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Queering the Stats **A Review of David Spiegelhalter's *The Art of Statistics: Learning from Data***

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The goal of this review is to explore *The Art of Statistics* using a mathematics education perspective and to illuminate the ways that it can be used as a resource in math instruction by students, preservice teachers, and math educators in general. I take the approach that the teaching and learning of mathematics is a part of the complex system comprising of many “interacting agents” (Davis, 2018, p. 77), such as students, teacher, curricula, and technology. The content of the book is a potential resource in the classroom, a potential part of the complex network. Echoing Jorge Louis Borges’ claim that a book is not an isolated entity, but that it contains infinite narratives brought by readers (Borges, 2007), I would like to examine the potential role of the content of this book in the learning ecosystem, including how the elements of this book could be used, and repurposed to fit our pedagogical goals.

Overview of the Book

The book, by a famous British statistician David Spiegelhalter (DS), consists of 13 chapters and gives an overview of data analysis, including new advances in data science and algorithms. Unlike many traditional texts on probability and statistics, it starts with statistics and then introduces probability by outlining the relationship between the two. Using examples as varied as true crime, a UK sex survey, election polls, and examples from his own practice, DS illuminates many statistical and probabilistic ideas including sampling, Bayesian reasoning, and hypothesis testing. In the end, it offers a critique of how statistics are being used (and misused) and what we can do to use statistics better. The book contains access to R files for the data, as well as a glossary of terms that resembles glossaries in textbooks. The description of statistical and probabilistic concepts particularly of hypothesis testing and the meaning of confidence interval are one of the

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best that I have read and this description surpasses any standard textbook on probability and statistics that I have used. The book's focus on conceptual understanding is evident and the book can serve as a great introduction and refresher on statistics and probability for students (secondary and postsecondary), researchers, and teachers. In this review, however, I want to focus on several themes of the book and how the text can be used in teaching to address these themes.

From Statistical Literacy to Critical Statistical Literacy

The *Art of Statistics* incorporates a mathematics education perspective and math education literature, albeit a couple of decades old. It is refreshing that the author acknowledges that the book starts from the teaching principles and that it takes into account statistics education research, theory, and practice. In the introduction, DS adopts the Wild and Pfannkuch's (1999) Problem-Plan-Data-Analysis-Solution (PPDAC) framework, which is referred to throughout the book. Weiland (2017) makes a distinction between statistical literacy and critical statistical literacy and, according to this distinction, DS takes the statistical literacy approach, which includes making sense of data and constructing and critiquing statistical arguments in diverse contexts. In addition, DS uses the heuristics work that comes out of educational psychology, particularly Zhu and Gigerenzer's (2006) work on natural frequencies. According to Gal (2005), statistical literacy includes both knowledge elements and dispositional elements. The dispositional elements of statistical literacy include asking the "worry" questions about the data. DS does include his own version of the "worry" questions or, in his words, "ten questions to ask when confronted by a claim based on statistical evidence." (pp. 369-371).

Applying Weiland's (2017) distinction, DS falls short of introducing the critical statistics elements including the understanding how statistical arguments can shape and enforce social structures, understanding one's own privilege and positionality and how it influences the statistical arguments, and use statistical information and arguments to "destabilize and reshape structures of injustice for a more just society" (p. 41). One of the chapters of the book describes how algorithms built from data can be used for classification and prediction and describes challenges with algorithms including how they

reinforce racial bias. This chapter could be a good basis for building critical statistics literacy by motivating students to suggest ways in which such bias could be addressed and mitigated.

Queering the Art of Statistics

The book opens with the quote by Nate Silver, the founder of the opinion poll analysis platform FiveThirtyEight, that “the numbers have no way of speaking for themselves” and that people “imbue them with meaning.” (p. 1). This is true, but we also imbue the meaning with numbers. As humans, we use our own worldviews, beliefs, and social commitments to ask questions, collect quantitative data, and build interpretations. This is particularly evident in the long description, analysis, and interpretation of the UK National Sexual Attitudes and Lifestyle Survey (Natsal) which is carried in the UK every ten years since 1990. Although the survey covers all aspects of sexuality, DS focuses on heterosexual relationships and the question he is interested in answering is whether men exaggerate the number of sexual partners and whether women underreport them. In math education there has been a discussion on how cis-normative, heteronormative, and gender normative examples pervade mathematical texts, especially in recent years (Yeh, 2017) and this is definitely one of them. In addition, the gender binary is assumed in this book. Even when the author mentions that people can “switch” from one gender category to another (p. 27), he leaves out non-binary individuals, agender individuals, and other gender categories.

In order to go beyond cis- and heteronormativity, a pedagogical possibility would be looking at the UK sexuality survey and asking questions that includes 2SLGBTQ+ population or asking students to pose those questions themselves. This approach to equity which is an inclusion approach or what Rands (2009) calls “add queers and stir” is a surface-level approach which doesn’t interrogate on a deeper level what is considered normal. Instead of inclusion of 2SLGBTQ+ topics in otherwise cis-normative and heteronormative space, there have been calls for the process of queering mathematics education (Yeh & Rubel, 2020). One such approach has been done by Waid (2020) who, following Rands (2009), offers the method of mathematics inq[ue]ry by questioning the

assumption of the text and what the text considers “central”, “essential”, and “normal”. These questions go beyond gender and sexuality and interrogate the practice and communication of statistics. For example, DS presents a statistics problem concerning a “friend in the US” who has just given a birth to a baby and wants to know if the baby’s weight is “unusually low” (p. 85). He then proceeds to present the data for non-Hispanic white women in the US explaining that the “race is important, since the birth weights are reported for different races.” (p. 86). The question that would be part of the inquiry is to ask why the author decided to concentrate on non-Hispanic white women, whose data is reported and who is left out from the discussion.

Focusing specifically on gender and sexuality, Waid (2020) offers the list of the questions that are a part of mathematical inquiry and that could be applied to this book:

1. What do you notice?
2. What do you wonder?
3. What is the context?
4. What genders are represented, and how are they presented?
5. Who is included in the represented genders and who is not?
6. What other genders are there?
7. What would considering other gender identities (not just male and female) add to our understanding? (p. 14).

Productive Struggle

The book really shines when DS includes his own experience and when readers can sense the author’s excitement and anxiety about doing his job well as a statistician. For example, DS describes a randomized trial comparing alternative methods of repairing hernias decades ago where the treatments were printed on small pieces of paper and placed in envelopes. DS describes that he remembers:

watching patients lying on the pre-op trolley, with no idea which treatment they were going to get, while the anesthetist opened the envelope to reveal what was going to happen to them, and in particular whether they were going to go home with one large scar or a set of punctures. (p. 106)

Or with this confession about probability that should put most students at ease:

Even after my decades as a statistician, when asked a basic school question using probability, I have to go away, sit in silence with a pen and paper, try it a

few different ways, and finally announce what I hope is the correct answer (p. 209).

These examples humanize the practice of statistics and normalize what NCTM (2014) calls productive struggle or ingraining in the students the view that doing mathematics requires grappling with problems, making mistakes, revisiting your work, and persevering through problem solving. I don't think that enough courses in statistics offer students a chance to understand that the struggle is the norm and offering a leading statistician's recollections of his own struggles, concerns, and fears would be a great addition to the instruction.

Conclusion

The process of reviewing popular texts on mathematics from a "mathematics education perspective" leaves a question of what this process really entails. I defined this as finding the room for the text in a learning ecosystem where the text is malleable, changeable, and adaptable. In this article I offer a way in which this rich text written by one of the world's most prominent statisticians can become the part of the complex web of mathematics teaching and learning.

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