STRIKING A BALANCE IN THE TEACHING OF QUANTITATIVE COURSES

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ABSTRACT

The past decades have seen a tremendous increase in the mathematical sophistication of the statistical techniques which are taught in the average university. As this sophistication increases, however, there is the growing danger that we are failing to strike a practical balance in two critical areas: (1) Will the student realistically have occasion to use the techniques? (2) Does the student have the mathematical aptitude to implement these more sophisticated techniques outside the sheltered and structur- ed classroom environment?

INTRODUCTION

As instructors in many courses requiring the utilization of quantitative methods, the authors were intrigued and encouraged by the theme selected for this Educator's Conference. There are several areas in which the teaching of quantitative methods appears to be "out-of-balance". In specific, a case could be made that the teaching of quantitative methods is "out-of-balance" in at least two major areas: One, does the student have a real probability of utilizing certain statistical techniques in an operational business environment? Two, would the student actually be able to implement such a technique? (Or in other words, has the student mastered the technique sufficiently so as to actually utilize it?)

Over the last few decades the field of quantitative methods has witnessed a virtual explosion in the number and complexity of the statistical techniques which are available, and which are routinely presented to the typical student. One can easily verify the magnitude of this explosion by examining a business statistics textbook from the 1930's versus a current business statistics textbook. The same type of comparison could be made with respect to marketing research texts from earlier periods versus the current texts, and that comparison would also illustrate the greatly expanded variety of techniques which are presented to current university students.

In all probability this increase in quantitative sophistication would be viewed by most educators as a positive development, and surely one would not expect to see a textbook selection committee recommend the adoption of a fifty year old text. However, this ever-increasing sophistication goes beyond the ability of the user to make use of them. Hence, a balance needs to be struck between the amount of sophistication which is academically desirable and that level of sophistication which is desirable from a strictly pragmatic perspective.

Striking a Balance: Is it Used?

In this instance, we are seeking to strike a balance between what is taught as opposed to what is actually used in business. Admittedly, certain individuals routinely use quantitative techniques of the highest sophistication. Yet these persons represent a small and rather atypical minority. The average manager, salesmen, or small business executive actually makes very little use of the various quantitative techniques which are available. And when quantitative techniques are used, their use will usually fall into one of several simple types of analysis: overall means and/or percentages, percentage breakdowns by group or classification, and cross-classification tables.

In the field of marketing research, for instance, it is very rare to see any type of analysis beyond means, percentages, breakdowns, and classification tables. Of course, when a research project has been done in the hope of a journal publication, tests of significance will be routinely performed, yet in sporadic consulting work, such tests are the exception rather than the rule.

The obvious reason for the absence of statistical testing in consulting is that tests of significance only answer the very narrow question, "Does the observed difference seem to be more than zero when compared to some standard?" The absolute size of the difference is of no consequence so long as the statistical test makes it appear that strict equality is unlikely. Thus the question of a statistical difference becomes of little concern to an actual, for profit, business manager. The manager is looking for important differences; differences that are large enough to contain what can be termed "managerial imperative".

Hence, with respect to what we teach our students, it appears that far too much time is spent upon the moreoteric aspects of statistical testing, topics such as: the Z test, the t test, the use of the Z vs the t, unbiased estimators, finite population correction factors, the F test, homoscedasticity, linear models, analysis of variance (let alone topics such as: canonical analysis, discriminate analysis, multidirectional scaling and factor analysis). Quite frankly, the probability that the average graduate from the typical large university would encounter such techniques is quite small. Thus it would seem appropriate that more emphasis needs to be made at those initial stages of a research design, as well as increased emphasis upon the more simple types of data tabulation and analysis. Emphasis upon such topics as: How to code a questionnaire? How is the data set prepared for analysis? How is the data set entered into the machine for processing? How are the analysis routines actually computed? How do you use the machine to perform analyses such as means, percents, breakdowns and cross-tabulations? How does one read computer output? How does one write a summary report based upon such analyses?

