

Characterizing the Quantitative Biology Curricula from Institutions Across the United States

Wendy Levenson, Monika Herbst

wjl21@pitt.edu, mnh22@pitt.edu

Department of Biological Sciences, University of Pittsburgh



Introduction

Despite the growing influence of quantitative approaches in biology, there has been relatively little research addressing the integration of quantitative approaches into undergraduate biology courses¹. However, the number of interdisciplinary undergraduate majors in mathematical biology is growing. Because mathematical biology is a new major, there is no standard for how the program should be designed nor is there a place to easily access information about the courses required in the different curricula.

Our study characterizes the curricula of eight mathematical biology programs²⁻⁹ by comparing their core components and interdisciplinary sequences. Our research does not include bioinformatics because it focuses more heavily on computer science than on mathematics.

Questions

The following questions were used to assess the similarities and differences between the different institutions:

- What percentage of credit hours is devoted to mathematics vs. science?
- In which department is the major housed?
- How many introductory, intermediate, and advanced courses are required?
- How many interdisciplinary courses are offered?
- How many undergraduate students are enrolled in the major?

Standard Definitions for Disciplines and Course Difficulty

We defined science courses to include all natural sciences: biology, chemistry, physics, and neuroscience. Mathematics courses include: computational, statistics, and traditional mathematics courses. Interdisciplinary courses are those that are cross-listed in multiple departments and/or have a title that includes both a quantitative and science term.

Course difficulty level (Figure 2) was determined by characterizing the prerequisites for the course. 'Introductory level' courses require no prerequisites. 'Intermediate level' courses have one prerequisite introductory level course. 'Advanced level' courses have one or more prerequisite intermediate level courses.

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Spectrum of Science vs. Mathematics Credit Hours

- Math bio programs are diverse in their emphasis on math vs. science, as the percentage of credit hours required in math ranges from 34% to 80%.
- There is no program that requires exactly 50% math and 50% science
- Rutgers is the most evenly distributed with 53% science

