Integrating Social Justice Data and Scaffolded Writing with Universal Design Principles Into Introductory Statistics

Laura Kyser Callis
Curry College

The very history of modern statistics is entrenched in racism (Clayton, 2020). The famous statisticians whose names grace the methods students learn in introductory statistics, such as Karl Pearson and Ronald Fisher, were overt white supremacists and eugenicists (Clayton, 2020). To be redundantly clear: the methods that we teach our students were developed for the expressed purpose of having a seemingly objective measure to demonstrate the inferiority of specific populations of people (Clayton, 2020). Moreover, mathematics and statistics have often been used as weapons of oppression historically, in living memory, and today—redlining, algorithmic policing, and even, closer to home for our students, the use of mathematics placement metrics to limit who is allowed access to high-quality mathematics instruction and STEM careers (D'Ignazio & Klein, 2020; Ngo & Velasquez, 2020). Undergraduates can and should have these conversations—and, indeed, in my (elective) History of Mathematical Inquiry class, students engage in these topics with passion. However, most college students do not take math electives. Many students end their mathematics study with a required quantitative reasoning course, such as college algebra or, increasingly, statistics. It is understandable that statistics faculty may be reluctant to include the racist history of statistics in their courses. Statistics is often compulsory for students and a service course for faculty. Students may already be disengaged due to the compulsory nature, and faculty feel pressure to "cover" an ambitious list of topics in a syllabus to support the needs of other departments. Even if instructors were aware of this history, sharing it with students would, first, be time away from helping students develop the statistical mindset and skills necessary for their careers and civic participation and, second, could risk students' disengagement from the field altogether.

One solution is to integrate social justice topics and data sets into the syllabus, to use data sets about racism, sexism, and injustice to teach the statistical topics addressed in introductory statistics. This approach frames statistics as a powerful tool for highlighting the reality of injustice; it is not just a tool of the oppressor. This method can broaden the range of students who are interested in statistics and mathematics by demonstrating that statistics can be used for purposes other than finance or science; statistics can be used to help others and understand the scope of real-world problems.

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Giving students the tools to understand and quantify real-world problems with statistics is only part of the equation, however. To truly be able to use statistics for change, students need practice in communicating as well. Just like "Standard" English (see Blomstedt, this collection), mathematics and statistics are languages of power. People listen when statistics are used. Statistics instructors apprentice students into thinking statistically and communicating quantitative information.

This chapter describes two assignments that integrate real data about social justice topics and prompt students to write about quantitative information about social justice topics. The assignments, one used as an in-class lesson or discussion board prompt and the other used as a midterm project, were both used in an introductory statistics course. In this chapter, I first articulate the conceptions of equity that inform this work. Next, I detail the contexts of the college and the course in which the assignments were used. Then, I describe each assignment and the students' responses to the assignment, explaining how concepts of Universal Design for Learning (UDL) can be seen in the assignments. Last, I identify challenges that arise in designing and enacting these assignments and similar ones.

Theoretical Framework

Rochelle Gutiérrez (2012) described different conceptions of equity used by mathematics educators and researchers. She identified two dimensions of equity: the *dominant axis,* which addresses access and achievement, and the critical axis, which is concerned with identity and power. Through the *dominant axis* lens, educators consider whether students have opportunities to learn mathematics at a high level and whether these opportunities result in equitable outcomes. Educators and researchers ask, do policies result in learners from historically excluded populations enrolling in higher-level mathematics courses at the same rate as their peers? Does the curriculum support them in understanding key ideas? Do students from marginalized backgrounds learn as much and persist as long in STEM courses as their peers? The assumption of this lens is that educators are working to include students in the dominant system. However, the dominant axis does not prompt educators to consider if the system itself is a just one.

In teaching literature, Rudine Sims Bishop (1990) wrote about how books are mirrors and windows, allowing one to see both oneself and to learn about others. Gutiérrez (2012) similarly used this metaphor when explaining the role of identity in equity in mathematics education—part of the *critical lens*. If the only mathematicians highlighted in mathematics textbooks are white and male, female students of color may not see themselves in mathematics. If mathematics instruction only rewards fast fact recall and symbolic manipulation, students with processing difficulties or dyscalculia may not see themselves in mathematics. If the discourse around mathematics ability is about ranking or if classroom activities valorize competition, women, who are more likely to be socialized to cooperate, will be less likely to see themselves in mathematics. If placement policies consistently keep students of minoritized racial or linguistic groups in courses that repeat previously learned content, students may not see themselves in mathematics (Larnell, 2014; Ngo & Velasquez, 2020; Rios, 2023). If practice problems are primarily about optimization and consumer finance, learners who are more concerned with improving the world around them may not see themselves in mathematics. As Muna Abdi (2021) noted, "It is not inclusion if you are inviting people into a space you are unwilling to change."

