INTRODUCING STATISTICS TO ULTRA-ORTHODOX JEWISH STUDENTS BY EXAMPLES FROM THE BIBLE

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The Holy Bible is a source of many disputes and discussions. Some issues that are discussed may be reviewed considering the knowledge that modern science has to offer, specifically the principles of statistics. In this paper, we aim to examine a biblical story that is found in the Book of Daniel the prophet through the prism of statistics. The text describes the first documented clinical experiment conducted by Daniel and three of his friends. This story enables the calculation of p-value and can serve to present the principles of experiment design. We believe that this approach will make the study of statistics more understandable to the Ultra-Orthodox students and increase their motivation to engage in scientific studies.

INTRODUCTION

Understanding statistics is key to conducting and critically reviewing research in almost any field of science. Therefore, unsurprisingly, statistics is a topic that is included in the curricula of most higher education programs across the world. Probability and statistics are introduced in at least one mandatory course in both undergraduate and graduate programs. Making statistics accessible to the general student population may be challenging because, in many cases, the students taking a statistics course are not inclined toward exact sciences and specifically mathematics.

In addition, student populations may be culturally diverse. A large body of knowledge demonstrates the importance of awareness of cultural diversity in the classroom as well as the need to adjust classroom management, teaching styles, and learning styles accordingly. Lesser (2008) presents a statistical literacy course with a gender equity theme. Plank and DiPietro (2008) describe a freshman seminar course that explored statistics of the gay and lesbian population. Verhoeven and Tempelaar (2014) provide an overview of the literature regarding statistics education and cultural diversity. They found patterns of differences between cultural regions in attitudes towards statistics, which should not be ignored when teaching statistics. Hulsizer and Woolf (2009) argue that statistical reasoning and thinking require understanding context, and because diversity is contextual, instructors must take diversity into account. They describe diversity as including race/ethnicity, gender, sexual orientation, age, disability, cross-cultural, international, socioeconomic status, language, educational level, religion, marital status, social class/caste, computer literacy, and physical appearance. In conclusion, teaching statistics should be culture-oriented and sensitive to students' backgrounds. Introducing statistical concepts may be more effective when using ideas and examples from the students' own cultural environment.

In accordance with Lesser (2010), we wish to argue that good course examples should be taken from the students' everyday lifestyles that would address problems and issues to which the students can relate. Along these lines, we wish to present the challenge of teaching statistics to a specific population—the ultra-Orthodox (Haredi) Jewish community in Israel.

In reference to students in Israel, Cahaner and Malach (2021) state that the number of ultra-Orthodox students in academic degree programs has been small for many years. After changes in the demands of the labour market, however, academic institutions specifically tailored courses to the needs of the ultra-Orthodox population. Between 2010 to 2020, the number of ultra-Orthodox students in higher education increased three-fold. According to Cahaner and Malach, in the 2019–2020 academic year, their numbers had reached 13,100, and 68% of them were women. In the same year, the number of ultra-Orthodox students rose once again, by a rate of 9–12% for ultra-Orthodox women and just 3% for ultra-Orthodox men. The number of those studying in advanced degree programs has risen even more dramatically, reaching 1,630 in 2019—five times the corresponding figure for 2010. In 2019–2020 alone, the number of ultra-Orthodox students in advanced degree programs rose by 17%, as compared with the previous year.

On his website, Jonathan Rosenberg demonstrates several interesting applications of probability theory, knot theory and game theory in explaining some verses from the Mishna, a written

collection of Jewish oral laws. He shows, for example, how the expected number of children in a family varies according to the interpretation of the biblical command to "be fruitful and multiply." His explanation can be used to demonstrate the concepts of random variables, expected values, and variance, and practice their calculations.

In this work, we present one example of how a Biblical story can be used to make relevant the concepts concerning clinical trials and hypothesis testing. This example has not yet been tested in an actual class setting and is intended for use in an introductory statistics course.

EXAMPLE OF A CLINICAL TRIAL

The Book of Daniel is one of the books comprising the Holy Scripts of the Jewish people. The events that it describes are dated around the 7th century BC at the time when the people of Israel were forcibly exiled to the land of Babylon. Because of their fine qualities, the King of Babylon chose Daniel and three other young men to serve as his consultants. Therefore, the king insisted that they had the best food and wine from the king's table. As such, a diet was necessarily in contrast with the Jewish dietary laws of *Kashrut*, and Daniel was not willing to eat this food under any circumstances. When he informed the king's official that he and his fellow Israelites will not eat the king's food...

