We provide several possible answers to the first question. One is largely historical: Introductory statistics courses at many institutions have been viewed as low-level service courses with not enough mathematical content to warrant credit for a student majoring in mathematics. One is based on resources: There are not enough faculty members to provide such a course for majors, and there are not enough statisticians around to teach it. One is based on the tendency of mathematicians to view all courses through the lens of theoretical mathematics and to therefore evaluate the courses on how they might prepare students for doctoral programs in pure mathematics. Answers to the second question on what we can do to change the pattern are harder to come by. We address some of these challenges in Appendix B.

V. Description of the Recommended Course

Our Statistics Area Study Group is fortunate to have a widely respected set of guidelines from which to start. The GAISE Guidelines (Guidelines for Assessment and Instruction in Statistics Education) were written in 2005 and endorsed by the American Statistical Association. They have since also been endorsed by the American Mathematical Association of Two-Year Colleges. The

courses could achieve the goal of introducing mathematics students to effective data analysis. We provide syllabi for some such courses in Appendix D.

Cognitive Goals:
Applied Statistics is an outstanding course for helping students meet the cognitive goals set out in this *Guide*. Specifically, in the process of working with real data, students have to read with understanding, recognize patterns, identify essential features of a complex situation, and apply appropriate methodologies. All of these enhance critical thinking skills. Communication skills are also emphasized in such a course, as students learn to effectively interpret and justify their conclusions. Learning to use technology intelligently as an effective tool is an integral part o 0 0c-

The knowledge of deciding which statistical methods to use in which situations and the ability to check necessary conditions for those methods to be valid.

Extensive experience with interpreting results of statistical analyses and communicating conclusions effectively, all in the context of the research question at hand.

An awareness of the power and scope of statistical thinking for addressing research questions in a variety of scientific disciplines and in everyday life.

Prerequisites:

Basic proficiency in algebra is all that is required, combined with a bit of analytical maturity. Some data analysis courses could have calculus as a prerequisite.

Sample Syllabi:

Sample syllabi and course outlines are provided in Appendix D. We also include in Appendix C a recommended two-course sequence for future mathematics teachers, shared with us by the authors

Finally, students should know:

How to interpret statistical results in context
How to critique news stories and journal articles that include statistical information, including identifying what's missing in the presentation and the flaws in the studies or methods used to generate the information
When to call for help from a statistician

Appendix B: Challenges

Statisticians:
This is a bit of a Catch-22. In order to attract more quantitatively-inclined students into statistics, we need to expose more of them to the subject earlier in their college careers. However, in order to offer these courses, we need to recruit more statisticians as faculty in Mathematics Departments. We don't have a ready solution for this one, but a recent ASA/MAA Joint Report, "Qualifications for Teaching an Introductory Statistics Course," offers some guidance.

Resources:
How can departments, already stretched for resources, afford the resources to offer courses such as the one proposed? One solution is to reconfigure the current introductory statistics course offered at many schools. As a low-level probability and statistics course with a focus on procedures and formulas, the course is designed for non-

deal with complex real situations and that is project-based with a heavy emphasis on communication skills. In the same way, we hope that departments will embrace the idea of having their students explore the field of statistics, so that they are prepared for a world full of data and are exposed to more of the richness of the mathematical sciences.

Appendix C: Recommendations for Mathematics Education of Teachers

Students majoring in the mathematical sciences as well as those in a variety of other fields (which will vary depending on the institution)

Course Description: An introduction to applied data analysis, designed to enable students to effectively collect data, describe data, and make appropriate inferences from data. Students are expected to communicate effectively about statistical results and to use a statistical software package for data analysis.

Proposed prerequisites: Basic algebra

How the course fits into a program of study: The course should be taken during the first two years of an undergraduate program in the mathematical sciences. It can be taken concurrently with calculus or any other sophomore-level courses in mathematics. Those students wishing to continue on in statistics are urged to take the probability and mathematical statistics sequence as well as any additional courses in advanced data analysis offered at the institution.

Course Outline:

Data collection, including random sampling and design of experiments (2 weeks)
Data description, including graphs and summary statistics for categorical and quantitative variables and relationships between variables (2 weeks)
Introduction to the key ideas of estimation and testing, using modern resampling methods to build conceptual understanding (3 weeks)
More on confidence intervals and hypothesis tests, using the normal and t distributions (3 weeks)
Advanced tests, as time permits, such as chi-square tests, ANOVA, regression tests, multiple regression (3 weeks)

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