TEACHING ACADEMICALLY DIVERSE GROUPS

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Imagine entering the classroom the very first day of the term and realizing how academically diverse a particular student body is. You would likely be caught unprepared for this, as I was this past September, and a first thought might be to quickly evaluate how much the prepared syllabus must be reengineered. Practitioners of the "Management-by-Process" philosophy attributed to Deming would immediately opine that understanding and managing variation is fundamental and then view a heterogeneous classroom as both an opportunity and a challenge to explore and develop pedagogy that enhances overall student performance. Others, perhaps more pragmatic or perhaps less risk assertive in the classroom, might immediately get a sinking feeling, and then try to contemplate how the course might be salvaged. This paper will explore various possibilities for making the best out of a situation in which a difficult constraint has been imposed.

INTRODUCTION

Heterogeneity takes many forms in academia and our University of Westminster colleagues have clearly articulated the socio-economic diversity observed on their campus (see Porter *et al*., 2006). Other forms of diversity that impact on the pedagogical approaches we take can be described as either cultural, gender- or ethnic-related, age-related, or dependent upon student capability and/or student major area of interest. Each of these factors is readily observed in undergraduate day session programs. In undergraduate evening session programs there are two more forms of diversity, work-experience-related and family-related. In graduate school programs there is yet another form of diversity and this is related to prior educational preparation. Although the recommendations that will be offered can be applied more generally, this paper will be limited to an assessment of prior educational preparation, i.e., "academic diversity" as the operational definition of heterogeneity. In particular, this paper will outline one effective approach aimed at maximizing the teaching of the required graduate-level statistics core course in a B-school setting. Other approaches may also be valuable.

BACKGROUND

Dealing with student academic diversity in the form of heterogeneous prior educational preparation presents a challenge to the most gifted and experienced of teachers. One is reminded of a very old cartoon from a statistics journal that shows a person in a kitchen with one hand in the cold ice box and the other hand on the hot oven and the caption says something like, "Well, I feel normal." But one cannot "feel normal" when facing a graduate B-school class the very first night of the semester last September and learning only through an introductory survey that of the 21 students nearly half of them (10) were enrolled in a statistics course for the very first time while the slight majority (11) had already completed an undergraduate level course.

It was clear that I had to make some changes in the way I usually teach. In prior semesters there were typically a few students without previous statistical background and one could argue on Jeremy Bentham's utilitarian principle (1789) to "adapt to the greater number to achieve the greater good." Graduate level courses at Montclair State University are capped at 25 so the one, two, or perhaps three individuals could always be given extra assistance and this approach provided resolution to a pedagogical dilemma. Based on my experiences I believed two approaches were obviously inappropriate. One should not address academic diversity by teaching to the least prepared or weaker level of the class because it would bore the more accomplished students and, at the same time, one should also not be teaching to the most capable and best prepared students because it would likely lead to catastrophic results among the class's weaker and least prepared.

In assessing the situation, I conjectured that effectively monitored student teamwork and "creative" faculty involvement would help resolve the problems such an academic diverse classroom posed. Neither student teams nor being readily accessible to the students were new to

me. I had used student teams in the introductory graduate core course for well over thirty years and I pride myself in always being available to my students. In my course management, in addition to assuring the students of swift email replies or prompt telephone responses, I decided to take accessibility one step further, I increased my office hours and publicized a "specially designated" office hour for students of this class. By demonstrating I cared, wanted them to succeed and would be available, I reduced the anxiety level for the half of the class that had no prior educational experiences with the subject.

TEAMWORK: AN ESSENTIAL ELEMENT FOR HANDLING ACADEMIC DIVERSITY

It has been a long-held belief that students must learn to work in groups. In life's experiences nobody works completely alone and students must learn to deal with dependencies and interdependencies. The use of teams in a required graduate-level core course in statistics provides the members with several benefits. A team approach serves to sharpen the members' already developed interpersonal skills. In addition, working in student teams can be more fun, help reduce anxiety in a subject like statistics, and build camaraderie in the student body.