Don't get the wrong impression. The authors have no vendetta against the more sophisticated techniques. The topics which are covered in the standard statistics course are appropriate subjects for investigation and instruction at the college level. However, it seems that a very good argument could be made that the traditional areas of statistical analysis and statistical hypothesis testing are receiving too much attention. And in the same manner, it also seems obvious that those more mundane analytical skills which were mentioned in the series of questions listed above are not getting the emphasis they deserve, especially in the light of their higher probability of usage.

In short, we are sending forth our graduates, rigorously trained in statistical concepts that they, in all probability will never use, being at the same time, woefully under-trained in those more simple types of analyses which they will use. Although some may protest this line of thought, claiming that this represents a "retreat in sophistication", the problem of over-sophistication remains a valid concern. We need to take a closer look at the intended objectives of our quantitative courses with an eye toward striking a greater balance between what is taught and what is used.

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Striking a Balance: Can They Do It?

Obviously we all desire that "perfect teaching environment": classes filled with extremely bright, highly motivated students; with every student possessing a full measure of those background skills and native abilities necessary to do an exemplary job. Unfortunately, and equally obviously, such attributes do not accurately describe the average college class. Admittedly, such students may exist at certain "elite" universities; however, when approximately 85% of the educations in an association such as this one teach at state-funded universities, our attention must understandably be directed toward that individual who more accurately typifies the "average student". As most of us know, this average student is usually not overly bright, relatively unmotivated, and is generally unprepared with respect to both specific quantitative skills as well as overall quantitative aptitude. In short, they lack the ability and preparation necessary to truly master many of the more sophisticated techniques.

Given this more typical and less talented breed of student, there are basically two approaches: independent and relative. The independent approach is to set the standards and curriculum independent of the skill level of the students. That is, decide what materials should be covered, and at what level they should be covered, and do it. If the students make it, fine... if they don't make it, tough. A simple "sink or swim" proposition.

This approach represents the traditional attitude of most academics, and ideologically speaking would be the favored alternative. Yet such an approach when viewed in the light of the reality of the actual skill levels of most students may be too elitist, and as such may violate the mission of those state universities which account for the vast majority of students. The second approach then becomes to set the standards and curriculum relative to the students. That is, decide what materials the students can reasonably handle and work at that level. The objective in this approach is not (necessarily) to "water-down" the curriculum, but rather to place primary concentration upon only those techniques which the average student has a reasonable chance of mastering. Obviously, this is not the ideal solution; in fact, most professors would probably characterize it as a bad solution. Admittedly this is not the type of teaching environment which most professors prefer. However, that is not the relevant question. The relevant question before us is this: "Given that we have a bad situation, how do we make the best of that situation?"

The relative approach has the advantage of at least making the best of a bad situation. On the other hand, to consistently teach at a level which is above the level of proficiency which the typical student can reasonably attain is quite frankly, a waste of everybody's time.

Unless the faculty decides to undertake the drastic step of eliminating all of the marginal students, more effort should be made to teach skills that actually may benefit the student. The plain truth of the matter is that the "average" student in the typical quantitative methods class never really understands what he/she is doing. They simply memorize enough of the definitions and problem formats to stumble through the exam, get through the course, and promptly forget all of it. Even though they have been exposed to an impressive goullet of statistical tests of undeniable sophistication they generally remain rather impervious to the process, devoid of both conceptual comprehension and computational competence. In short, they leave the course with nothing.

Thus a balance needs to be struck between those techniques which we teach versus those techniques which the average student has a reasonable chance of mastering. Ergo, it would seem reasonable to focus upon a smaller set of simpler techniques, giving greater emphasis upon how these techniques could actually be implemented.

Along this line, the authors would like to share the results of a "proficiency analysis" which was performed upon a set of student test papers. Most introductory statistics classes present several techniques for testing for "significant differences", as well as techniques for examining other types of relationships which may be present in the data set, such as regression and correlation analysis.

