COMMUNITY-BASED LEARNING: MOTIVATING ENCOUNTERS WITH REAL-WORLD STATISTICS

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We explore the effects of optional community-based projects on students and particularly on motivation and learning in an applied statistics course. We consider how the nature and structure of community-based projects enhance student learning in a constructivist classroom. We critically assess the intellectual challenges of a community-based project and the nature of the statistical problems that arise. We review students' evaluations and our own estimation of their ability to learn from experience and from the community.

INTRODUCTION

In a previous article (Root & Thorme, 2001), we describe our success with community-based research projects in a college-level applied statistics class. We detail how we find such projects and organize them for maximum benefit to the students and the community. In this article we expand on how the nature and structure of these community-based research projects facilitate realizing our most important learning objective for the course: students' gaining an appreciation for the statistical process and the nature of statistical inquiry. We emphasize a practical understanding of descriptive statistics, sampling, design, and basic inference which students construct in the context of the real-world experience of community-based projects. Offering semester-long community-based research projects allows us to implement the best practices for instruction generated by the burgeoning literature on cognition. We base our understanding on a constructivist approach to cognition (see Driscoll (2000), Garfield (1995), and Lovett & Greenhouse (2000)). We consider how motivation, assessment, skills practice and developing a framework for knowledge are involved in these projects and lead not only to the development of statistical understanding but also to many aspects of personal growth, particularly the ability to function as a member of a collaborative team. Garfield and Ahlgren (1988) provide an excellent survey of the literature investigating potential pitfalls in teaching statistics. Garfield (1995) and Lovett and Greenhouse (2000) have carefully and insightfully considered the application of many constructivist principles to the teaching of statistics in general.

Quantifying the value of projects as teaching tools

Several variables present challenges for the design of a statistical study to test the effectiveness of projects in the teaching of statistics. Because the authors allow the students themselves to decide whether their own semester project will be community-based or not, a study based on our own sections cannot provide random samples. The work of Stukas, Snyder and Clary (1999) suggests that random assignment of students to community-based projects is pedagogically questionable and may harm students' future willingness to volunteer in the community. On the other hand studies across sections introduce the confounding variable of instructor while not offering any improvement in randomization. (Our students are not assigned randomly to various sections.) Because of divergent goals and expectations of instructors, it is not reasonable to expect students of different instructors to perform uniformly on any particular assessment instrument.

Despite this difficulty, students indicate on evaluation forms that they found the project to be a valuable learning experience. We designed a supplemental evaluation form for the semester projects and found the students' answers to questions about their interests and learning process to be very helpful. We will discuss their responses to our questions below.

HOW DO STUDENTS LEARN?

In this section we consider how students learn and describe how our community-based projects conform to pedagogical recommendations that flow from a constructivist theory of learning. This theory holds that learners create their own understandings of the material. Constructivist pedagogy encourages problem-solving, collaboration and attention to the attitudes and beliefs of the learner in the development of knowledge. Some implications of this understanding are outlined below; several of which are adapted from Garfield (1995).

Students construct knowledge

Just as students of statistics learn that data are "numbers with context" (Moore & McCabe, 1998), instructors of statistics do well to heed the dictum that knowledge is information with context. As Garfield states: "students will understand the material only after they have constructed their own meaning for what they are learning."

Most importantly, students build this knowledge on a framework of their previous understanding of statistics. This prior knowledge is often faulty. In particular, college students cherish naïve understandings of causality, representativeness, association, and distribution (Nickson, 2000). We have also noted students' misconceptions of essential concepts such as means, standard deviations, and probabilities.

Driving questions situate learning

Singer, Marx, and Krajcik (2000) point out that concrete issues or problems are useful motivators in the sciences, as concrete goals can impel the students to master abstract material. Multistage learning, where concepts build on one another, is especially affected by this kind of motivation. The first interim report for our semester projects asks the students to construct their driving question and outline how they will answer it. This is the first issue the team must grapple with, and if they are successful in reaching a consensus on a driving question, then the entire team has bought into a motivation for its success.

In addition, focusing on a question more than a technique models the nature of statistical inquiry. For example one team recently studied the effect of participation in a summer day camp program on children's ability to resolve conflict. This required application of a matched pair design to compare assessments made by counselors at the beginning and end of the program. Another team sought a trend in the prevalence of functionally disabled residents at a local homeless shelter. This problem involved time series and regression.