The critical axis also addresses the idea of power. The power dimension is multilevel. At a micro level, there are power differentials in classrooms. At a macro level, there are power differentials in what counts as knowledge or proof, or who is asked to provide data to support their claims (D'Ignazio & Klein, 2020). The assignments described in this chapter are most aligned with the power dimension in that they support students in using mathematics to examine social injustice. In this way, they are aligned with the work of Eric Gutstein (2006) in *Reading and Writing the World with Mathematics*. Building on Paulo Freire's work, Gutstein defined reading the world with mathematics: "to use mathematics to understand relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language and other differences" (p. 25-26; see also Fink, this collection). To write the world with mathematics is to use mathematics to change the world. Gutstein's work offers up cases where students and communities have used mathematics to work for change, as have others (e.g., D'Ignazio & Klein, 2020; Turner & Font Strawhun, 2013).

The assignments I describe here were designed to address issues of identity and power. They were written in a context infused with efforts to address achievement and access through policy changes, curriculum examination, and professional development efforts around UDL. Admittedly, the assignments are focused more on understanding statistics than on understanding the social dynamics that lead to injustice. They are focused more on learning to write in the field of statistics than writing to change the world with mathematics. They are not social justice mathematics lessons; they are statistics lessons that use social justice contexts. However, this approach may be one that is easier for statistics instructors who are new to social justice education to implement within their introductory statistics courses without sacrificing class time for addressing statistical concepts.

Context

Curry College is a proudly neurodiverse college that welcomes students with a wide range of academic preparedness. A small private college south of Boston, Curry has a nationally recognized Program for Advancement of Learning (PAL), an optional fee-based program that supports students diagnosed with specific learning differences, executive function challenges, and attention deficit disorder. About 20 percent of incoming students enroll in the program. A recent survey of Statistics 1 sections estimated that between 29.0 percent and 43.5 percent of students identify as having a learning or attention disability or having an individualized education plan in secondary school (McNally, 2024). Because of the prevalence of students with learning differences and PAL faculty, the culture at Curry College may be very different from other colleges. Students talk more freely about their learning disabilities (LD), and many faculty understand LD through a *difference* versus a *deficit* lens. There is also familiarity with UDL principles. In this chapter, I will call attention to the elements of UDL or UDL-Math that are used in the assignments (CAST, 2011; Lambert, 2021).

Curry College also has a moderately racially diverse student body. Although we are a primarily white institution, our racial diversity mirrors that of our location, Massachusetts. Two-thirds (66.3 percent) of the students identify as White, 12.30 percent are African American, and 7.58 percent are Hispanic or Latino (*Curry College | Data USA*, 2021). In Massachusetts, 79.4 percent of residents are White, 9.5 percent are African American, and 13.1 percent are Hispanic or Latino (*U.S. Census Bureau QuickFacts*, 2022). Like other colleges across the country, Curry is not immune to the increasingly overtly racist and sexist rhetoric. In 2022, Curry experienced a bias incident the College took very seriously, canceling classes to host a mandatory community meeting of students, staff, and faculty. During that meeting, students asked faculty to include more opportunities to learn about and talk about racism, sexism, and social justice in their courses. Some of the materials described in this chapter were developed in response to students' requests.

With an acceptance rate of 88 percent in academic year (AY) 2023–2024, students in our courses vary widely in their academic preparation. Surveys of our students in Statistics 1 show that some students have taken AP Statistics or another statistics course in high school, while other students stopped at Algebra 2 in their penultimate year in secondary school. Students typically take Statistics 1 in their first or second year at Curry to meet their general education quantitative requirement or a prerequisite requirement for their major. There is often a significant amount of time between this course and students' previous mathematics courses. In our in-take assessments, student responses vary widely in regard to their perceived skill and interest in mathematics. Given the diversity in our courses, the faculty have agreed that class size for mathematics courses be capped at 26; statistics courses are usually at capacity, though summer courses may be smaller.

