Using Action Research to Bring the Large Class Down to Size

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Particularly at the college level, a truism exists that the professors who are most closely involved in the day to day process of science teaching are often unfamiliar with the corresponding educational research base. Many research scientists recognize that their classroom instruction needs improvement and yet discover that the traditional educational research literature often fails to provide insight of immediate utility. In 1986, Hustler, Cassidy, & Cuff went so far as to suggest that nearly everyone with a direct interest in classroom teaching is disenchanted with traditional educational research because it appears to be irrelevant and impractical to the real classroom. An alternative paradigm that seeks to bridge the gap between research and teaching and provide a new model for professional practice is *action research*. After briefly reviewing the history of the action research movement, this article summarizes several action research studies recently conducted at Montana State University in an introductory astronomy course. These results are not presented as having generalizable implications but rather as examples of how to include systematic inquiry as an integral part of the teaching process.

WHAT IS ACTION RESEARCH?

An enormous amount of what constitutes successful instruction gets passed informally from experienced faculty members to newer faculty members. This is because informal success and failure stories address specific classroom situations and are expressed in the language of faculty. Most faculty cannot afford the time or expense to use highly validated cognitive instruments,

control groups, psychometric item response analysis, or other hallmarks of traditional educational research to determine exactly what individual instructional activities are working or not working in their classrooms. Further, when faculty discuss teaching with colleagues, it is in the common language of their profession and not in the highly specialized language of the educational researcher. (For example, Factor Analysis makes a lot more sense to scientists when described as an Eigenvalue problem.) Action research respects this informal tradition of reflective practice (Schön, 1983) and provides a framework for faculty-led inquiry and dissemination aimed specifically at enhancing the learning environment. In general, there are six key questions that provide the structure of action research methods and results. These questions can be abbreviated as: what did the pupils actually do; what were they learning; how worthwhile was it; what did the teacher/researcher do; what did the teacher/researcher learn; and what will the teacher/researcher do now? One of several excellent resources for suggestions on how to address these questions is *Classroom Assessment Techniques* by Angelo and Cross (1993).

The term "action research" was coined in 1947 by Kurt Lewin during a problem-driven effort to conduct sociology research aimed specifically at enacting changes in social programs (McKernan, 1991). As Lewin saw it, the role of the researcher was both to promote and understand the process of change and as such could not be treated as distinct from the system under study. This paradigm, which rejected the notion of researcher as disconnected observer, was not new to education theorists but it did provide an added impetus to the teacher-as-researcher movement. As applied to the study of education, the action research concept recognized the central role the teacher both as the primary agent of change in the classroom and the one best able to interpret the results. Readers interested in tracing the rich history of action research, which goes back more than fifty years, as

well as the surrounding philosophical foundations, are urged to consult Carr and Kemmis (1986) and Hustler, Cassidy & Cuff (1986) and references therein.

The two primary characteristics of action research that separate it from traditional lines of educational inquiry are that it is conducted by active participants in the teaching/learning process and that it is expressed in the language of its practitioners. Action research has been aggressively promoted in the K-12 arena as providing a model for the professionalization of teachers in which teachers become the primary focus of their own professional development. The goal is to encourage teachers to systematically study the impact of making change within their own classrooms. At the college and university level, action research provides a mechanism for transforming the role of faculty from that of researchers who occasionally lecture to a perspective that recognizes teaching as a scholarly creative activity (Boyer, 1990; Rice, 1996). The environment and natural language of college and university science instructors is clearly not the same as for most K-12 teachers. Whereas teachers are likely put off by extended discussions of experimental methodologies, control groups, sampling procedures, and data analysis, these terms and approaches comprise the natural language of research scientists—often a very different language than that used by some of our colleagues in colleges of education.

SOME ACTION RESEARCH RESULTS

Briefly summarized here are four action research studies conducted at Montana State University in support of improving Introductory Astronomy, which has an enrollment of more than 200 non-science major, undergraduates in a single lecture. These methods and results are meant to be brief

examples of how we have used action research to learn more about our classroom and positively impact students. More detailed methods and results are available by contacting the authors.

Question #1: Can we quickly determine students' pre-course knowledge without using an extensive pre-test? This is important for modifying the pace of instruction and creating effective collaborative working groups. The approach was to survey students to find out how they rated their level of understanding of seven specific astronomy concepts both before and after instruction (pretest/posttest strategy). The results were then matched to student performance on a 21 item multiple-choice test. Sample self-report and corresponding multiple-choice items are shown in Figure 1. Comparing pretest to posttest gains we found: (1.) there were statistically significant student gains on students' self-report of knowledge ($self_{pre}$=2.36 to $self_{post}$=3.71 on a scale of 1 to 5) implying that the 5-level self-report survey is sensitive enough to measure perceived gains in knowledge; (2.) there were significant student gains on multiple-choice items (MC_{pre}=50% to MC_{post}=70%) implying that learning did occur; (3.) there was a reasonably high correlation between self-report and exam performance (r_{pre} = .46 and r_{post} = .39 where r=0 is no correlation and r=1 is perfect correlation); and (4.) males self-report slightly higher than females, but demonstrate no difference in performance. This analysis suggests that self-report gains are representative of actual student gains on multiple-choice scores and that students can accurately recognize and accurately report their knowledge levels. It appears that, within the context of this class, two-minute self-report surveys can be substituted for conventional 20 minute pre-test exams to estimate students' initial knowledge state.

