Introductory Statistics Flexible Learning Project:

Resources and Student Interactions with Web Visualizations

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Abstract

Introductory statistics is taught in many UBC departments. Typically, instructional resources and expertise are not shared across units, resulting in duplication of efforts or underuse of valuable material. This project brings together instructors from Science, Arts, & SPPH, and uses instructional resources that address conceptually challenging topics in introductory statistics. The goal of the project is to provide resources that are open, adaptable, consistent in look and feel, and grounded in existing research on learning and statistics, for use at UBC and beyond.

Here, we briefly describe the resources being developed and then focus on one: web visualizations. We have observed students interacting with currently developed web visualizations and have gathered their feedback. We have used this information to improve the visualizations and accompanying instructional material, so that the resource can be more effectively used in instruction of the statistical concepts.

Introductory Statistics FL Group

Science	Medicine	Arts	Other
Statistics Eugenia Yu Bruce Dunham Melissa Lee Gaitri Yapa Andy Leung Rick White **Zoology** Mike Whitlock **Physics & Astronomy** Doug Bonn Joss Ives	**School of Population & Public Health** Mike Marin	**Political Science** Fred Cutler Andrew Owen **Economics** Diana Whistler David Green **Philosophy** Leslie Burkholder	**UBC Science Centre for Learning and Teaching** Gillian Gerhard **Centre for Teaching, Learning and Technology** Noureddine Elouazizi

Project Lead: **Nancy Heckman - Statistics** (nancy@stat.ubc.ca)

Introductory Statistics FL Resources & Resource Leads

Web Visualizations	• Mike Whitlock, Professor (Zoology)
Activities	• Fred Cutler, Associate Professor (Political Sci.) • Andrew Owen, Assistant Professor (Political Sci.)
Videos	• Mike Marin, Instructor (SPPH)
Webwork/ WebWorKIR Qs	• Bruce Dunham, Senior Instructor (Statistics)
Interactive Engagement Qs	• Eugenia Yu, Instructor (Statistics)

Introductory Statistics FL Resources: Overview

Web Visualizations	• Simulations (using HTML5 with JavaScript) to support visualization of abstract concepts, supporting learning wrappers
Activities	• IE questions and activities to engage students & facilitate peer-instruction (in lectures/labs)
Screencasts	• On-demand access to explanations of challenging concepts via 6-10 min videos
WeBWorKiR Qs	• Individualized online HW questions with automatic feedback (open-source on-line HW system WeBWorK, enhanced by R functionality)
Interactive Engagement Qs	• IE questions to be administered via Personal Response Systems (i>Clickers, etc.) to provide immediate feedback, facilitate peer-instruction

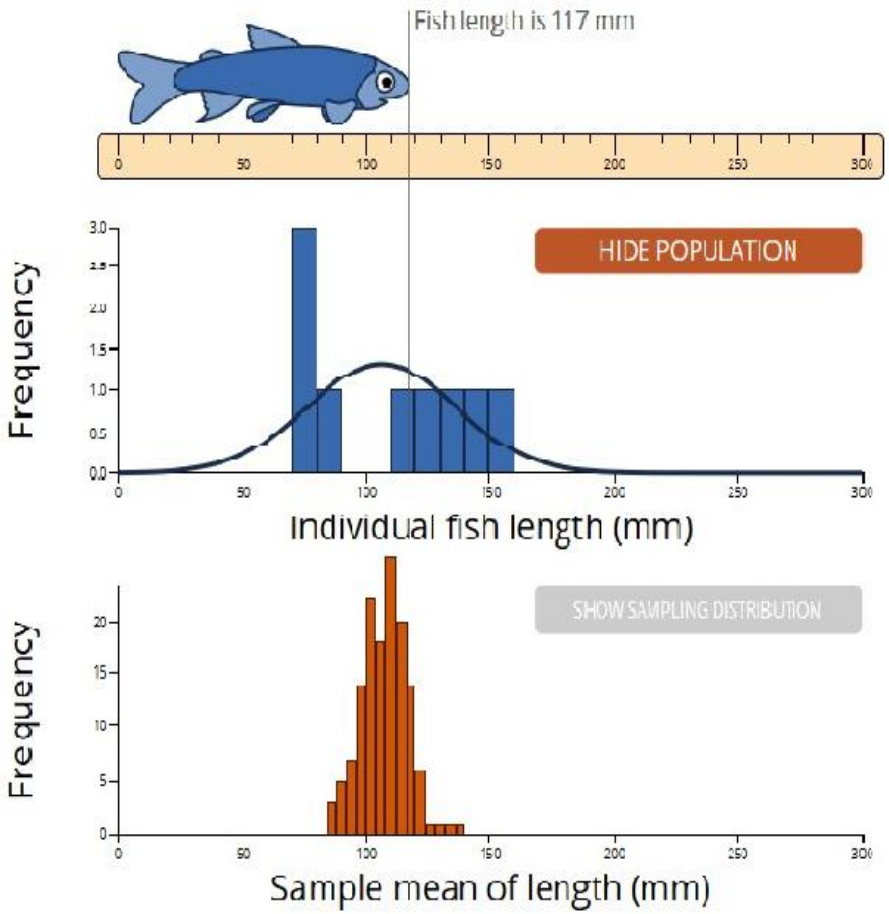
Introductory Statistics FL Resources: Goals