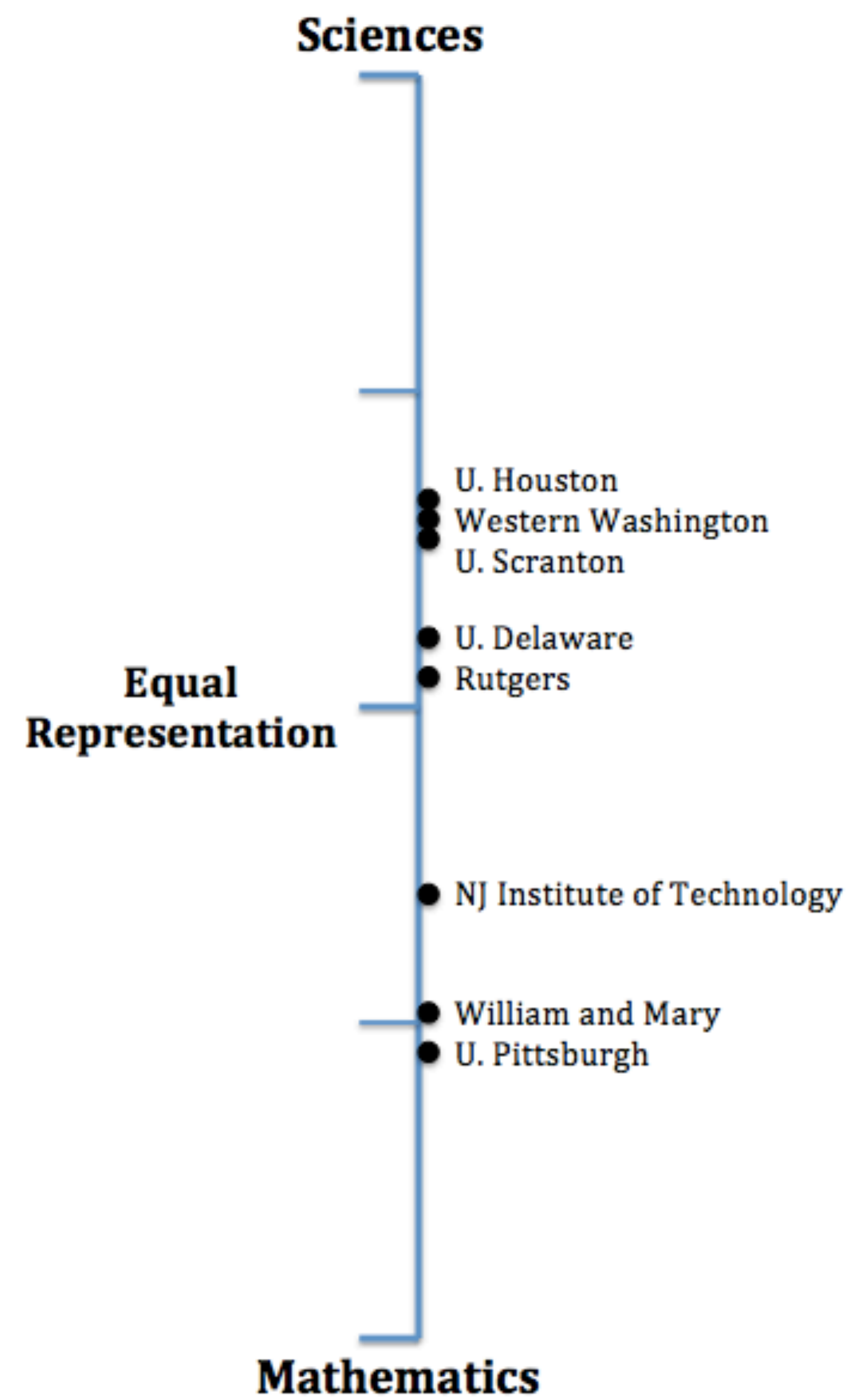


Figure 1: Proportion of credit hours for the mathematical biology major that are devoted to science vs. mathematics for 8 universities. Does not include interdisciplinary credits.

Course Distribution Among Difficulty Level

- Most of the institutions require more introductory courses than advanced courses
- Compared to science and mathematics courses, few interdisciplinary courses are required

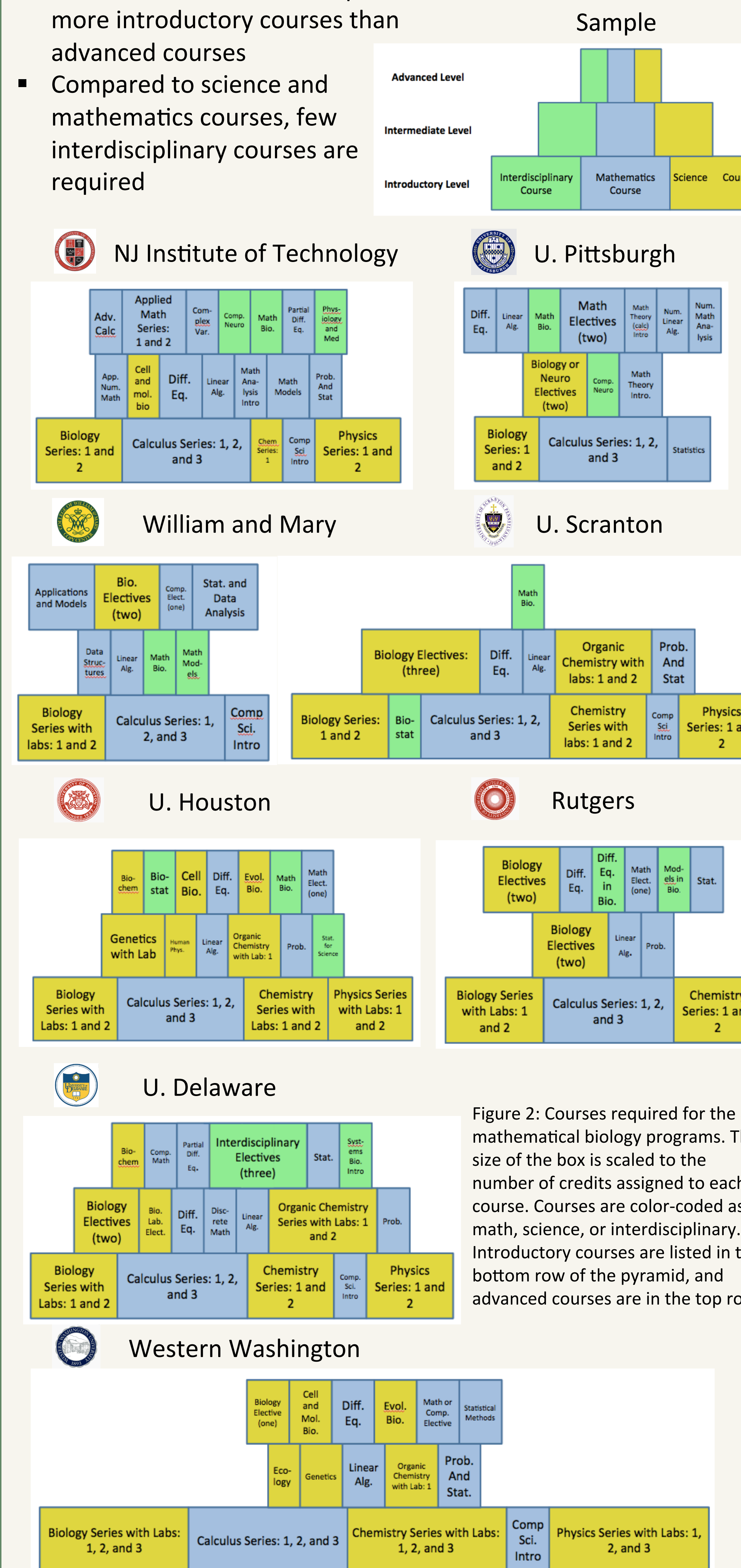


Figure 2: Courses required for the 8 mathematical biology programs. The size of the box is scaled to the number of credits assigned to each course. Courses are color-coded as math, science, or interdisciplinary. Introductory courses are listed in the bottom row of the pyramid, and advanced courses are in the top row.

