end class on time	1
less group work	2
eliminate journals/no e-mail	4
let out early every now and then	1
eliminate groups	1
have groups give the lecture	1
fewer group presentations	1
give early-presenting groups more help	1
great/one of the best UNL classes taken	4

Part 2

Please rate the instructor and the course. Unless otherwise noted, use the following scale:

1-excellent; 2-good; 3-average; 4-below average; 5-poor; NA-does not apply

1. The instructor's preparation for lectures and discussion.
   1 (23) 2 (8) 3 (1)
2. The clarity and helpfulness of the instructor's presentation.
   1 (17) 2 (12) 3 (3)
3. The instructor's general teaching effectiveness.
   1 (21) 2 (9) 3 (2) 4 (1)
4. The instructor's teaching ability compared to other instructors you have had at UNL.
   1 (23) 2 (6) 3 (3)

5. The fairness of the instructor's grading practices and policies.
   1 (23) 2 (7) 3 (2)
6. The clarity of course requirements and objectives.
   1 (19) 2 (9) 3 (3) 4 (1)
7. The degree to which the course was intellectually challenging.
   1 (15) 2 (10) 3 (7)
8. The extent to which the course stimulated interest in the subject matter.
   1 (15) 2 (9) 3 (6) 4 (1)
9. The workload of the course compared to other courses the same level you have had at UNL:
   (1 - considerably more, 2 - more, 3 - average, 4 - less, 5 - considerably less, NA - does not apply)
   1 (4) 2 (6) 3 (17) 4 (3) 5 (1) NA (1)
10. The degree to which the course helped you to develop analytical skills, such as thinking, analyzing and expressing yourself clearly.
    1 (9) 2 (12) 3 (9) 4 (1)
11. The overall value of the course.
    1 (15) 2 (10) 3 (2)

Quotes for #11: "It's worth a lot." "Great class experience." "Journaling was excellent." "I thought the course was very good and interesting. The course approach was different but challenged students to think about things and express ideas by writing, speaking, and working together in groups, very important life skills for work and home environment. Life skills for the real world."

I saw my students evolve into more critical thinkers as a result of the bombardment of discussion topics they had to work through each class.

Summary and Conclusions:

Teaching the spring semester, 1995-96 LOP class was one of the highlights of my entire teaching career. I saw my students learn and evolve (no pun intended) over the course of the semester into more critical thinkers as a result of the bombardment of discussion topics they had to work through each class. For the first time, many of my students were asked to assess their own performance in class. The value they assigned to their work would be the value that I used in determining their final grade. I had been worried all semester that students would uniformly assign themselves 25 points out of the possible 25 points. I was relieved to find that the student self-assessments ranged between 15-23 points on average, with not one student claiming the full 25 points. I truly believe that the students self-assessed their work accurately and somewhat impartially. If anything, it seemed to me that the "better" students in the class were more critical of themselves than the "poorer" students in the class.

In conversations with the students both during and after classes, I discovered that the students were, in fact, learning more about LOP than in my previous classes. I recognize that I did not cover nearly as many names as I usually do in the traditional lecture format, but names we went through in class were more fully explored and, I hope, retained. Furthermore, I am convinced that the students will retain more of the broad principles and concepts from LOP than they did under the traditional format. By discussing these issues and relating them to themselves in their groups, the ideas being discussed were more deeply ingrained in their minds than they would be by only listening to me and having little interaction with the ideas.

Sagor (1992) comments that many times teachers intuitively know what works and does not work in their classroom. They do not need a formal evaluation to demonstrate what is going well and what is not performing up to expectations. I have found this to be true in my class. I always had the feeling, as I observed the interaction among individuals and among the groups in my class, that the students were learning more than they did in my previous classes. It is true that I will have to interview my students one, two, or three years from now in order to compare their responses to my "Background Questionnaire" with those of previous students, and I hope to follow up on this over the next several years. I asked my students to provide me with contact addresses, and I intend to begin a new evaluation process next Fall (1996-97).