Addressing conceptually challenging topics:	• Sampling Distribution & Inference (existing resources have significant gaps)
Drawing from research-based best-practices on learning & statistics:	• Carl Wieman Science Education Initiative • U Colorado Boulder's PhET group
Easy to adopt to enhance existing course materials:	• Open & adaptable
Will be available to:	• Multiple departments, many faculties, UBC & beyond

Web Visualization 1: Sampling Distribution

Sampling from a Normal Distribution

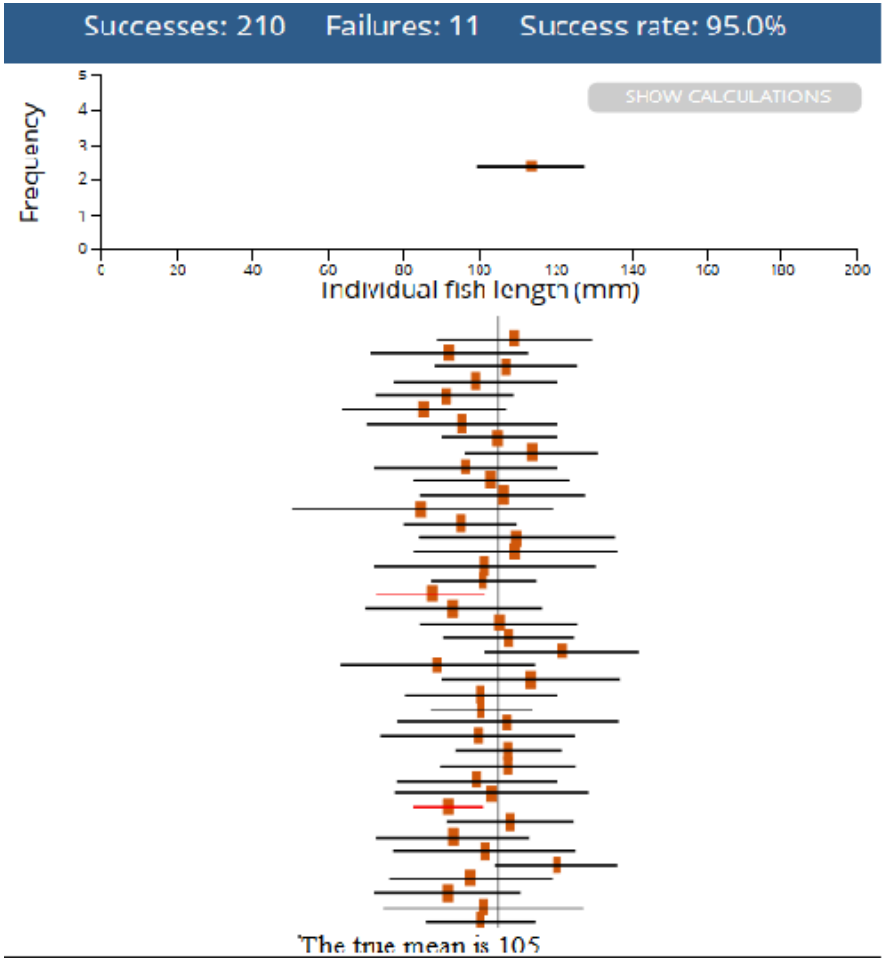
- What is the sample mean, on average?
- How variable are sampling means?
- How does the variation among sample means change with sample size?



