Redesigning Business Statistics and Related Courses in the Light of the Common Core State Standards

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ABSTRACT

The emergence of the Common Core State Standards (CCSS) presents challenges and opportunities for the role of statistics in business curricula. Although the base standards are common, additional standards are implemented unevenly. Where the optional statistical elements are implemented, business schools have a tremendous opportunity to rethink not only the core statistics courses but several related ones, including introductory computer courses, capstone research seminars, and even courses in specific fields. This paper suggests changes to the business curriculum based on the full implementation of the statistical elements in common core curricula.

1. Introduction

The emergence of the Common Core Standards presents challenges and opportunities for the role of statistics in business curricula. Although the base standards are common, additional standards are implemented unevenly.

Our paper focuses on both scenarios, states that choose to fully implement Core standards, including optional standards, and those that do not. Universities that have vast majorities of students from states that implement additional standards can naturally adjust statistical offerings, and in particular advanced offerings, accordingly.

The variation between states, as well as their potential importance to the larger business curriculum also means that business schools should pay close attention to changing state standards, and perhaps even join the push for higher statistical standards in each state. Regardless, the implications to business programs of the full implementation of these standards are significant, and deserves further study.

2. Base standards

2.1 Junior High

So what are the base standards? These begin in junior high school itself.

It is without a doubt, a triumph for the statistical education community for CCSS to have included statistics not only in the high school curriculum but in a thoughtful, often sophisticated level, in the junior high mathematics curriculum. Even better, the standards mentioned in this section are universal, applicable to all students.

Concepts of variability, data collection, the shapes of distribution, and measures of central tendency are introduced in the sixth grade itself. These are reinforced through the use of data and visual graphics. In the seventh grade, the addition of a second data set is made, so that students can begin to think about differences not only in measures of central tendency but also variability across two populations. They learn the concept of probability, and are even introduced to the uniform distribution. They also learn tree diagrams and are introduced to simulation.

In the eighth grade, they continue with bivariate analysis, constructing and interpreting scatterplots and begin to recognize linear and even nonlinear association. For linear association, they begin to think about whether it is positive or negative, and about the data itself: clusters, outliers and goodness of fit. They are introduced to the idea of the slope of a linear model and its significance and also two-way categorical tables. (1)

That students will have achieved proficiency in so many high-level statistical concepts before even reaching high school is a major achievement, creditable to so many in the math education field, NCTM as well as many in the ASA itself, including those behind the GAISE reports. (2)

2.2 High school standards

Students are introduced to further concepts in high school. Topics include an introduction to probability, including sample spaces, intersections, unions, independence, conditional probability, frequency tables, the Addition and Multiplication rules, as well as permutations and combinations.

The concepts presented in grades 7 and 8 for univariate and bivariate data are strengthened. Students receive exposure to histograms, boxplots, and most of the best known measures of central tendency and variability. Linear, quadratic and exponential models of fit for bivariate data are introduced. Residual analysis is further explored. Students are introduced to correlation, and are asked to distinguish between it and causation.

The statistical inference section includes the idea of a population parameter and the purpose and use of samples, as well as statistical modeling, surveys, experiments, and observational studies and comparison of treatments in randomized experiments.

An additional section has been deemed optional, which is a section that's potentially important in a business school context. This set of standards appears under the title "Using Probability to Make Decisions." It includes expected values, sampling distributions, expected payoffs, and the use of probabilities for decision making and strategies.

A good deal of controversy has attached itself to common core standards. A primary controversy, as stated by Wurman (3) and others, is that common core presents a problem to high achieving

states, although it is an improvement for lower achieving ones. There is no question that there is some truth to this, particularly in other mathematical subfields. In the field of statistics, however, the optional portions are relatively minor. Even though decision analysis has particular application in the field of business, it is, perhaps wrongly, at best given only glancing attention in most business statistics textbooks.

Franklin, et al (4) note in connection with AP courses, that universities must begin to adjust their curricula for students who come in with an AP Statistics course, equivalent to an undergraduate one semester course, under their built. Further, they suggest that colleges begin to create second courses for students with this advanced background, so that they need not simply "place out of stats" but advance in their knowledge in depth of the discipline. And indeed, this may create a pipeline for future specialists and subspecialists in the discipline, whatever their undergraduate major may turn out to be.

3. The Business Curriculum

We then see that, at least in states where the Common Core is adopted, students will come in with strong preparation in probability in statistics in a number of areas, regardless of whether their state included optional topics (this assumes that these topics are indeed taught at school by prepared teachers—doubtful at present but potentially achievable over the medium and long terms). How then, should the business curriculum change? And why do we speak of the business curriculum changing rather than the business statistics course changing?

There are several courses involving methods in business. These aid students in achieving learning goals that are the focus of many accreditation agencies (for example, the The Association to Advance Collegiate Schools of Business or AACSB), particularly the integration of writing, data analysis, technology and research into every part of the curriculum. (5) The use of statistics can play a role in the following undergraduate business courses:

a. The introductory information systems course, particularly those with laboratory components.

b. Obviously, introductory business statistics courses, whether one or two-semester sequence

c. Business research methods courses and seminars

d. Courses in subspecialties, where statistics courses are a prerequisite, whether in marketing, industrial management, etc.

The first three of these are commonly referred to as "methods" courses, and we will primarily focus on these in our recommendations. There is a great deal of variation in their scope and in the topics covered from business school to business school, as well as the time at which students encounter them. At our own institution, for example, the introductory information systems course and the first of two business statistics course are taken (with some exceptions) at the beginning of the sophomore year, as freshman spend much of their year fulfilling core general education requirements.