The course uses a simulation-based inference (SBI) curriculum rather than the consensus curriculum, Introduction to Statistical Investigations (ISI) by Nathan Tintle and colleagues (2016). In the consensus curriculum, students first study descriptive statistics and then learn the formal rules for when they can apply different distributions—primarily the binomial and normal distributions—to conduct different tests of statistical inference. Typically, there is a focus on formalism, notation, and hand calculation. In SBI, students study statistical inference at the beginning of the semester. They create chance models with real and digital dice, spinners, cards, and other probability devices to represent the null hypothesis and sampling. The curriculum we use has freely available applets for this purpose. Nationwide, researchers have found that the SBI approach has helped students to learn and retain more statistical concepts, particularly students with weaker procedural fluency (Chance et al., 2018; Tintle et al., 2012, 2018).

In our pilot of this curriculum at Curry College, we found that students with learning disabilities performed better both in terms of their final grades and in terms of a low-stakes concept inventory under the SBI curriculum, compared to the previously used consensus curriculum, even when active learning techniques were used with the consensus curriculum by an experienced instructor (Callis, 2022b; Callis & McNally, 2021; McNally, 2024). In our early investigations of instructional practices that relate to students' development of conceptual understanding, opportunities to talk with each other and with the professor about their thinking, in real time in the classroom or over Zoom, seemed to be a key component. Thus, the class uses small group work, whole class discussion, and immediate feedback systems through Desmos Activity Builder during class time.

The Assignments

Discussion Board: School Discipline

In most learning management systems, there are tools for creating discussion board assignments, where students and the instructor can write and react to each other's responses. In a statistics course, this tool allows students to consider their peers' methods and conclusions, some of which are legitimate and some of which are not, and to benefit from the feedback that the professor gives to their peers. A discussion board can be a space that is in between the informality of a student's own notebook, which only needs to be understood by one individual, and a formal paper, which is expected to provide enough detail to be understandable by the academic community and to follow the conventions and formalism of a particular discipline.

As part of addressing students' desire to have more opportunities to engage in social justice issues in their other courses, I created three discussion board prompts that ask them to apply the methods they have learned to scenarios addressing racism and sexism. I piloted these prompts in a summer 2023 course. Some of the students completed the course asynchronously, and some joined a synchronous session on Zoom, so there were likely varying degrees of feelings of belonging among different students. Students were graded on the prompts and received ongoing feedback from their peers and from me. At the end of the semester, students chose one of their responses to write up more formally for an ePortfolio, a requirement of the General Education curriculum. One of the prompts is presented below.

Discussion Board: The Chance Model & Pre-School Discipline

> There are a lot of data that suggests that African American children are more likely to receive exclusionary discipline consequences, like suspension and expulsion, than White American children in public schools, even for the same behavior. One group of researchers at the Yale Child Center began to investigate whether teachers might be more likely to unconsciously expect African American children to misbehave [see https://tinyurl.com/yzut382r]. They asked teachers to watch a video of four children together in a preschool setting: an African American boy, an African American girl, a White boy, and a White girl. The teachers were told that the researchers were interested in teachers' perception of misbehavior, but they did not tell the teachers they were investigating race. Teachers were told to press a bar if they saw misbehavior in the video, but no misbehavior occurred. The teachers were then asked which child they were the most "concerned" about in terms of needing to watch for potential misbehavior. There were 132 teachers in the study. 42 percent of the teachers chose the African American boy as the child they were most concerned about in terms of potential misbehavior.
>
> In a 2-3 paragraph response, address all of the questions below.
>
> 1. Why might this issue be worth investigating?
> 2. What is the research question?
> 3. What is the parameter of interest?
> 4. What percent of the teachers would you expect to choose the African American boy if race and gender were not factors?
> 5. What are the null and alternative hypotheses? Write them in words and symbols.
> 6. What is the value of the sample statistic?
> 7. How would you set up a simulation to determine if the sample statistics could have occurred due to chance alone?
> 8. Run the simulation using spinners in the applet [see https://tinyurl.com/rt585wxk]. Report your p-value.
> 9. Make a conclusion about this study. Does race and/or gender seem to impact teachers' anticipation of preschool students' misbehavior?