Department Where Major is Housed

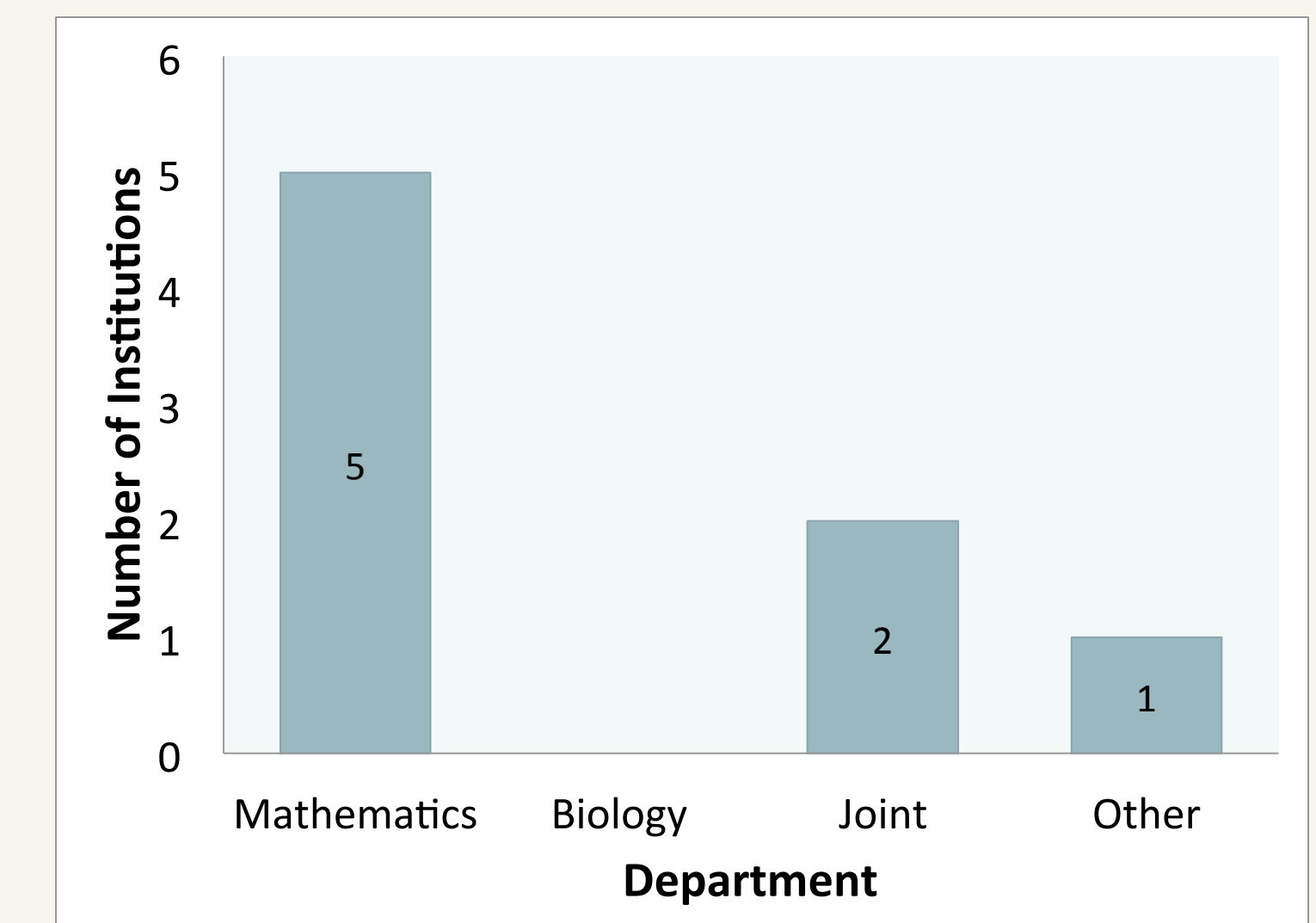


Figure 3: Number of institutions that house the mathematical biology major in their mathematics, biology, joint-administration, or other department.

Conclusions and Future Directions

The comparison of these eight institutions reveals extensive integration of science and mathematics within the major. Although none of the programs are housed solely in biology departments, the majority of the institutions require students to take at least 4 science courses. Despite integration across the curriculum, most institutions lack integration at the individual course level, as we observed very few interdisciplinary courses.

Many programs share a similar structure with respect to their introductory courses with students taking the Introductory Biology series and the Calculus series. There is more diversity among the programs when considering their intermediate and advanced courses.

Future research will address the number of students enrolled in each program and the amount of research that institutions require from students. Thus far, results indicate that a small percentage of students are enrolled in this major: Rutgers has 45 math bio majors out of 45,000 undergraduates, and U. Pittsburgh has 24 in their population of 18,000 undergraduates. Representatives of these two programs indicate that enrollment is growing. In the future, we plan to extend our research to include other programs across the country.

References

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