4. Changing the business curriculum

4.1 The introductory course in information systems

We begin with the intro to information systems course, which varies significantly from institution to institution. Some business schools may not have such a requirement at all. At our institution, this course has a lecture component, essentially an introduction to the field of information systems, and a laboratory component, primarily focused on the Microsoft Office suite and targeted use of the Internet. Some argue that lab courses are superfluous at a time when computers are ubiquitous, but others argue that in institutions that serve students from highly different backgrounds, an introduction to key software, in particular to the MS Office suite, is important to put all students are an equal footing, regardless of class and prior education.

How would Common Core training in probability and statistics potentially impact this course? In the past, it could be argued that data analysis could not be inserted into this course because students had no background in statistics. But this is no longer the case. Students will already have been introduced to not only the basics of descriptive statistics but even bivariate data since the 8th grade itself. Therefore, students can and should be introduced to the use of computer assisted data analysis.

Even if, as at our university, the use of a basic statistical package isn't part of this course (although it would be ideal to introduce the package that is later introduced in business statistics, so that professors in advanced courses can assume it as standard knowledge), students can easily be introduced to the data analysis tools in Excel. Students can also collect secondary data and evaluate their accuracy and potential value, whether through the Internet or other sources. Furthermore, they can research the theme connected to the data itself. This exposure to the idea of a literature search is itself a valuable initial exposure not only to statistics but to all business research.

4.2 The business statistics course

A more difficult analysis has to be made with regard to the business statistics course or sequence. A series of topics taught in the intro business statistics courses are replicated in the Common Core curriculum, beginning in 7th grade itself. This is a radical change, and a tremendous success for the statistical community that has pushed for the inclusion of these topics from the times of the GAISE project, the Quantitative Literacy series and before (6). By the time they reach college, students will have had not single but repeated exposure to

a. Descriptive statistics
b. Graphical depictions of descriptive statistics
c. Probability and rules of probability
d. Bivariate data and graphical depictions of it
e. Simple regression
    i. Goodness of fit
    ii. Outliers
    iii. Residuals
    iv. Quadratic and exponential models

This represents an enormous portion of even a two-semester business statistics sequence. Indeed, if the students have mastered these elements, all they are *missing* from certain business statistics curricula is a more sophisticated look at distributions, sampling distributions, estimation and hypothesis testing. Many business statistics courses don't even include or gloss over quadratic

and exponential models. Again, this is an astonishing turn of events in American statistics education.

But this begs the question: how should introductory statistics courses adjust to this new reality? There are three alternatives:

a. Do nothing and provide a "final coating of paint" to the material students already know.

b. Assume that students have mastered the material in the high school curriculum, skip the hours that would be assigned to material that would be repeated, and teach more advanced or sophisticated topics. Under this scenario, the present set of topics in two-semester statistics sequences could be reduced to a single course, with a second course devoted to advanced topics, such as:

    i. Nonparametric methods
    ii. Design of experiments
    iii. Basic survey sampling
    iv. Preliminary analysis of questionnaire data
    v. Projects
    vi. Time series and forecasting

c. Pursue a middle course. This is the most likely outcome, but necessarily one that individual business schools will have to tailor to their needs. The greater the variation between schools, the harder time textbook writers will have to reflect this newfound diversity.

In all three scenarios, professors would have far greater freedom to include the use of cases more extensively than in the past.

4.3 The research methods course

The research methods course in our university is taught as a seminar, generally taken during the final year. The course has two components, one a lecture portion, where students are trained in research methodology. The second component involves a major project, in which students must go to a company and solve a real-life managerial problem. This can be considered, in many ways, a "capstone" course, where students apply the many skills they have developed in prior years.

The Common Core can impact this seminar in two ways. The first is that a number of concepts connected to research have already been embedded into the Common Core statistical guidelines. These extend from spurious correlation vs. causation to questioning linearity itself in the relationship between variables to the analysis of outliers and residuals in regression. In short, students arrive as freshman with concepts that in the past were not taught, in many cases, until a *second* statistics course.

Much of the work in this seminar is connected to the analysis of questionnaires administered to employers and consumers. Surveys and sampling are absolutely essential to much business research yet often undercovered in statistics courses. This, then, represents the second way that statistical thinking developed through the Common Core can have an impact: the inclusion of basic survey analysis, nonparametric and categorical data methods in business statistics courses greatly assists the professor of the business research methods seminar. It permits him or her to provide advanced training in research, categorical data, and the analysis of questionnaires without having to waste hours unnecessarily reviewing prerequisites.

4.4 Courses in business specialties

Research, statistical thinking, communication skills, and the use of technology are key, naturally, to success in methodology courses. However, they are crucial tools to courses in business specialties, and increasingly so, to the degree that schools have made them learning goals for accreditation agencies. The added topics discussed in sections 4.2 are important to almost every business discipline, but particularly so in areas such as marketing and human resources. In addition, the changes in 4.1 permit closer collaborations between information systems courses and statistics, paving the way to business analytics.

5. Conclusion

Although we have outlined several potential changes to the business curriculum, we must close with three caveats. The first is that Common Core has not become established policy in all 50 states, and it remains to be seen to what degree political reaction could cause a rollback in statistical standards. The second is that even if they *do* become established policy, teachers are clearly not yet prepared to teach them in every jurisdiction. Finally, business statistics textbooks will need to reflect these changes; it remains to be seen if they will be leaders or followers of the change.

References

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