Student Response. Eight of the students who wrote responses to this prompt correctly answered all parts of the question and engaged in a concerned way about the topic itself—children and racism. They explained the null model conceptually—if racism were not a factor, we would expect the African American boy to be picked 1 out of 4, or 25 percent, of the time. This could be modeled by spinning a spinner with four equal parts, each part labeled with one of the children, and spinning the spinner 132 times to represent the 132 teachers. These eight students were also able to articulate conclusions that reflected their understanding of the simulation and the resulting p-value. These students were able to write the hypotheses correctly with formal notation, $H_0{:}\pi = 0.25$ and $H_A{:}\pi > 0.25$, where π represents the long-run proportion of times the African American boy would be chosen if it was random chance.

Four of the students set up their null hypotheses "incorrectly": $H_0{:}\pi = 0.5$ and $H_A{:}\pi > 0.5$, but these were sensical "mistakes"—in their less formal writing, they explained that they were testing a hypothesis that African American and White American children were equally likely to be identified by the teachers; gender was not taken into account. Indeed, one of the students herself pointed out this difference in method. Their conclusions would have been valid if they had included the African American girls in their sample statistic. The linked article notes that 11 percent of the teachers chose the African American girls, so the sample proportion of teachers choosing an African American student would be 42% + 11% = 53%. However, this "mistake" led to very rich discussions. For instance, it does not make sense to test the one-sided alternative hypothesis $H_A{:}\pi > 0.5$ if our sample proportion is smaller than the null hypothesis parameter value, as 0.42 is compared to 0.5; this reason is why these four students were getting such unusual p-values, over 0.50. A one-sided alternative hypothesis needs to align with the direction of the data. The "mistake" also highlights the importance of multivariable thinking. If we ignore gender and use the sample statistic of 0.53, the proportion of teachers who chose an African American student, we find that the p-value is quite large, around 0.28. The sample proportion of 0.53 is so close to our null hypothesis parameter value of 0.50; a difference of 0.03 could be due to chance. However, when we consider gender *and* race, when we use the sample proportion of 0.42 teachers choosing an African American boy as concerning and the null hypothesis parameter value of 0.25, the p-value is very close to 0. The sample proportion of 0.42 is so far away from what we would expect under the chance model, 0.25, that it is not reasonable to think this difference would be due to chance. These are major topics in statistical inference—multivariable thinking, the role of chance, factors that impact the strength of evidence—and these issues were able to surface in the first two weeks of the semester through a writing assignment that gave students access to their peers' thinking and the instructors' thoughts on their thinking. These opportunities might have occurred during a traditional class, but the writing assignment allowed there to be a public record of these topics.

The affective impact of writing for others about social topics is also evident here. Students commented on the unfairness of African American preschoolers being expected to misbehave more by teachers. They cheered each other on in their responses as well. Often, mathematics is portrayed as cold and unemotional, but educational researchers know that emotion is an important part of learning. One student commented on the prompt's impact on her perception of mathematics in a response to a peer's post: "It's interesting how statistics can be used to solve societal and racial issues, I feel like that's often brushed past and it is mainly only viewed as something used solely for math-based problems." Addressing social issues in community writing assignments like discussion boards may be a way to bring emotion back to mathematics.

Mid Term Project: Deaths in Police Interactions

One of the challenges instructors face in introductory statistics courses is giving students the opportunity to explore all parts of the statistical inquiry cycle. In our curriculum, students identify a research question from an existing study, but they do not create their own research question. Developing a research question, collecting or finding a data set, and cleaning the data can all take well over a semester, leaving little to no time to explore and analyze the data itself. In addition, learning how to conduct the methods using technology itself can be a challenge. To give students an opportunity to engage in more parts of the statistical inquiry cycle, for the past three years, I have assigned a controlled research project; students must use the data set I choose in Google Sheets so that I can support them; being familiar with 30 to 50 different data sets that students find would take too much time away from the work that I know has an immediate impact on student learning.

The data set we use is found at www.fatalencounters.org (Burghart, 2021). Housed in a Google Sheet, it attempts to document every death that has occurred in a police interaction. Paid and volunteer researchers use media reports, but they also comb through files from Freedom of Information Act requests and other data sources. There are over 30,000 cases, but the author is clear that this is not exhaustive; there is no way to know how many people actually die in police presence. There are several variables, some well researched and others still developing, from the intended and actual use of force, the location, the race, recorded gender, and age of the deceased. Students are tasked with identifying a research question *that can be answered with this data set* and working through the statistical inquiry process to answer that question in a final, short paper.