One of the most rewarding things for me personally was the number of powerful and personal responses I received from my students. Several students sent me unsolicited e-mail letters in which they expressed appreciation for something they learned in class; several students wrote letters to me after the class conclusion thanking me for making this one of the better classes they had at UNL. This has happened to me once or twice per class on occasion in the past, but never so much as I received this year. I was nominated to be the "Outstanding Teacher" at UNL this year, the first time in my professional teaching career that I was ever nominated for such a distinction.

Do I think that the innovative pedagogical teaching strategies I used in my last LOP class really work? You bet I do, and this teacher who once questioned the effectiveness of these strategies in a large, content-rich science class is now, and will be, a willing practitioner of these techniques in future classes. The most important thing I learned is that it is never too late to objectively investigate one's teaching and learn how to be a better teacher.

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Acknowledgments:

Many thanks to De Tonack for welcoming me into her action research class at UNL and encouraging me throughout the year. Betsy Kean served as my "critical friend" and graciously helped me over the rough spots in revising and managing my new class. I appreciate her willingness to work with me. My wife, Connie Kaplan, helped me in many ways. Her constant review of my efforts and her supportive advice—

teacher-to-teacher—kept me going. Thanks to Aimee Krabbe and Donnie Fisher for working with me in class. I hope that they will remember all the things they learned in their last geology classes. This paper is dedicated to all of my students—past and present—who have taught me a great deal as I was struggling to teach them something about a subject I love: geology.

Resource List

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NOTES

NOTES

MID-CONTINENT REGIONAL EDUCATIONAL LABORATORY (McREL)

The Mid-continent Regional Educational Laboratory (McREL), established in 1966, consists of three affiliated entities: the Laboratory, McREL Institute, and MCL, Inc. Although each entity has different projects and funding sources, they share a common mission: to make a difference in the quality of education and learning for all through excellence in applied research, product development, and service. McREL has a main office in Aurora, Colorado and a field office in Kansas City, Missouri.

McREL operates the Central Region Educational Laboratory, funded by the U.S. Department of Education. The Laboratory provides field-based research, technical assistance, professional development, evaluation and policy studies, and information services to state and local education agencies in Colorado, Kansas, Missouri, Nebraska, North Dakota, South Dakota, and Wyoming.

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Major research areas at McREL include standards, curriculum, and instruction; assessment and accountability; human development, learning, and motivation; technology; organizational and leadership development; mathematics and science; diverse student populations; and evaluation and policy studies. McREL has more than 30 years of experience providing technical assistance and consultation in all of these areas as they impact on school improvement, change and student performance.

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THE EISENHOWER HIGH PLAINS CONSORTIUM FOR MATHEMATICS AND SCIENCE (HPC)

"... to promote and support systemic reform in mathematics and science education."

The Eisenhower High Plains Consortium for Mathematics and Science at the Mid-continent Regional Education Laboratory (HPC) was established in 1992 by the National Eisenhower Program for Mathematics and Science Education. HPC is one of the ten regional consortia and serves the same seven states as McREL.

The mission of HPC is to promote and support systemic reform in mathematics and science education in the seven-state region. To facilitate change, HPC collaborates with state departments of education, post-secondary institutions, National Science Foundation (NSF)-funded initiatives, school districts and other state and federal agencies. HPC is guided by a 24 member Advisory Committee representing various client groups from the seven-state region.

The tasks of HPC are:

Collaboration
- provide assistance in developing state and regional plans for systemic reform;
- provide assistance in establishing communication links within and between states;
- facilitate communication among groups.

Service Delivery
- overcome challenges created by geography;
- define available services;
- utilize technology for service delivery.

Training and Technical Assistance
- develop corps of teacher leaders;
- identify and disseminate exemplary practices;
- provide information about informal education entities;
- train teachers regarding instructional methods, materials and assessment.

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