Students learn by practice and sharing their knowledge

The techniques required of students vary broadly among the applications. Thus although each student is not exposed to every statistical technique in their project, the variety of techniques practiced by the students can motivate the entire class to take each technique more seriously as they learn it from the textbook. This is leveraged by presentations to the class by each project team, underscoring the real-world utility of each technique for the entire class.

The group work aspect of these projects adds an important dimension to the learning experience. Our course includes two important group work opportunities before the students must choose their team for the semester project, as well as numerous informal opportunities to collaborate. The students are encouraged to work with a variety of partners and consider whom they want to work with on the large project. They must effectively delegate responsibility and communicate ideas in order to accomplish the goals of the semester project. They also are rewarded for fruitful brainstorming and the ability to derive motivation from their team.

Students learn better if they receive consistent, timely, and helpful feedback on their performance

The projects are structured with three interim reports and a final report. See Root and Thorme (2001) for a schedule. The interim reports are not graded; they are reviewed and typically receive ample remarks to guide the students to the next signpost. Each commented report is copied before the original is returned to the students. The copies are used in assigning the final grade as a record of the quality of the original report and a baseline for judging the quality of the team's response to the comments. Groups discuss the reports with the instructor, which provides

an opportunity for reflection on their statistical understanding as well as the social significance of these projects.

We aid our students to grasp sophisticated conceptions by constructing a temporary edifice of knowledge, or "scaffolding"

The concept of scaffolding, described by Singer et al. (2000) is useful in structuring our projects. The students design their data collection and preliminarily consider its analysis when they know only descriptive statistics. We encourage them to engage in visual explorations of their data, since a graphical representation may yield results which challenge the students' assumptions about the distribution and its implications (Nickson, 2000). Students' familiarity with descriptive statistics by this point in the semester is adequate for design of surveys and appreciating the kinds of questions one might ask and answer. The inferential statistics they learn later in the semester offer more powerful techniques for answering those questions and more nuanced understanding of the meaning of the answers.

Indeed, for many students, the bulk of the material covered is scaffolding that will be lost through disuse, leaving behind a core of higher level understanding of the meaning of basic statistical ideas like the center and spread of a distribution, and a nuanced understanding of commonly used tools of inference: confidence intervals and hypothesis tests.

Social relevance motivates students

Offering students a choice of projects allows them to pick one that suits their own interests, which engages students in this semester-long undertaking. Student evaluations and informal conversations confirm that students are motivated by community-based projects for a couple of reasons. First of all, students correctly perceive the projects as being of importance in the outside world. Their community partners (and the in-class presentation of projects by the College's Outreach Center Director) make it clear that more rests on these projects than just a grade, which drives students to work harder. The motivating effect of social significance applies both in our experience and in general (National Research Council, 2000).

Secondly, students want these projects to matter. When asked why they chose community-based projects, they overwhelmingly cite a desire to "help" or "make a difference." The drive to have an impact through their academic work fits this age group's "tendency to introspectively see oneself as personally responsible for, and uniquely capable of, correcting the social ills of the world" (Dunlap, 1997, p.56). This generalization does not apply equally to all college students, of course, but it fits some of the students who choose to do the community-based projects in this course.

DISCUSSION

This cursory overview shows some of the ways in which structured, semester-long community-based projects help college students learn statistics in an applied statistics class. This structure, which involves keeping the projects on pace with the course and requiring that students reflect on their knowledge at several points, is one that we have adopted after tinkering with the design of these projects in several offerings of the course (see Root & Thorme (2001) for an extended discussion). In the future we will continue to explore these ideas and more carefully consider the role of reflection and emotional engagement in the student's construction of meaning.

No method is effective for all students

There are students who are uninterested in statistics and/or in community service that will not be swayed from either or both positions by an instructor, no matter how dedicated or talented. The optional nature of our community-based projects allows those not interested to avoid doing volunteer work and receive an acceptable level of responsibility for the mastery of statistical concepts in order to receive credit for the course. Indeed, many students, inspired by the goals of their classmates, undertake projects for college organizations that are comparable in their richness to the community-based projects. Examples include studies of dining patterns of students for dining services, contribution trends for the athletics department, and student reactions to the

campus alcohol-awareness program sponsored by the counseling center. Although not every student finds their semester project a transforming experience, the positive impact community-based projects have on the class makes them worth the considerable effort required to implement them effectively.

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