Another challenge that instructors face with final papers such as these is receiving poor quality products that are difficult to grade. One solution to this is breaking a project into steps and giving feedback to students throughout the semester on each step. For this project, each step is a step in the statistical inquiry process. First, in the second week of class, I orient students to the data. Students have some time to talk in groups about the data set and develop three research questions that they think could be answered by this data set. They post their potential questions on a discussion board post. I give them feedback on their questions. For example, *Does the race of the police officer matter?* is a very important question but one that cannot be answered by this data set, as there is no information about the officers. Students also benefit from support in developing research questions that lead to a plan of action. For example, one student suggested, *Does the location matter?* While an excellent question, it does not have an obvious plan of action. Instead, we might ask something like, *Are people disproportionately likely to be killed in a police interaction in a city or suburb? In a state with gun control laws or without? In higher poverty neighborhoods or lower poverty neighborhoods?* Students might ask questions that leave very little to write about, questions that are *mathematical* questions and not *statistical* questions—questions that do not anticipate variability. For example, students have suggested *How many victims have been shot by police?* This question can be answered with a single number; it is a mathematical question, not a statistical question.

In the fourth week of class, students review my comments and the comments of their peers to choose a research question. On the discussion board, after a brief conversation with peers in class, they brainstorm some graphs and methods that could help them answer the research question. This step is another opportunity for me to give them early guidance. For example, students are often interested in the number of deaths that occur in different states. However, states vary significantly in their populations; a bar graph of the *number* of deaths in each state would look very similar to a graph of the state populations and add very little insight. On the discussion board, I coach them through thinking about rates per 1000 people, very similar to a percentage, that could help us understand the relationship between states and deaths that occur in police presence in a deeper way. As another example, students are often surprised to find that there are more instances of White people dying in a police interaction than African Americans—14,731 White people, or 46.78 percent of the data set, compared to 8,545 African Americans, or 27.13 percent of the data set. However, there are more White people in the United States than there are African Americans. The United States is 75.5 percent White and 13.6 percent African Americans; 27.13 percent is a lot higher than 13.6 percent, and this is what is meant by the idea that African Americans are disproportionately likely to be killed in a police interaction.

The discussion boards are also a way for the instructor to gain data to inform instruction. Based on the questions I see students asking, I create videos using their lines of inquiry to show them different spreadsheet techniques, such as pivot tables. Watching these videos and trying some techniques is their pre-homework for the two class sessions that we spend working on the project, either independently or in groups, as I circulate to help. For efficiency, during this class period, I also group students together who have similar lines of investigation so that they can support each other, and I can troubleshoot the same technique fewer times.

The discussion boards also serve as a way for me to address students' use of language before their final product. There are language challenges that are both mathematical and contextual. Contextually, for example, students sometimes refer to the deceased in the spreadsheet as "criminals" or "suspects," but they are not all criminals or suspects. Indeed, one of the deceased has the age listed as 0.25—a three-month-old baby who was killed in a vehicle pursuit, the linked story explains. A three-month-old baby cannot be a criminal or a suspect. As a mathematical example, the issue of the denominators used in percentages often appears when students are studying two categorical variables. For example, students are often interested in the relationship between the highest use of force and gender. In a pivot table, students can find the total number of women who died in a vehicle pursuit. Dividing by the total number of women would lead to a different percentage than dividing by the total number of people who died in a vehicle pursuit. The sentence construction must match the calculations so that we understand which "whole" or divisor was used. Some guidance can be provided on the discussion board, and some points are worthy of addressing with the whole class during class time. This feedback is more likely to be picked up by students than comments on an end-of-term paper.

The discussion boards also allow students to interact in a hybrid social/academic way that may be limited during class time due to seating habits. On the discussion board, the instructor can direct students to others who have similar ideas for research projects, enabling them to find peers to work together with—either to work together on one common project or to submit separate projects but support each other with technology during class time. In interviews with students with learning disabilities or negative prior mathematics experiences, students reported that these structured times to interact socially and academically helped them learn more both during and outside of class time (Callis, 2022b).

Student Response. Statistics 1 is an introductory class; it introduces key ideas. In mid- and upper-level classes, these ideas are reinforced and mastered. The Fatal Encounters project is also a midterm project submitted in the seventh week of class; it is more a learning opportunity than a formative assessment. Given these stipulations, Tables 4.1 and 4.2 show some data from student papers.

