REGRESSION AS A FOUNDATION FOR A QUANTITATIVE ELEMENTS COURSE FOR THE LIBERAL ARTS

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Liberal arts students with insufficient quantitative development for entry into elementary statistics were offered project-based sections of College Mathematics in which regression modeling was used as a tool for motivating the study of standard functions as descriptors of real data. Success rates were higher in project/modeling sections with no required textbook than in traditionally-taught sections using a textbook as primary instructional resource.

In the years since ICOTS 4, significant advances in availability of modeling technology have allowed correspondingly significant curriculum changes. With the help of these new tools, statistics educators now are able to address the following problem: Students in large numbers arrive at US colleges with insufficient quantitative development for immediate entry into the elementary statistics course required in several majors in the liberal arts. Specifically, algebra skills are poor and neither the notion of slope nor the general function concept is understood. But more fundamentally, basic quantitative thinking skills are lacking. Students have few common experiences which can provide context for quantitative problems. Numeracy is considered unimportant. The problem is not restricted to US students (e.g., see Thompson, 1991).

Most of these students are products of pedagogical styles which depend on the memorization of algorithmic processes for success. As do many of their peers around the world, they view math and statistics as lists of rules to be memorized, selected and applied in response to problem types whose solutions are demonstrated in immediately adjacent sections of a text. The disciplines are seen as bearing little relation to reality and devoid of context within their own lives. Behar and Ojeda(1997) observe, "[N]onstatistics majors will learn statistics only if the usefulness of it in their professional life is made clear to them." This statement can be applied in a broader context to include attempts to bolster the quantitative development of liberal arts students to prepare them for understanding statistics.

The way in which many of us have traditionally used the textbook as our primary instructional tool may have compounded the problem of perceived irrelevance. *Pursuing Excellence*, a report on the Third International Mathematics and Science Study, points out some interesting differences in instructional paradigms between the US and countries such as Japan where math instruction is more successful. One of the striking differences in middle-grades instruction is the proportion of class time during which the textbook is used by students. That proportion is about two percent in Japanese classrooms but much higher in less successful countries. In the US, middle grades math classes use the textbook about fifty percent of instructional time (Peak, 1996).

The recent availability of inexpensive calculators and computers allows new options for laying mathematical foundations. The University of South Carolina Spartanburg has developed a successful approach which uses regression modeling as a foundational tool for describing real data which students perceive as applicable to their lives. The course, titled College Mathematics, was formerly taught with standard texts, e.g., Lial and Miller. In the version of the course that makes maximum use of available technology, students have access to Quattro Pro or Excel, X(PLORE), BASIC, Minitab, and the TI-82 or -83 calculator. They complete group and individual projects which range from analysis of local infant mortality rates to the construction of a personal long term financial plan. Most choose WordPerfect or Word to produce required reports. In addition to traditional tests and a comprehensive final exam, assessment tools include portfolios, presentations, and a term project.

For the project-based version of the course, there is no required textbook . A packet of activities and projects accompanies a forty-plus page booklet containing the topics to be covered. This written material is similar to Japanese instructional materials as reported in Peak, 1996. The booklet lends structure to the activities and projects. It contains, however, insufficient drill problems to support an instructor who might opt to spend an inordinate amount of class time in drill and practice. This intentional omission thus forces practice to occur in the context of an activity involving real data. Fewer problems are worked than in the traditional course, but, as statistics instructors such as Moore (1997) have noted, the payoff is large: “[A]lthough we may ‘cover’ somewhat less material when we increase interaction...students appear to emerge with a greater store of usable knowledge.” Student opinion of the approach has been quite positive.

With the new technology, a variety of functions or models can be introduced through regression. In completing the projects, the students are exposed to all functions traditionally taught in introductory college mathematics: linear, quadratic, higher order polynomial, rational, exponential, logistic and logarithmic functions. Probability and statistics comprise a small portion of the course. Although the concept of regression is central to implementation of the course, the statistical aspects of regression are postponed for a more advanced course.

Another point of comparison in this approach involves pedagogy. The pedagogical style suggested is more student centered than that of traditional classes. Generally, a concept such as linear modeling is introduced via a small individual project before any lecture or discussion is attempted. When the project is submitted lecture/discussion is held using the project as a point of departure. Then the instructor assigns a larger group project which involves the same concepts. The individual project is graded and returned for corrections and for entry in a personal portfolio. The group project is then submitted, graded, discussed and returned for corrections and portfolio entry. Next, another individual project is assigned. Ideally, this second individual project extends understanding to more advanced concepts and the cycle continues. Much of the student's work is done out of class.

Currently, data are available on fifty College Mathematics sections of which twenty-five used the project/modeling approach. Median student success rate for traditionally-taught sections is 57% as compared to 75% for the project/modeling sections. (Here, and elsewhere in this paper, student success rate for a section is defined by the number of passing students as a percent of initial enrollment in the section.) See Figure 2 below for a descriptive summary.

Since we still have not solved the problem of students postponing matriculation in statistics, data on subsequent success is meager. The tracking of fifty-three students from College Mathematics through the required statistics course reveals the following: Of eighteen who succeeded in the traditionally-taught sections of College Mathematics, fourteen (78%) succeeded the next semester in statistics. Of thirty-five who succeeded in the project/modeling sections, twenty-nine (83%) succeeded the next semester in statistics. If one can accept these percentages as indicative of long-term results, the projected median two-term success rate through statistics for students initially entering a traditional section of College Mathematics is approximately 45%. For students initially entering a project/modeling section of College Mathematics the rate exceeds 60%.

Figure 2 Summary statistics for success rates in project-based College Mathematics (SMTH 120) sections vs. traditional sections. “Project-based” sections, coded “6”, are those in which at least six projects were assigned and graded. Output is edited from Minitab.

	Project?	N	MEAN	MEDIAN	MIN	MAX	Q1	Q3
PctPass	0	25	56.47	57.14	14.29	94.12	48.68	68.47
	6	25	73.58	75.00	54.55	95.45	63.82	81.78

Summary and comment: Our experience indicates that project-based instruction is effective for liberal arts students possessing insufficient quantitative development for entry into elementary statistics. Current data indicate higher success rates for students in project/modeling sections than for students in traditional sections. The ease and speed of regression modeling with today's technology may satisfy today's student's expectation of immediate gratification. Perhaps this is a factor in the success of the project/modeling approach.

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