The question before us is this: Are certain techniques executed with greater proficiency than other techniques? Realizing that many of these techniques are rather interchangeable, it would seem advantageous to emphasize those techniques which the student has the highest probability of mastering.

An analysis of several classes was performed to assess the level of proficiency which students could attain with respect to five statistical techniques: the chi-square test, the Z test, the t test, regression analysis, and correlation analysis. For the 72 students in the combined classes, TABLE 1 shows the number of students who (1) got the problem perfectly correct, (2) missed a somewhat minor amount of the problem, or (3) missed a substantial amount of the problem.

TABLE 1

<table>
<thead>
<tr>
<th></th>
<th>chi-square</th>
<th>Z test</th>
<th>t test</th>
<th>regression</th>
<th>correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>perfect</td>
<td>52</td>
<td>20</td>
<td>24</td>
<td>36</td>
<td>14</td>
</tr>
<tr>
<td>minor errors</td>
<td>18</td>
<td>32</td>
<td>37</td>
<td>26</td>
<td>38</td>
</tr>
<tr>
<td>major errors</td>
<td>2</td>
<td>20</td>
<td>11</td>
<td>10</td>
<td>20</td>
</tr>
</tbody>
</table>

To simplify TABLE 1 and to emphasize the strength of these findings, TABLE 1 was partitioned and then collapsed to produce TABLE 2 and TABLE 3.

TABLE 2 represents a cross-classification table which compares the chi-square test against the Z and t tests combined (since they are quite similar). In addition, the categories of minor miss and major miss have been combined.

TABLE 2

<table>
<thead>
<tr>
<th></th>
<th>chi-square</th>
<th>Z and t</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% correct</td>
<td>52</td>
<td>44</td>
</tr>
<tr>
<td>some miss</td>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>

Independence of classification test: chi-square value = 33.75 (.01 value = 6.64)

In TABLE 3 the chi-square is compared against the combined regression plus correlation results since these techniques are also covered in tandem. As before, minor misses and major misses have been combined into a single category.

TABLE 3

<table>
<thead>
<tr>
<th></th>
<th>chi-square reg and corr</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% correct</td>
<td>52</td>
</tr>
<tr>
<td>some miss</td>
<td>20</td>
</tr>
</tbody>
</table>

Independence of classification test: chi-square value = 27.08 (.01 value = 6.64)
Judging from these results it seems readily apparent that the average student finds it significantly easier to master the chi-square test than any of these other techniques. Given the fact that the chi-square test can produce roughly the same conclusions as these other tests, and in view of the fact that it avoids many of the technical assumptions required by the other tests, and finally in light of the fact that students find it demonstrably easier to use, more attention should be given to this technique. In emphasizing the chi-square test the instructor is striking a greater balance between the techniques which are presented, and those techniques which the average student can execute with reasonable proficiency.

CONCLUSION

In summary, this paper has argued that more attention needs to be given to the ultimate goals and objectives of our quantitative courses. In the quest for greater sophistication in our quantitative courses two important, practical considerations have been neglected. These two considerations are applicability and proficiency. In order to more adequately address these considerations it was suggested that more emphasis be given to the more basic analytical steps such as data collection, coding, entering, tabulating, developing means and percentages, developing sub-group breakdowns, and cross-classifying. If a statistical test of significance is desired, the chi-square test was recommended due to the higher levels of proficiency associated with this test.

Admittedly such a shift in emphasis would be highly controversial, and many would decry these suggestions as a "retreat from sophistication", a shameful watering-down of the curriculum. Nevertheless, attention needs to be given to the end product of our educational efforts, the student. While there is an undeniable need to maintain requisite academic rigor, it seems equally apparent that universities have failed in their educational mission if the bulk of our efforts are spent in the presentation of techniques which our students will not use and cannot master. Truly a balance needs to be struck!