The first finding is that, while the project allows students to choose variables other than race, students are willing to investigate race. Table 4.1 lists the topics students chose during the 2022-2023 academic year. Students were also very interested in multivariable thinking. For instance, some wondered if the relationship between gender and the highest level of force used was different for different racial groups. The asterisk indicates that projects in this topic may overlap with other topics.

Second, students were able to engage with the learning outcomes for the course. Table 4.2 describes the learning outcomes and the degree to which they were achieved by students through the project.

Among the fall 2022 papers, 21 students communicated clearly about the meaning of the quantitative information and connected the numbers with the context. In contrast, 22 students communicated and made connections but required clarification on some points on the final paper. These numbers are not necessarily comparable. Students varied in the complexity of their questions and the complexity of the spreadsheet mechanics to answer their questions. More complexity results in a higher challenge to precisely articulate conclusions. In short, this is not a standardized assessment.

Table 4.1. Topics Chosen by Students in Fatal Encounters in Police Interactions Project

Topic	**Number of student projects spring 2022**	**Number of student projects fall 2022**
Race*	17 (53%)	11 (37%)
Age*	6 (19%)	8 (27%)
Gender*	9 (28%)	5 (17%)
Geography	8 (25%)	2 (7%)
Time	0	1 (3%)
Mental Health	1 (3%)	1 (3%)
Other	1 (3%)	1 (3%)
Total	**32**	**29**

** Projects may overlap in topic.*

Table 4.2. Learning Outcomes Addressed by the Fatal Encounters Project

Learning Outcome	**Level**
Engage in regular discussion of quantitative information or results, with special emphasis on the context of the problem and general, real-world knowledge.	Achieved by all who submitted paper
Utilize statistics software to perform data analyses to interpret and compare multiple representations of quantitative information and draw inferences from them.	With support
Organize, summarize, interpret, and compare single-variable data using descriptive methods of statistics.	With support
Recognize and apply the different representations of quantitative information (e.g., symbolic, visual, numerical, verbal) when describing relationships between two variables.	With support
Communicate quantitative information effectively, incorporating symbolic, numeric, and/or graphical representations and appropriate syntax within verbal and written communication.	Varies; majority met with support & feedback

The purpose of the project is not just to master learning outcomes, however. The project also provides the instructor with ways to see students' capabilities beyond mathematics. Through mentoring students in this project each semester, I witness their writing skills, their perseverance, their ability to act on feedback, and other skills needed in their workforce and civic life. I call upon what I notice about individual students in many situations. I invite students with quality projects to present at the college academic forum. Two of my students, both women, have presented, and one of them went on to present at the Joint Mathematics Meeting, the largest mathematics conference in the world, on a panel on undergraduate research (Conley et al., 2023). Inspired by Talithia Williams' introduction to her book *Power in Numbers* (2018), where she describes a moment when a teacher suggested she study mathematics, I personally invite students to take more mathematics, and my observations of their work on the project or in class directly impact the invitations. At the end of the semester, I look at all students who have received a grade of B- or higher. I write them emails, personalized based on their major and the skills I've noticed that they bring to the class, to suggest they consider a math or data analytics minor. Students often write me back with grateful emails, surprised to think of themselves as a "math person." When mathematics is done in a social, supportive environment with a real purpose that matters, many more people can think of themselves as "math people."

Universal Design for Learning

Based on learning sciences, the UDL Guidelines provide a framework for designing instruction to support students with learning differences (CAST, 2011). Like universal design in architecture, the elements of design in UDL often end up benefiting all learners, including neurotypical learners. UDL calls for engagement in the three neural networks used in learning: the affective network, the recognition network, and the strategic network. These networks are activated across the process of learning: accessing, building, and internalizing knowledge. A full discussion of the Guidelines is outside the scope of this chapter; more detail can be found at https://udlguidelines.cast.org/. Here, I give a few examples of how the assignments described above demonstrate elements of UDL. I do not claim that these assignments are exemplars of universal design. Instead, I offer an example of how statistics instructors might begin to think through elements of their assignments with UDL in mind.

