

Is There Life After Introductory Statistics?

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1. Introduction and Data Collection

The purpose of this paper is to give examples from a variety of countries of classes beyond introductory statistics that are offered in various academic institutions for students with programs of study other than Mathematics, Mathematics Teaching, or Statistics. The method of data collection for this paper was far from a random sample. I first contacted the 40 National Correspondents for the IASE (International Association for Statistical Education). Disappointingly, I only received responses from 5 Correspondents about their own universities and only one Correspondent forwarded my email to others in his country. I also sent basically the same email message to two listserves. The first was the Isolated Statisticians listserv, whose primary audience is 165 statisticians at institutions in the USA that focus on undergraduate education. The second was the listserv of the approximately 200 members of the Special Interest Group-Educational Statisticians of the American Educational Research Association. The audience for this listserv is statisticians with an interest in statistics as applied to Education and Psychology. Finally, I sent basically the same email to 56 individuals in 9 different countries who have an interest in undergraduate statistics education and were not, to the best of my knowledge, on any of the previous lists.

The basic email message said that I was preparing this paper for the ISI Session in Seoul as part of a session titled "Undergraduate Statistics Education in Non-Statistics Degree Programmes". As part of this paper I want to give examples of classes, courses, units, co-operative experiences, or projects BEYOND INTRODUCTORY STATISTICS that are completed by undergraduates that are either statistical in nature or very heavily depend on statistics. The examples I want are for students who are NOT completing degrees in mathematics, statistics or applied statistics. The examples I want may be either required or optional for the students. I also asked each person to forward my email to appropriate people in their institutions who could give me examples for my paper.

From all of these emails, I received useful responses from one university each in Colombia, England, Spain, and the Ukraine, 5 universities in Australia, and 13 universities or colleges in the USA (with more than one response from two of the institutions). In addition, I went to a list on the web (<http://www.ma.utexas.edu/users/parker/minors/schools/index.htm>) of undergraduate minors in Statistics at selected academic institutions that was created by Mary Parker. This list is also not random since she only included the 15 institutions that sent her information. Surprisingly, there was an overlap of only one institution between this list and the institutions that responded to my earlier emails. In the USA a minor usually consists of anywhere from 15 to 24 semester hours (1 semester hour = 15 hours of instruction) of classes. Most minors in Statistics have a mixture of required and

elective classes and are intended for completion by students whose programs of study are other than Statistics. From the lists given by each academic institution I was able to gather information on statistics classes typically taken beyond introductory statistics by students pursuing these minors.

2. Who is required to take classes beyond introductory statistics and why?

Before answering this question I need to discuss how introductory statistics was either explicitly or implicitly defined by those institutions responding to my emails. I purposefully in making my email requests did not define introductory statistics, because I wanted to see how others defined it. Most define introductory statistics as a class with 30 to 45 hours of instruction covering descriptive statistics, some probability, and inferential statistics including t-tests and the chi-square test of independence. However, those in Business, Marketing, Economics, Finance and Commerce tend to define introductory statistics as two classes with the first class being the same as just described above and a second class dealing with regression, measures of association, and analysis of variance. There are also those in Business, Marketing, etc. who do define introductory statistics as only the first class. These definitions were consistent across all six countries.

Who takes required classes beyond introductory statistics seems to vary greatly across academic institutions. It is very common in the USA for Psychology majors to be required to take an experimental design or ANOVA class or research methods class and a psychological measurement class in the Psychology department. At Swinburne University of Technology (Australia), however, the ANOVA class is taught by a statistician in a mathematics and statistics department. In addition, at Swinburne, psychology students take classes that cover Regression (including Multiple Regression), MANOVA, and factor analysis. One of the reasons why many Psychology programs require more statistics than other degree programs is that the faculty members in charge of these programs feel that is important for their students to complete a research project that uses more than basic descriptive statistics and t-tests before they graduate.

Three other programs followed this pattern of additional statistics followed by a required research project were Sport Science at Sheffield Hallam University (England), Marketing at Stonehill College (USA) and agriculture and horticulture at Monash University (Australia). All required a combination class in regression, ANOVA, and measures of association, with the Sheffield Hallam University class also covering some multivariate analysis and ethnographic data analysis. The only other programs of study that required more statistics were in Economics, Finance, and Commerce. The Economics program at Kiev National University of Economics (Ukraine) required several classes in econometrics. The Finance program at Winona State University (USA) required a forecasting methods class and the Commerce program at Deakin University (Australia) required a Sampling class.