In my required graduate-level core course the teams have several major responsibilities. The members work together on classroom exercises, in submitting homework assignments, in writing the take-home portion of the midterm examination, in preparing members for the individual, in-class concept questions portion of the midterm, in developing a semester-long project report and preparing members for their individual oral presentations of the project report findings. In addition, in developing the project report the members are being prepared for their individual, in-class final exam.

Forming the Teams

When forming class teams for a graduate course two issues must be considered; the first deals with the member selection process and the second deals with member composition. It is essential that the students consider the selection process appropriate and fair and it is essential that the issue of diversity be properly addressed in the team composition.

The selection process is a function of intended team size. Allowing the students to select one or more of their team members amongst themselves seems preferable to a lottery selection process. However, the faculty member must reserve the right to monitor the results and finalize that selection process by moving students in or out of teams to achieve balance with respect to academic diversity.

Over the years I have experimented with different sized student teams in a variety of undergraduate and graduate courses. Student teams of size two facilitates logistical coordination for outside-of-class meetings and I have formed and successfully used them in some courses for mini-case assignments and for projects of limited scope. In other courses, I have also used student teams of size two to work together in the classroom on multiple-choice portions of exams and in exams requiring the interpretation of computer printout in regression model-building. Nevertheless, teams of size two are simply too small for effective work on large scale term projects. Teams of size three or four provide that "critical mass" and, typically, teams of those sizes enabled absorption of the few students without prior background.

For the heterogeneous class of 21 students enrolled in the September 2005 semester, three teams of four members and three teams of three members were formed. Each of the even-sized teams had two members with previous background in statistics and two members with no prior background. Although lacking balance, each of the odd-sized teams each had at least one member with prior statistics background.

In addition to size of team and the need for balance with respect to handling academic diversity, a third issue regarding team composition concerns academic interests. Are teams more effective if their composition is more "specialist" than "generalist," or vice versa? I contend that it would only be more interesting if not better for the team members to all have the same major, say finance, if the term team project were one that dealt specifically with a financial data set for some group of companies or industry. For broader-based data sets, however, a more "generalist" approach would allow for a mix of perspectives that might be of greater value to the team

members. The issue of academic interests was thus deemed of less importance than that of team size and team balance with respect to academic diversity.

Managing the Teams

Team members must know what is expected of them individually and collectively. A course contract between the faculty member and the students should incorporate expectancy in terms of team performance. The learning goals and objectives of the course must be stated in this contract so the students know from the opening class what the intent is, what they can expect and what the instructor expects. Not only should the students be rating the course and faculty member at the end of the semester, as is suggested if not required in most institutions, it is also important for the members to evaluate their own performance and that of each teammate at the end of the semester. This should be made known to the students from the beginning.

The teams must be monitored in and out of class. "Walking the room" and observing team members participate in in-class assignments accomplishes the former; officer hours, the telephone and the Internet can be used to accomplish the latter.

When dealing with this thoroughly academically diverse student body the particular challenge for me was determining how I was going to allocate my time, in and out of class, to manage these teams effectively; in short, how I was going to alter my teaching style for this class.

Teaching to an academically diverse group does not alter the fact that "learning" results from "doing," nor does it impact on my long-held belief that classroom and homework exercises should relate to actual data whenever possible, that graduate students should work with rich data sets and be encouraged to think critically, looking beyond the statistical analysis of the data to an interpretation of results in a managerial context which they can articulate in memo format. Regardless of the composition of the class, to develop our students' analytic skills we must help them "learn how to learn." Whenever presented with a set of univariate numerical data, they must immediately think of plotting it, observing it, computing from it, and describing it. Such data exploration endeavors will enable them to develop their statistical thinking abilities.

In retrospect, perhaps the largest impact that this academically diverse class had on my teaching style was that I believed I needed to do far more lecturing than I had intended. Should my January 2006 class be "academically homogenous" with respect to prior background, I would like to structure the course in a manner that would empower the students to learn more on their own and with their teammates. (I will report on this at ICOTS-7.) But this could not be done here. I did more lecturing, more hand-holding, and more team-monitoring, both inside and outside the classroom.