Under "Engagement," to activate the affective network and provide access to the content for students, Guideline 7 calls for recruiting interest by optimizing individual choice and autonomy (Checkpoint 7.1) and relevance, value, and authenticity (Checkpoint 7.2). The authors of the Guidelines recognize it is not appropriate to give choice over every component of an assignment; as an example, I limit students to a particular data set rather than allowing them to choose a data set so that we can better support each other. Students do, however, have a choice in their research question. They are allowed to choose whether they work independently or with a group; even if they work with others, they are allowed to choose whether they will submit separate individual papers or one final group product. They have some choice in their analysis methods, though this is highly guided by the instructor through feedback so that they are making sensical choices. The context of these two assignments is also socially relevant. Students had asked for more opportunities to discuss racism in their other courses; they lived with racism through the bias incident. They themselves remember being students in preK-12 schools and have thoughts and opinions on teachers' perception of misbehavior, or lack thereof. Students are also learning skills, such as manipulation of data through Google Sheets, that they can use in their classes and their daily lives. While many students will go on to learn other data analysis software, because Google Sheets is free, widely accessible, and shareable, it or Microsoft Excel, which behaves similarly, is likely to be highly used in their careers or personal lives.

Under "Representation," to activate the recognition network and build understanding, the Guidelines recommend attending to vocabulary, symbols, syntax, and structure (Checkpoints 2.1 and 2.2). Statistics is a particularly language- and symbol-heavy discipline. It is not just a matter of new vocabulary and symbols; familiar words and symbols are also repurposed. For example, the word "mean" now signifies average; the word "variable" is no longer just a placeholder for an unknown numerical value; the symbol π now represents a population parameter instead of a familiar irrational constant. There is also a high level of precision required, both when explaining common quantities like percentages, as described earlier, and when explaining new concepts, like a p-value. For example, the p-value is not the likelihood that the null hypothesis is true; it is the likelihood of getting results similar to the observed statistic *if* the null hypothesis were true. To novices, these seem like equivalent descriptions, but they have very different meanings and consequences. The two assignments highlighted here provided repeated opportunities, through the discussion boards, for students to use both more casual language and to try out the more formal language of the discipline. The discussion board allowed me, as the instructor, to give students feedback on their developing use of the language of the discipline. Instruction for these assignments was also provided with multiple media (Checkpoint 2.5). Students had access to closed-captioned videos demonstrating how to use the applets and execute techniques in Google Sheets. Students also had static handouts with annotated pictures. In addition, I demonstrated to students in class and during office hours in real time and coached them as they tried the techniques themselves.

Under "Action & Expression," to activate the strategic network to internalize learning, the Guidelines suggest supporting planning and strategy development (Checkpoint 6.2). For example, they suggest providing "prompts to stop and think before acting," "checklists and project planning templates," and "guides for breaking long-term goals into reachable short-term objectives."(CAST, 2011, p. 26) In the Fatal Encounters project, the discussion board prompts served as a guide to break the long-term project into short-term objectives: identifying a research question, planning an analysis method, conducting the analysis, and writing the findings. There was also a template for completing the assignment, with a model response, so that students could envision the final product. The prompt for analyzing the preschool teachers' data was also scaffolded with individual prompts to work through the process. Eventually, the hope is that students will be able to work through the process on their own, but in an introductory statistics course, repeated, explicit modeling of the inquiry process can support students to internalize it.

There are other ways in which these assignments incorporate the UDL Guidelines and ways in which the assignments may fail to incorporate the Guidelines. Awareness of the Guidelines and the way they inform assignments helps me, as an instructor, think more carefully about what I emphasize and make explicit to students and how I can continue to improve the assignments over time.

Challenges in the Design and Enactment of the Assignments

All teaching has challenges. Some challenges are meaningful and interesting. In enacting these assignments, I have mostly found meaningful and interesting challenges. In designing additional assignments that integrate social justice data sets, I continue to face challenges and wonder whether there are challenges that are still unknown.

With the Fatal Encounters project, the first challenge is helping students navigate discomfort with an open-ended, ambiguous project. In most school contexts, students are not typically asked to develop their own research question, and many are unaware of what a worthwhile research question would be. This can cause frustration and confusion among some students. However, I believe that sitting with this frustration, confusion, and anxiety is a life skill they will call upon in their careers, and so it is worth the time, effort, and discomfort to help them build this skill. At the end of the project, I teach them how to talk about this experience in interview questions.

