Presentation of Quantitative Literacy Materials in a Math Education Course

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1. Introduction

American statisticians interested in education have longed to see statistics taught to students in the junior and senior high schools of America. A major obstacle to the attainment of that goal has been the lack of materials specifically designed to reach that audience. This obstacle has been overcome by the completion of the Quantitative Literacy Series which consists of four books entitled *Exploring Data, Exploring Probability, The Art and Techniques of Simulation*, and *Exploring Surveys and Information from Samples*. Teacher's editions of the books are also available as is a videotape and computer software for Apple or IBM PC compatible computers. These materials are statistically sound and useful for students in the age range of 13-18 years.

The next step is to encourage use of the materials. The ASA's Quantitative Literacy Project has endeavored to acquaint junior and senior high school mathematics teachers with them through in-service workshop programmes held at various sites around the United States. Reports on some of these workshops can be found in the newsletter *The Statistics Teacher Network* (October 1989). Workshops like these are no doubt important. An alternative approach would be to introduce teachers to the Quantitative Literacy materials as part of the undergraduate training of Education students. This alternative approach has been tried at the University of Missouri.

2. General considerations in course development

In the past at the University of Missouri, Math Education students were required to take a calculus-based course in Mathematical Statistics. One might question whether such a course would meet the needs of future teachers. We have anecdotal evidence of current teachers whose bad experience in their undergraduate statistics course makes them less than willing to try to teach statistics to their own high school students.

I would suggest that the statistics course for Math Education students should be taken during their junior year, after they have completed the calculus sequence and have taken some courses relevant to education, such as psychology. I feel that it is important to have the students advanced enough that they are starting to think of themselves as teachers-to-be. They should be able to view material that they are learning as useful for presenting to their own students in the future as well as being of personal use. If this is a reasonable expectation, then it can be argued that much of the material in a standard "math stat" course, such as moment generating functions, transformations of random variables, derivation of theorems, etc. would not satisfy these criteria of usefulness.

We have modified our course so that about 75% of the time is devoted to traditional topics in probability and statistics and about 25% to studying the Quantitative Literacy (QL) materials. This allows the students to have some theoretical understanding for the methods presented in the QL materials. By acquainting the Math Education students with these materials at an early stage of their training, it is believed that they will be more likely to use them when they have the opportunity.

3. The course at Missouri

I have my own thoughts as to what would constitute a good syllabus for a statistics course for Math Education students, but do not have complete autonomy in the matter. Although the course is taught under the auspices of the Statistics Department, it is prudent to take into account the ideas of the faculty in Education. They feel that the material taught should be a "mathematical statistics" course at the level of textbooks such as De Groot or Hogg and Tanis. My feeling is that this is *not* the proper level for these students. In general, one might say that the level of a course is not the proper one for a particular audience because (1) the students are not strong enough (with respect to mathematical ability) to handle it, or one might say that it is not proper because (2) it does not meet the needs of the students. As mentioned above, I believe that reason (2) holds in this case. However, I have perceived a resistance on the part of the Math Education faculty to a course that is not mathematical statistics. I have gotten the message that they do not want a "watered down" course and that they want their students to take the same course as the regular math majors.

We have reached a compromise in this situation. We have used a "math stat" book, namely Hogg and Tanis, but have omitted topics such as moment generating functions to allow time for inclusion of QL materials.

Another issue to be addressed would be how much time should be devoted to QL materials. At one extreme, one might assign these as outside reading, perhaps requiring some written report on the reading at the end of the semester. At the other extreme, one might require that students work out and hand in virtually all the lessons (or "applications") in the four QL booklets. I believe that a middle course should be taken. Approximately 25% of the time is spent on QL materials and the balance on standard material. This is a three semester hour course. It includes a "lab". One day a week we have a double class period (two 50-minute periods) where we go through the QL materials as a class. During this time, we have dice, cards, m&m's etc., push back the chairs and get a little noisy. In my case we have the lab once a week and have (50-minute) lectures the other two days for a three credit hour class. (Of course it would

be possible to design this to be a four hour course. There could be one additional hour of credit given for the "lab" portion of the course with no decrease in the basic statistics course usually offered.) I also use the "lab day" for giving examinations. This gives me about 30 lecture periods and about three lab periods to spend on each QL book. We can't (and probably shouldn't) get through all the lessons in the QL books, but we do do some on each type of activity. As part of the homework, students are asked to answer selected questions from the QL books. It is interesting (and somewhat humbling) to note that they do not come close to getting all the answers correct. Many of the QL questions ask the students to guess what might happen in a given situation. When appropriate, I ask my students to give exact answers rather than guesses. For example, in a binomial situation, the problem might ask for a guess as to how many basketball free throws a player might make. I ask the students to give the actual expected value.

The QL books are good, but it is impossible to keep them totally up-to-date when trying to use data based on "Top 40" music or recent movies, for example. For this reason I feel that it is important for the students to make up their own QL-type lessons. The final homework assignment is for them to make up two lessons (or "applications"), complete with motivating introductory example, instructions, and questions. I also require that they give answers to their own questions. (Here too I find that some students cannot answer their own questions correctly.) In the few years that I have taught this course I have received some creative and interesting lessons.

4. Student response to the course

I have taught a version of this course four times with roughly 10 students each time. These students were primarily undergraduates, many of them juniors when they took the course. I did get some immediate feedback from them concerning their initial impressions of the course. In this last spring I explicitly requested them to give me written comments about the strong and weak points of the presented materials. They were asked to comment on the areas they most enjoyed and the areas that they felt that they would most likely try to use when they are teaching. The most common answer was the Simulation materials. Some aspects of this were felt to be tedious, but they recognised that the use of the computer for simulation would overcome this objection. The least favourite was Exploring Surveys, although that might reflect the fact that we spent less time in that book. One student was quite negative about the whole concept, but most comments were positive. A few comments follow:

> "The labs were quite helpful. They were more like real-life encounters of statistics. The applications based on articles found in the newspaper were very good."
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> "QL will help us more than the other material in the brown book [Hogg and Tanis]."
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> "I enjoyed the QL materials. I thought that many of the activities were helpful, but I think that some of the discussion got kind of long and overdrawn."

> "I thought all four of the books were very helpful - especially to future teachers. And I loved the creativity."

In general the students seemed to appreciate the real-life nature of the QL materials and understood their potential usefulness to a future teacher.

While I think the initial responses of the students in the class are important, I am more interested in long-term follow up, i.e. in how useful they find these materials when they themselves begin teaching. I did manage to get addresses for 8 of the 17 students who took the class one and two years ago. Of these, five responded to a letter and brief questionnaire that I sent to them. Unfortunately one is not in teaching at this time. The four other students who responded indicated that they might be making use of the QL materials within the next year or two. Two already had used some material from Exploring Probability. Three had talked with their colleagues about the QL materials. While this is a very small amount of information, it is encouraging.

5. Conclusions

I believe that school teachers will benefit from being exposed to QL materials as a part of their undergraduate education. It seems likely that statistical concepts will be included at a local level if a teacher has been exposed to usable materials.

The course we have developed is far from perfect. It is too early to tell what the impact will be in the schools where these mathematics teachers will work in the future. I believe that the concept of presenting these QL materials as a part of the undergraduate education is sound. I would encourage others to try to employ such a strategy and to share with others their successes and failures so that we can all improve our curriculum.

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