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 structured 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 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 does present a danger. The danger is that the techniques go 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 prespective.

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, salesman, or small business executive actually makes very little use of the various quantitative techniques which are available. And when quantitative techniques are used, that use will usually fall into one of several simple types of analysis: overall means and/or precentages, 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 renumerative 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 more esoteric aspects of statistical testing, topics such as: the Z test, the t test, 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, multidimentional 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 (usually canned programs) called forth for execution? How does one direct 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 analysis?

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 far 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 undertrained 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-sohpistication 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.

Striking a Balance: Can They Do It?

Obviously we all desire that "perfect teaching environ-
ment": classes filled with extremely bright, highly moti-
vated students; with every student possessing a full mea-
sure of those background skills and native abilities neces-
ssary to do an exemplary job. Unfortunately, and equally
obviously, such attributes do not accurately describe the
average college class. Admittedly, such students may ex-
ist at certain "elitist" universities; however, when ap-
proximately 85% of the educators 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 unpre-
pared 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 rela-
tive. The independent approach is to set the standards
and curriculum independent of the skill level of the stu-
dents. 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
academicians, and ideologically speaking would be the fa-
vored 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 that 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. Admit-
tedly this is not the type of teaching environment which
most professors desire. However, that is not the relevant
question. The relevant question before us is this: "Gi-
ven 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 con-
sistently teach at a level which is above the level of
proficiency which the typical student can reasonably at-
tain, 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 for-
mats to stumble through the exam, get through the course,
and promptly forget all of it. Even though they have been
exposed to an impressive gauntlet of statistical tests of
undeniable sophistication they generally remain rather
impervious to the process, devoid of both conceptual com-
prehension 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 sim-

pler techniques, giving greater emphasis upon how these
techniques could actually be implemented.

Along this line, the authors would like to share the re-
sults of a "proficiency analysis" which was performed upon
a set of student test papers. Most introductory statis-
tics classes present several techniques for testing for
"significant differences", as well as techniques for exam-
ining 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 exe-
cuted with greater proficiency than other techniques? Re-
alizing that many of these techniques are rather inter-
changeable, 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 re-
spect to five statistical techniques: the chi-square test,
the Z test, the t test, regression analysis, and correla-
tion analysis. For the 72 students in the combined class-
es, TABLE ONE 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

	chi-square	Z test	t test	regres-sion	corre-lation
perfect	52	20	24	36	14
minor errors	18	32	37	26	38
major errors	2	20	11	10	20

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-classificaiton table which com-
pares the chi-square test against the Z and t test com-
bined (since they are quite similar). In addition, the
categories of minor miss and major miss have been combined.

TABLE 2

	chi-square	Z and t
100% cor-rect	52	44
some miss	20	100

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

	chi-square	reg and corr
100% cor-rect	52	50
some miss	20	94

Independence of classification test: chi-square value = 27.08

(.01 value = 6.64)

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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 slighted. 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 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!