Whenever a project is incorporated into a course, the first question other faculty often ask is, how do you find the time? This question especially comes up when technology is used because both the content and the technology are new to students. In my experience, introductory statistics students typically know very little about spreadsheets; even understanding the impact of clicking on a cell, column, or row is new. I front load many issues by using the discussion board to give feedback, giving students a few minutes in class to read the feedback and brainstorm with their peers, and providing videos and handouts as resources. Instead of a midterm exam and review period, we work for two 75-minute periods in class on the project. If students have not completed the project by then and still need support, I meet with them during office hours, either in person or over Zoom. During these weeks, I schedule extra time for office hours, which is a challenge with a full course load, advising duties, and service commitments. However, this challenge is meaningful and interesting: meeting with students individually is rewarding and positively impacts my relationship with them. It helps them develop a habit of meeting with their professors, which will support them in their other courses.

In designing lessons that incorporate social justice contexts, the biggest challenge is finding studies and data sets. Racism, sexism, and injustice are complex, multivariable issues. Therefore, studies investigating these issues use complex methods for multivariable analysis, which introductory statistics students have not yet been exposed to. In addition, our curriculum uses simulation-based inference (SBI), which often requires that we have close-to-raw data, which is typically not provided in papers or available by contacting the authors. Creating new lessons requires a significant amount of time reading research studies to understand the phenomenon oneself and searching for data that would not only be accessible to students at a given point in the semester but also highlights a particular mathematical idea, such as factors that influence the width of a confidence interval or size of the p-value.

There may be challenges and difficulties that I am not aware of. I recognize that for many students in my classes, issues of racism, sexism, and injustice could be painful issues to consider. I am a white woman. While I have experienced sexism, I have not been afraid for my safety in a police interaction because of my race. I have not felt like a teacher expected I would misbehave. Before we begin a lesson, I check in with students using a Desmos slide to see how they feel about the topic. This lets me assess if we are in a somewhat safe space. For instance, one beginning slide asks students what they think about deaths that occur in police interactions. So far, students have indicated that it is upsetting, wrong, tragic, and important to address. A secondary reason I have for allowing students to choose their own research question is so that students can choose to examine something other than race. I don't ask students to present their findings or to share their personal experiences. I do not include questions that ask about racism on high-stakes summative assessments. I thank students for being willing to engage with difficult topics. I hope that these choices mitigate the discomfort the right amount. Bringing emotion back into mathematics, rehumanizing mathematics, is not without risk.

Conclusion

Often, the discourse around equity in STEM is about increasing the number of students who go further in STEM pathways and careers. The outcomes of interest are participation rates, pass rates, and persistence rates. Even in introductory courses that serve non-STEM majors, questions of success for introductory quantitative courses are often framed around success within a student's major or career. However, preparing students for careers is only one goal of higher education. We are also responsible for preparing students—of all majors—to become active, caring citizens. To this end, introductory courses that serve the general student body can be a place where students can learn to consider, discuss, investigate, and write about challenging and important issues affecting our world. Courses can attend to both the dominant axis, to access and achievement, as well as to the critical axis, to identity and power, and hopefully, the work on both dimensions will be mutually reinforcing.

The Curry College mathematics faculty has a commitment to equity. As a department, we worked together to pilot a curriculum and examine its impact on students with learning disabilities and African American students, not just on the aggregate learning gains (Callis, 2022b; McNally, 2024). We examined and changed our assignments, our policies, and our course offerings using the UDL frameworks (Callis, 2022a). As a result, we have seen positive outcomes in the access and achievement dimension. The diversity of students taking upper-level mathematics courses has outpaced the growing diversity of the college (McNally & Callis, 2021). The gap between students with learning disabilities and neurotypical students and between BIPOC students and white students has narrowed in multiple measures in Statistics 1 (McNally, 2024).

On the critical axis, I hope that the assignments I design, like the ones described here, address issues of identity and power. I hope that students are able to see themselves as mathematical because mathematics is about collaboration, about trying things out, about caring relationships, and about addressing issues that matter. I hope, too, that they learn that mathematics is a tool for critiquing injustice; it is not just a tool for science and finance. Though it is necessary to critique the disciplines of mathematics and statistics, which enjoy their own unearned privilege as "objective," many instructors, myself included, dare not broach this topic with introductory statistics students, who may already be suspicious of a subject that has been unkind to them in their K-12 schooling. Perhaps, however, by using data sets that highlight injustice to teach the statistical topics we are charged with teaching anyway, we can recruit a wider range of students to the quantitative fields. Then, perhaps they can join us in the critique—or they can stand on our shoulders, as Newton stood on the shoulders of his forebearers, and see new possibilities for mathematics and statistics based on justice.

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