By monitoring the teams at work on class assignments I was able to observe team interactions, listen to what was being said and see what was being done, answer questions and give suggestions. This helped me assess learning. The teams of size three worked together. The teams of four divided their in-class assignments differently. One team seemed to involve all members and other two preferred to work in pairs and pool their results. It was good to see those with prior experience in statistics working with teammates that had no prior background and it was good to see the camaraderie that evolved within the teams. Surely such camaraderie had to have been beneficial to the students with weaker backgrounds in preparing the take-home portion of the midterm as well as the team term project, and in studying for the in-class exams.

With respect to managing the teams outside of class, the specially designated office hour served to reduce anxiety and some of these working students visited my office more frequently before our evening class, perhaps sacrificing dinner. I had very frequent email correspondence with one of the students throughout the semester. Others contacted me sporadically. Some individuals acted as "team captains" and called with respect to questions pertaining to their assignments and projects.

In sum, it was clear that I did have more outside-of-class involvements with this academically diverse group than with the other, more homogenous graduate student classes I had previously taught.

The biggest disappointment was that a team of three students decided to withdraw from the class owing to increasing personal obligations and job-related responsibilities that began to conflict with their ability to communicate and work together outside the classroom effectively.

The members withdrew from the course soon after I had returned their graded midterm examinations and they recognized that they could not find the time to appropriately work on the term team project.

Perhaps, for academically heterogeneous groups one needs to build in a reward system that would insure even stronger teamwork between the students with and without a prior background in statistics. Frequently, it is the early part of the semester where the difference in background is observed. As the newcomers begin to learn statistics, read the text and work out examples with teammates and individually, the performance of those with stronger quantitative skills may reach or even surpass some of their teammates with prior subject background.

And this actually happened in my academically diverse class.

ASSESSING SUCCESS IN HANDLING ACADEMIC DIVERSITY

Most institutions require tenure-track or promotion-track faculty to receive both formal peer and student evaluations of their teaching. If used properly, such feedback can help the faculty member evolve as teachers. At Montclair State University feedback from the student evaluations are provided to the faculty during the first week of the subsequent semester. (At the time of this writing the evaluations from the 18 students completing the very academically diverse course have not been seen. A summary of this analysis along with any comments from these students will be discussed at ICOTS-7.) For immediate feedback, however, one could evaluate solicited or unsolicited written commentary from the students.

Initial, Informal Student Reaction to the Course

Below are the three email messages I received (Emails 3, 4, 5) following my announcement of posting both final exam grades and final course grades (Email 1) and following my note to one graduate student (“B”) who had taken an undergraduate statistics course years before and had scored a 99 on the final exam (Email 2). The other two students who responded (“L” and “T”) had not studied statistics before.

EMAIL 1 --TO THE CLASS

“All grades are now posted on Blackboard. The stem-and-leaf for 18 test results were as follows:

4 4
5
6 *03*
7 06*7*8
8 *0*1
9 0*012*55*58*9

All best wishes for a happy holiday. I hope you can relax a bit and enjoy life away from campus for the next month. Mark Berenson”

EMAIL 2 -- TO STUDENT B

“Your work was truly outstanding this semester. Please know I am not at all surprised by your 99. All best wishes, Mark Berenson”

EMAIL 3 -- RESPONSE FROM STUDENT B

“Thank you very much for the compliment! It's as much a reflection of you as me so thanks for teaching and structuring the class the way you did.”

EMAIL 4 – UNSOLICITED FROM STUDENT L

“First, thanks for the semester. I was very nervous going into the semester about the statistics class because I had not studied this subject before. But I applied myself and kept to it and actually enjoyed it. … This was my first "numbers" test in a very long time, maybe 9 years. … even after flubbing the last part [regression analysis], I feel I

accomplished so much in your class. Thanks for all your teachings and prompt replies back. You made "stats" very doable and accessible."

