BOOK REVIEW

Mathematics for Social Scientists. By Jonathan Kropko.
Thousand Oaks, CA: SAGE Publications, 2016, 408 pages.

It hits every graduate student in the social sciences at some point. For some it happens in the first month; for others it doesn't occur until they're working on their dissertation. Regardless, at some point every student encounters mathematical concepts that they do not understand. This may be in the structural modelling of an empirical paper, the bordered Hessian in the second-order condition of a behavioral model, or even the calculation of a basic correlation coefficient. I certainly had such experiences. Working at an interdisciplinary lab for social research in graduate school, I saw that this was a problem affecting students from all the social sciences. Our lab provided resources for students to work through their questions. Repeatedly encountering their deficient understanding of math, we created a "math boot camp" for incoming graduate students in a proactive attempt to address this recurrent problem.

One reality became quite clear. Short of requiring every graduate student in the social sciences to have an undergraduate degree in mathematics, which may not even be sufficient, this problem is going to persist. This is the problem addressed by Jonathan Kropko in *Mathematics for Social Scientists*. This review will provide an overview of the book's content, compare it to some similar resources, and consider its appropriate place in academic training or professional careers.

Three other comparable resources are *Mathematics for Economics and Business* by Ian Jacques (2018), *Mathematics for Economics* by Michael Hoy et. al. (2011), and *Mathematical Applications for the Management, Life, and Social Sciences* by Ronald J. Harshbarger and James J. Reynolds (2018). From the titles alone, it is clear that the first two refer directly to economics as a singular discipline rather than to the social sciences in general. This is consistent with the market for such books. A survey of academic publishers reveals that there are far more math texts targeted to economics than there are for any of the other social sciences alone or collectively.

Mathematics for Social Sciences consists of ten chapters covering three areas, the first being Algebra, Pre-calculus, and Probability. Chapter 1 is a review of algebra, which progresses from basic number theory and operations fractions to solving quadratic equations and logarithms. Chapter 2 covers basic set theory and Venn diagrams, polynomial functions, and concludes with the basics of linear regression. Chapter 3 on probability begins by building on set theory from the previous chapter, explains the theory of events and outcomes with their associated probabilities, and concludes with an explanation of conditional probability and Bayes' Rule.

The second section of the book covers the elements typically found in Calculus 1 through Calculus 3 that are most commonly used in the social sciences. Chapter 4 provides the basics of limits and integration that would be part of a Calculus 1 course. Chapter 5 applies the principles of derivatives to the area of optimization, while Chapter 6 covers the basics of integration. With a fairly precipitous increase in complexity, Chapter 7 delves into the concepts of multivariate regression and integration typically found in a Calculus 3 course.

The final section of the book covers linear algebra, the topic with which social science students tend to have the least exposure. Chapter 8 introduces the reader to matrices on page 271, and by page 277 is explaining the difference between scalar multiplication, Kronecker multiplication, and matrix multiplication. By page 294 it is considering eigenvectors. Chapter 9 examines inverting matrices and finding determinants, before explaining the basic calculation of slope coefficients and residuals through Ordinary Least Squares. Finally, chapter 10 returns to the concept of eigenvalues in more depth to build an explanation of principal component analysis.

There are many similarities between *Mathematics for Social Sciences* and the other texts mentioned previously, specifically in subject matter. *Mathematics for Social Scientists* is most comparable to the text by Hoy et. al., with the two texts covering nearly the exact same topics. The other two texts cover the same material, with the text by Harshbarger and Reynolds adding a section on financial calculations, and the text by Jacques adding sections on financial operations, linear programming, and differential equations.

While the subject matter in these texts is largely similar, a key distinguishing factor between the texts is their length. At just under four hundred pages, *Mathematics for Social Sciences*, is the shortest by a reasonable margin. The Jacques text is the next shortest at over six hundred pages, while the other two texts both come in at over nine hundred pages. The relative brevity of *Mathematics for Social Scientists* is both a strength and a weakness. The longer texts can be so large that it can be difficult to find specific material. However, the shorter text leaves substantially less space to explain and develop themes. Over the span of a few pages, the reader is introduced to a topic and then quite quickly to its fairly high-level application.

Mathematics for Social Scientists has two key uses. The first is as a text for introductory graduate courses or "math camps" that cover basic mathematical principles useful in the social sciences. The second is as a reference for graduate students to use independently when they encounter mathematical concepts in their work. *Mathematics for Social Scientists* is clearly and concisely written, and thus would serve as an excellent text for both of these uses. However, it does not go into great depth on any of the subjects, leaving instructors who use it to provide additional practical applications of the subject matter to the particular field of study.

A brief survey of ranked programs in the areas of sociology, psychology, and political science suggests that required introductory math courses are the exception rather than the

rule. Nevertheless, such courses are fairly standard for graduate programs in economics. This likely explains the higher number of mathematics texts for economics compared to those for other fields in social sciences. The fact that so few courses are offered in the social sciences reduces the leads one to question: whether there will be much demand for a text for such a course. Moreover, the fact that the content in *Mathematics for Social Scientists* is so similar to those designed for economics raises questions about whether the choice of content is appropriate for social sciences other than economics. A search for the content of mathematics for social sciences other than economics did not prove useful in answering this question. If the subject matter is appropriate for all social sciences, is a separate text really necessary?

Since most graduate programs in the social sciences do not require a course for which *Mathematics for Social Scientists* would be a suitable text, is it nevertheless a useful resource for students to reference on their own? As previously mentioned, the book is laid out clearly, and is clear in its explanations. It moves the reader effectively from the simpler concepts to their more complicated applications. Plus, it provides appropriate practice problems with explanations that assist the reader in grasping the concepts. Unfortunately, its relative brevity hurts it in both of these regards. The pace at which it moves from introductory to high-level concepts is too rapid at times. While this may be an appropriate feature in a course where the professor wants to emphasize particular details of her choice, it can render the book less helpful as a resource for independent work. With regard to practice problems, both a greater variety and more instructive solutions would be more helpful. As a resource for independent study, the solutions should not only help the reader know whether they answered the question correctly at each step of the process, but the solutions should be seen as part of the instructional process, explaining how the problem is worked out.

Overall, *Mathematics for Social Scientists* is a clear and well-written text that covers the full spectrum of mathematical concepts that graduate students in the social sciences are likely to encounter. Unfortunately, it may be a good tool without many opportunities for use. While the text would be appropriate for a math course for majors in economics, it is unlikely that professors using other texts will be drawn to adopting this one. Yet it would probably be helpful in similar courses for other social sciences. This text is certainly worth considering if the social sciences offer more such courses in the future.

Graduate students are likely to continue running into mathematical concepts beyond their understanding. Thus the demand for books in this genre will also continue. The biggest shortcoming of *Mathematics for Social Scientists* is its brevity. Since my time assisting graduate students in a lab for social science, many online resources have emerged, such as Khan Academy. The strengths and weaknesses of these online sources are complementary to the strengths and weaknesses of this text. What it lacks in detailed solutions may be easily resolved with an online video solution, while what they lack in textual explanation may be easily filled by the book. Paired in this way, *Mathematics for Social Scientists* can be a very useful resource.

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References

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