Are life sciences students prepared for quantitative research?

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Scholarship of Teaching and Learning
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Human Biology
UNIVERSITY OF TORONTO

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FACULTY OF ARTS & SCIENCE

Department of Statistical Sciences

Motivation

Background

- Widespread misuse and interpretation of statistics, especially in the life sciences (Weissgerber et al., 2016) impacting validity of research results.
- Statistical error rates of 38% or higher reported by many authors over the last several decades (Allen, 2015).
- Most "misuses of statistics are inadvertent and are from a lack of knowledge or planning" (Thiese et al., 2015).
- Need for improvements to quantitative training in life sciences (e.g., Gardenier & Resnik, 2002, Weissgerber et al., 2016).

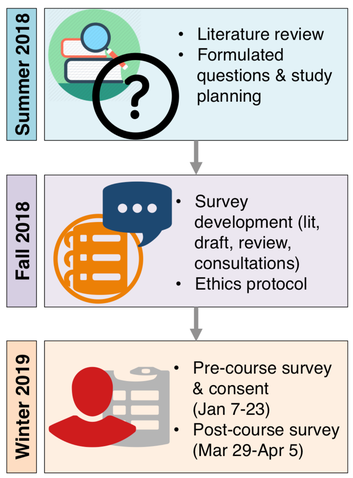
Context

- **Team-taught** (Statistics + Human Biology) statistics course for Human Biology and Pharmacology & Toxicology students introduced in 2018.
- **Non-traditional introductory statistics course** (e.g., little emphasis on calculations; focus on conceptual understanding, interpretation, critical thinking and decision-making; integration with research process)

STA288H1: Statistics and Scientific Inquiry in the Life Sciences
Hours: 36L/18P
Introduction to statistics and its connection to all stages of the scientific inquiry process. Issues around data collection, analysis and interpretation are emphasized to inform study design and critical assessment of published research. Statistical software is used to conduct descriptive and inferential statistics to address basic life sciences research questions.
Prerequisite: BIO230H1/BIO255H1

Is this course preparing students to engage with statistics in life sciences research?

Methods

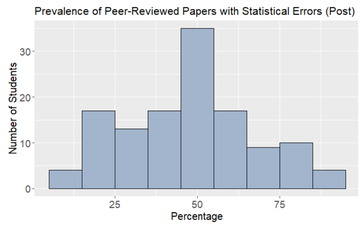


Pictured Above: RAs, Lilin Tong & Mack Zhao with Dr. Bethany White

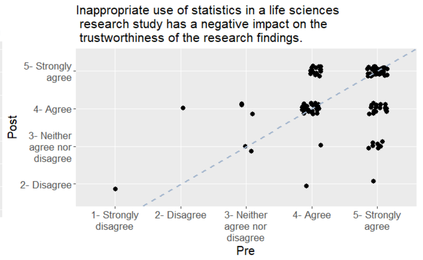
- RAs (previous STA288 students; not connected with W19 course) managed surveys and data
- Surveys (not participation) each worth 1% of students' grade
- 68% **female**; 71% **year 2**
- Participation rate = 83% (n=126)

Results

Student perceptions about statistical errors



Post-survey responses about % of life sciences research published in peer-reviewed journals that involve inappropriate use of statistics. 95% CI for mean 48.3% ± 3.4%.

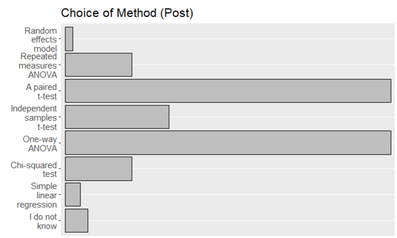


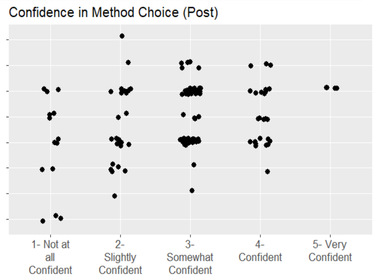
Students' perceived impact of misuse of statistics on trustworthiness of research findings (post- versus pre-survey responses).

Ability to recognize when standard methods are not appropriate

You are in a laboratory course where you are working with a group of students to collect data on the effects of different drugs on blood vessel constriction. The experimental apparatus is set up so that an artery is mounted on a contraction measuring device in a bath. Different drug solutions can be added to the bath. The baseline contraction is measured, then the contraction is measured after adding Drug A, and again after B. After administering Drug A, the bath is emptied and washed out before Drug B is added. Each group of students uses one artery sample. The class results are summarized in the following table:

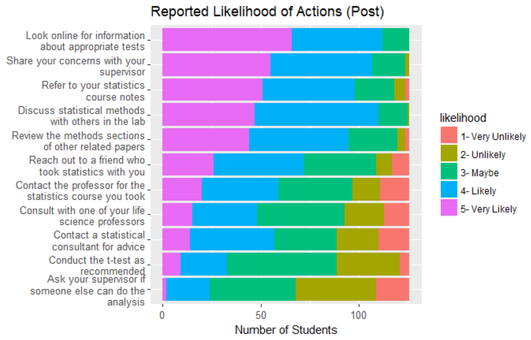
Group #	Contraction force (g) at baseline – No drug	Contraction force (g) after Drug A	Contraction force (g) after Drug B
1	2.9	2.3	4.1
2	2.8	3.1	3.8
3	3.2	3.5	4.7
4	3.0	2.6	4.2
5	2.9	2.9	3.9
6	2.6	3.8	5.2
7	2.6	3.2	4.3
8	2.9	2.5	4.0
9	2.8	3.1	4.6
10	2.7	3.0	4.7





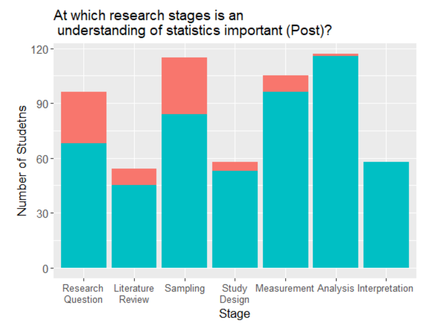
Selected methods (and reported confidence on their choices) for these data on post-survey. *Best answers are "Repeated measures ANOVA" or "Random effects model" (neither covered in STA288).*

Actions when advised to perform an inappropriate t-test

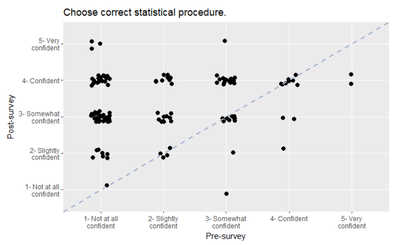


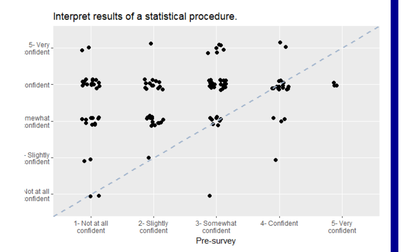
Results

Perceived relevance of statistics and self-efficacy



- <50% of students see relevance of statistics in literature review, study design & interpretation
- 77% of students more confident to choose correct statistical procedure at post
- 74% of students more confident to interpret results at post





Conclusions

- **Self-efficacy** to choose correct statistical procedure and interpret results **improved**.
- Many students still **not** able to recognize when **standard methods** not appropriate at end of course.
- **Not** all students see the **relevance** of statistics to all stages of scientific inquiry process.

Next steps

- Develop and evaluate course activities to target gaps.
- Longitudinal study of how students engage with statistics after course.

References

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