EMAIL 5 – UNSOLICITED FROM STUDENT T

"Throughout the year you reiterated your request for class feedback. I enjoyed the group midterm and project. I definitely agree that it was more beneficial to work with a group than individually. Hearing other interpretations and angles on the same topic definitely made me think outside the box and learn the subject matter a little more in-depth. I have never taken a statistics class before and thought I would be overwhelmed. The class was challenging but I feel I learned a lot. … Overall I definitely enjoyed the class."

For me, teaching the academically diverse graduate class in September 2005 was one of the most challenging experiences in a lengthy academic career. From my personal assessment of student reaction upon completion of the final examination and from the above informal feedback, I consider the class to have been conducted successfully. I await the official student evaluation feedback next month.

Assessing Student Performance in the Course

I opined that the best measure to assess what the students learned in the course was to evaluate their performance on the 150-minute final examination that they took individually in the classroom. The examination had three broad questions evolving from scenarios, one dealing with a comparison of differences between two proportions, one dealing with a completely randomized designed experiment with four treatment levels and requiring *ad hoc posterior* analysis, and one involving a complete descriptive and inferential simple regression analysis (with implications on how the model could be further improved). Microsoft *Excel*-based computer printout was given for the second and third problems and the students were required to write memos for all three, articulating their findings and drawing conclusions. In response to a question posed to the class one week before the final, none of the nine students with prior statistical background could recall having previously studied ANOVA in their undergraduate class and none could recall having previously studied regression from an inferential perspective.

To facilitate a comparison of differences in the final examination performance between the two groups of students I took the liberty of distinguishing them in the stem-and-leaf displayed in Email 1 above by using "*light italics*" for the test scores achieved by the nine students with no prior background in statistics. (Note that in the initial email sent to all the students no such distinction was made.)

The left-skewness indicated the collective class results were encouraging. The five-number-summary is: 44, 74.5, 85.5, 95, 99. The median (85.5) and midhinge (84.8) are respectable for an introductory graduate-level core-course and the midspread (20.5) shows reasonable homogeneity from such an initially academically diverse group.

More importantly, and as is obvious from the above stem-and-leaf, there appears to be no difference in level of performance by the two groups. A confirmatory Wilcoxon rank-sum test yields an approximate *p*-value of 0.93.

A Reflection

Although I am pleased with the results and the way my managerial adaptations impacted on learning for this academically diverse group, I was surprised. Two questions must be addressed: (1) Why was there such diversity in prior background preparation that heretofore was not experienced? (2) Shouldn't prior background preparation have mattered? Interestingly, the response to the first question may affect the second.

The Graduate School at our university had decided to impose more stringent waiver requirements owing to complaints by faculty teaching advanced courses regarding prior student preparedness. Thus I learned that my nine "experienced" students had either received undergraduate grades of C+ or below or had taken their course more than a decade ago. Moreover, the course previously taken may not have covered the same topics or have been conducted at the same level. Perhaps then, the only advantage this group of students really had was they all had already passed statistics before and that should have reduced some of their anxiety.

The second question is one of greater personal interest and has potential far-reaching implications in statistics education, subsuming issues of academic diversity and other forms of heterogeneity in our classroom. It is easy to say that 60 percent of the course material covered on my final exam (ANOVA and inferential regression) was new to all but it is harder to contemplate why prior exposure to the other topics as well as prior exposure to a previous successfully completed course didn't give the experienced group some additional advantage.

If we want all our students to be statistically literate consumers and, in addition, we want our B-school graduate students to be users so that they can effectively assist in a decision-making process, we must explore ways to insure that key concepts are learned, understood and retained. I know now something about what my students knew in late December 2005 – a static snapshot in time. What we don't know is what such students will retain by late December 2006, or by late December 2010. A consensus on what must be learned and retained will lead to pedagogical research on how best to achieve this. Some concepts will be general, others discipline-specific. Such research on how to most effectively convey this information will make an invaluable contribution to the statistics profession.

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