> The official told Daniel, "I am afraid of my lord the king, who has assigned your food and drink. Why should he see you looking worse than the other young men your age? The king would then have my head because of you." Daniel then said to the guard whom the chief official had appointed over Daniel, Hananiah, Mishael and Azariah, "Please test your servants for ten days: Give us nothing but vegetables to eat and water to drink. Then compare our appearance with that of the young men who eat the royal food, and treat your servants in accordance with what you see." (*The New International Version*, 2011, Daniel 1:10–13)

In that, Daniel proposes a clinical trial.

The following questions could be asked of students, depending on the students' knowledge:

1. What are this study's characteristics? In this case, the study is cross-sectional, comparing a sample of four Israelites to the sample of Babylonian youngsters who also dined at the king's table.
2. What is this study's outcome? How can it be measured? The outcome is the general well-being of the participants. It could be measured by weight, physical fitness (ability to perform certain tasks), mental capability, and more. The actual measure that was used in the story was a subjective measure of health and of good looks, based on the official's own impression.
3. What intervention is proposed here? The type of diet is used as an intervention.
4. What hypotheses are being tested? This is an interesting question because it strongly depends on who serves as the researcher here.
   (a) We may consider Daniel to be posing a research hypothesis, stating that he and his friends will *benefit* from the vegan diet they will follow. By that, he states a classic research hypothesis indicating a difference between two populations.
   (b) Daniel may be positing a non-traditional research hypothesis, stating non-inferiority of the diet he suggested compared to the king's diet,
   (c) The king's official may be posing the research hypothesis, stating that the vegan diet will have an adverse effect on Daniel and his friends. Again, this is a classic research hypothesis.
5. What are type I and type II errors in the study, assuming hypothesis (a) is tested? A Type I error would result from concluding that the Israelite's diet is better than the common diet when there is no actual difference between them. A Type II error would result from concluding that no difference exists between the diets when they are different.
6. What statistical test might be used here? Because we have no quantitative measure, and we rely upon the official's impression, the Mann-Whitney test may be applied if the official would rank his observations. Otherwise, the chi-square test (or Fisher's exact test, considering sample size) may be suitable if all that we know is if a boy looked "good" or "bad" at the end of the 10 experimental days, or maybe "better" or "worse" than the baseline measurement at day 0. A comparison can be made between the two groups, to test if appearing "good" or "better" depends on the diet—vegan or royal.

To complete the story, the experiment was conducted over a period of 10 days. At the end of the trial period, Daniel and his friends "looked healthier and better nourished than any of the young men who ate the royal food" (*The New International Version*, 2011, Daniel 1:15).

7. Describe the study's findings. The findings depend upon how we formulate this study's hypotheses, referring to the above enumeration.
   (a) The null hypothesis is rejected, we conclude that indeed the vegan diet positively affected Daniel and his friends' physical health.
   (b) The vegan diet is not inferior to the regular one.
   (c) The null hypothesis is not rejected. The vegan diet is not harmful.
8. What are the study's limitations?
   (a) The study did not employ random allocation. In fact, participants self-selected their own group assignment.
   (b) The observations are not necessarily independent.
   (c) The study design is not double-blind or blind.
   (d) Given the above, no causality can be inferred.

CONCLUSION AND FUTURE RESEARCH

We believe that effort should be made to identify and use classroom examples that are culturally sensitive, namely taken from the students' familiar world. This article demonstrates how the Holy Scriptures can be integrated into the teaching of statistics—a topic that is completely different and seemingly totally unrelated to reading the Bible.

Future studies should test the efficaciousness of such examples in two areas—one, the practical understanding of the statistical concepts, and two, the reduction of statistics anxiety. Statistical anxiety refers to "the feelings of anxiety encountered when taking a statistics course or doing statistical analyses, that is gathering, processing or interpreting data" (Cruise et al., 1985). Teachers of non-statistics majors often encounter various levels of anxiety and resentment towards statistics courses, even when the course is not highly mathematical in nature, but more practical. Bringing statistics "closer to home" by using culture-related examples reduces anxiety and resentment. It also aids in increasing the understanding of statistics and its importance.

The use of Biblical examples in teaching statistics will make statistics classes more accessible and interesting. This may be true not only for Jewish religious students but also for students from other Christian religious and cultural backgrounds. Adapting this teaching concept of using sacred literature or other culturally sensitive examples endows the field of statistics with greater relevance.

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