Question #2: Does required e-mail contact with between students and faculty improve instructor availability ratings on faculty evaluation forms? The approach was to award points to students for e-mailing the instructor twice during the semester. The students were encouraged to use the opportunity to initiate a meaningful interaction but understood that points were awarded irrespective of the content of the message—the instructor recorded in a personal journal the perceived meaningfulness of each electronic interaction. The instructor replied to all messages and, where e-mail was not the appropriate medium to hold the discussion, followed up with a phone call.

In the semester prior to implementing this strategy, the instructor received 15 e-mail messages from students and received an instructor availability rating of $\underline{x}$ =1.83 (1(*good*) to 5 (*poor*)). With the new strategy in place, the instructor received 157 email messages; 149 of which were judged to be meaningful. In addition, many students, who likely would not have done so without some encouragement, continued to e-mail the instructor. Surprising, however, the overall rating of instructor availability remained essentially constant at 1.88. These results suggest that student ratings of instructor availability are not impacted by e-mail communication even though the instructor's perception was an overall increase in meaningful interactions with students.

Question #3: How do student writing skills correlate with exam performance? Students in this course are required to complete three one-page writing assignments; each graded for content, grammar, and style. The assigned topics are not highly technical and encourage creativity. For example: "Since the time of Copernicus, we have known that the Earth goes around the Sun and yet newspapers still report the times that the Sun rises and sets, suggesting that the Sun goes around the Earth. Is it wrong to use a model that is inherently flawed?" This task is very different than the

homework and exams, which focus much more on technical knowledge. We were interested in how well student performance on the writing task was related to their performance on the multiple-choice exams.

We examined the correlation between each student's final exam score and her/his average writing score. A scatter plot of the data is shown in Figure 2. A correlation analysis, easily performed on most spreadsheet programs, yielded a correlation coefficient of r=0.50. To get a better sense of the meaning of this number, we compared students' final exams scores with their scores on chapter tests and weekly homework. The correlation with the chapter tests was higher at 0.76, as one would expect. Surprisingly though, the correlation between final exam scores and homework scores was only 0.45, which is slightly lower than the correlation with writing assignments. The data contradicted our initial hypothesis that, based on content similarity, the final exam scores would be more highly correlated to the homework than the writing assignments. This suggests a more integral connection between writing and test performance than we had anticipated—a connection that must be recognized in any future course revisions.

Question #4: What is working well and not working so well in implementing collaborative learning groups in the large lecture course? In the fall of 1997, we made major course revisions to our astronomy course. The goal was to increase student participation and attendance by incorporating frequent small group discussion activities into the lecture environment. We developed a series of sixteen mini-labs that students completed working in groups of four. Each activity required between 20 and 50 minutes to complete with each student receiving the group score. Both quizzes and examinations contained a group component.

To evaluate the implementation of this innovative approach, we coerced ten faculty from across campus to audio-tape exploratory focus group discussions with groups of up to 20 students. A survey of 10 hours of audio-tape revealed that: (1.) students enjoy the alternation between activity and lecture; (2.) students report learning from each other; (3.) students would prefer to have a more detailed reading list than was initially provided; (4.) the structure of the exam needed to be more clearly defined; and (5.) students would like to have more specific roles and responsibilities in their collaborative learning groups. The results of these interviews were reported to the class as a whole and, where feasible, changes were implemented to address students' concerns. End of course surveys indicated both that some of the students' concerns were addressed by our mid-course corrections and that the students appreciated the process. Students informally commented that this experience demonstrated that the instructors cared about students' learning.

DISCUSSION

It is our thesis that the college learning environment can be substantially improved by making decisions based on data. As scientists, we have powerful analysis skills that can inform and improve the classroom environment when directed at the issues of teaching and learning. As demonstrated by the above examples, focused classroom investigations can provide insights not available through casual observation. These insights can then inform curricular or instructional practices towards achieving the ultimate goal of improved student learning—a process called action research. Rather than focusing on generalizability as a means of adding to the educational literature base, action research provides a paradigm for both documenting our efforts to improve our classes AND communicating successes and failures to our peers thus elevating teaching to a scholarly

activity (Boyer, 1990 and Rice 1996). Moreover, by including observations of student behavior and student attitude surveys in addition to measures of student achievement, we have gained substantial insight into what our students expect. Probably the most exciting aspect is that not only is our instruction improving, but also students appreciate having their perspectives acknowledged as partners in the learning process—a partnership that carries with it both rights and responsibilities.

Finally, we live in a time when, aside from the personal desire of professors to see their students learn as effectively as possible, there is increasing external pressure to demonstrate competence in teaching to stakeholders in education. Action research is an approach to teaching that simultaneously leads to the improvement of instructional practices (Angelo, 1991) and the creation of products that comprise a teaching portfolio to be used by faculty and administration as tangible evidence of teaching success. As colleges and universities are beginning to place at more emphasis on effective teaching, action research methods and results provide a recognized structure for demonstrating reflective practice.

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