3. Why do student elect to take additional classes beyond introductory statistics?

Although my original intention in doing this paper was not to address why students do and do not take additional statistics classes, as I read through the responses I received, it became obvious that I need to address these issues in this paper. One reason that was mentioned quite often by others

and that many students at my own institution have directly told me is that they want to take more statistics because it will help them look more impressive on paper and thus help them gain entry into better master's and doctoral level programs. This is especially true in Psychology. Also, some master's or doctoral programs require additional statistics classes for admission. A related reason that some students take more undergraduate statistics is that they want to do non-required research projects as undergraduates in a wide variety of programs of study and they realize (either on their own or with the help of their academic advisor or tutor) that taking more statistics will help them do better projects. Other students take additional statistics classes as electives because they are afraid of graduate level statistics. By taking more statistics at the undergraduate level they reduce their own anxiety about graduate level statistics.

Another common reason for students taking more statistics than is required is that they want to make their applications for employment look different than most other applicants for the same jobs, hence giving them an edge in getting that first interview. Some tell me that their advisors have suggested this, while others say that someone they know who is already employed in that field suggested taking more statistics to them. Several people in several different countries mentioned that some students take more statistics because they prefer it to the other options available to them. For example, in the graduate-school-oriented degree program in Psychology at Winona State University, the students must take either a second statistics class, finite mathematics, pre-calculus, or calculus. A final reason that some students take more statistics is that they actually enjoy it and prefer statistics classes to all other subjects available to them at their university or college.

It is this last group of students in the USA that sometimes complete minors in Statistics, when this minor is available to them. The types of students completing minors varied widely from institution to institution. From years of teaching experience, I suspect the reason for this is which faculty advisors/tutors are enlightened and encourage their students to think about completing these minors. The students' programs of study listed more than once in the descriptions of the minors that I pulled off the web were Biology (7 out of 13 that listed which types of students completed minors), Economics (6), Psychology (6), Sociology or Social Science (6), Business or Management (5), Computer Science (3), Engineering (3), Finance (2), and Marketing (2).

4. What non-required classes do students typically elect to complete?

The most commonly listed non-required classes by those who answered my emails or from the lists of minors on the web were experimental design/ANOVA (13 listings), regression or linear models (13 listings), and classes that basically mimicked the second statistics class in business and commerce that combined regression, ANOVA, and measures of association into one class (13 listings). These 39 listings come from 28 different academic institutions. The students most commonly listed as taking these three classes were from psychology and economics programs. Other classes that were listed as non-required classes taken by undergraduates at more than two academic institutions were nonparametric statistics (10 out of the 36 institutions for which I had information), probability (10), industrial statistics and/or quality control (9), econometrics, time-series and/or forecasting methods (8), biostatistics (7), multivariate statistics (7), sampling and/or

survey research (7), and statistical computing and/or statistics packages (5). Many academic institutions listed a theoretical mathematics statistics class as a non-required class taken by undergraduates with only 4 of these institutions making the theoretical class a required class of those completing a minor. From my own experiences and from talking to colleagues at other academic institutions, I suspect it is very few undergraduates (other than mathematics or mathematics education students) that choose to take these theoretical classes as non-required classes.

5. Why are more students not taking statistics beyond the introductory level?

The discussion of this needs to be broken down into two pieces. First, why do programs not require more statistics and second, why do students choose not to take more statistics when the option is open to them? A major reason that faculty give for not requiring more statistics is that they do not feel it is important for their students to have. I must admit that this is probably true for students with programs in literature, foreign languages, music, art, theatre, etc. However, this reason often comes from older faculty members who do not know the state of the art in their fields of expertise even when their fields are now using more statistics. Two other reasons often heard from faculty are that adding more required statistics classes would decrease the number of students choosing that program of study and that there is no room in the program for more statistics, even though in both cases the faculty realize they should require more statistics.

There are several reasons why students do not take more statistics when it is an option for them. A major reason is, of course, that the students disliked their required classes in statistics and so have no desire to take more classes. Another reason is that some students who actually liked introductory statistics, but are still a bit afraid of it, do not take more because their advisors, tutors, or friends actively discourage them from taking more statistics. Further, there are students who wait as long as possible to take introductory statistics and then find out they actually like statistics and want to take more, but at that point they have no electives left to complete.

6. Is there hope?

The answer is YES! The best evidence I can give is the growth over the last 10 years of IASE from a committee of the ISI to an active and growing association. Further, in many countries, enrollment is growing in introductory statistics. The more students who take introductory statistics, the more students who will then take statistics beyond introductory statistics, especially if we continue to make introductory statistics classes more exciting and relevant to the students.

RESUME

Cette contribution présente les résultats d'une enquête visant les cours de statistiques après un cours d'introduction auprès des académiciens en six pays. Nous décrivons d'abord les cours différents qui sont requis dans les programmes d'études et leurs justifications. Puis nous discutons les types de cours qui sont achevés par les étudiants et les raisons pour lesquelles les étudiants s'inscrivent. Nous finissons en discutant pourquoi il n'y a pas plus d'étudiants qui s'inscrivent aux cours de statistiques d'un niveau plus avancé.