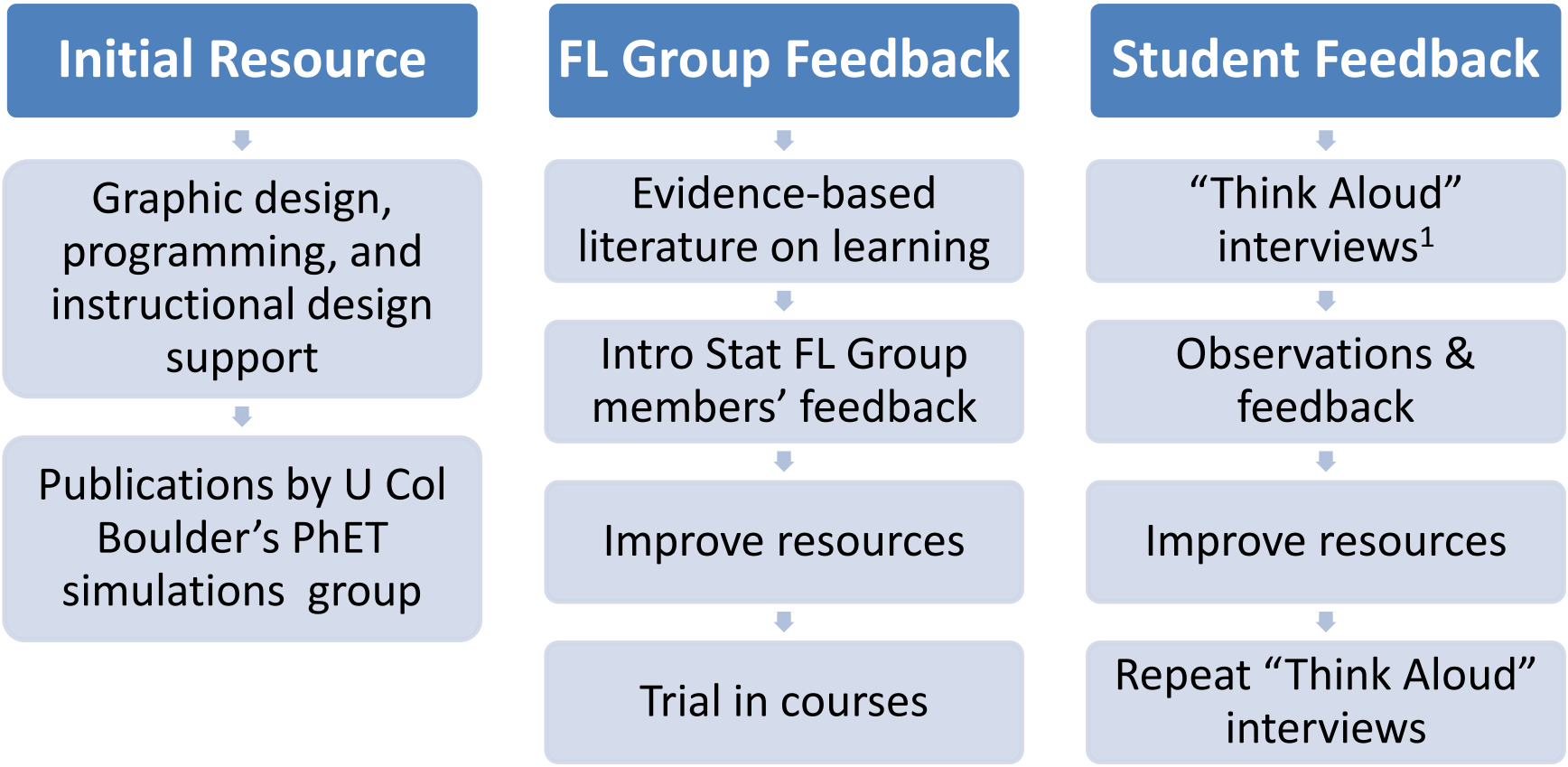
Web Visualization 2: Confidence Intervals

Confidence Intervals for the Mean

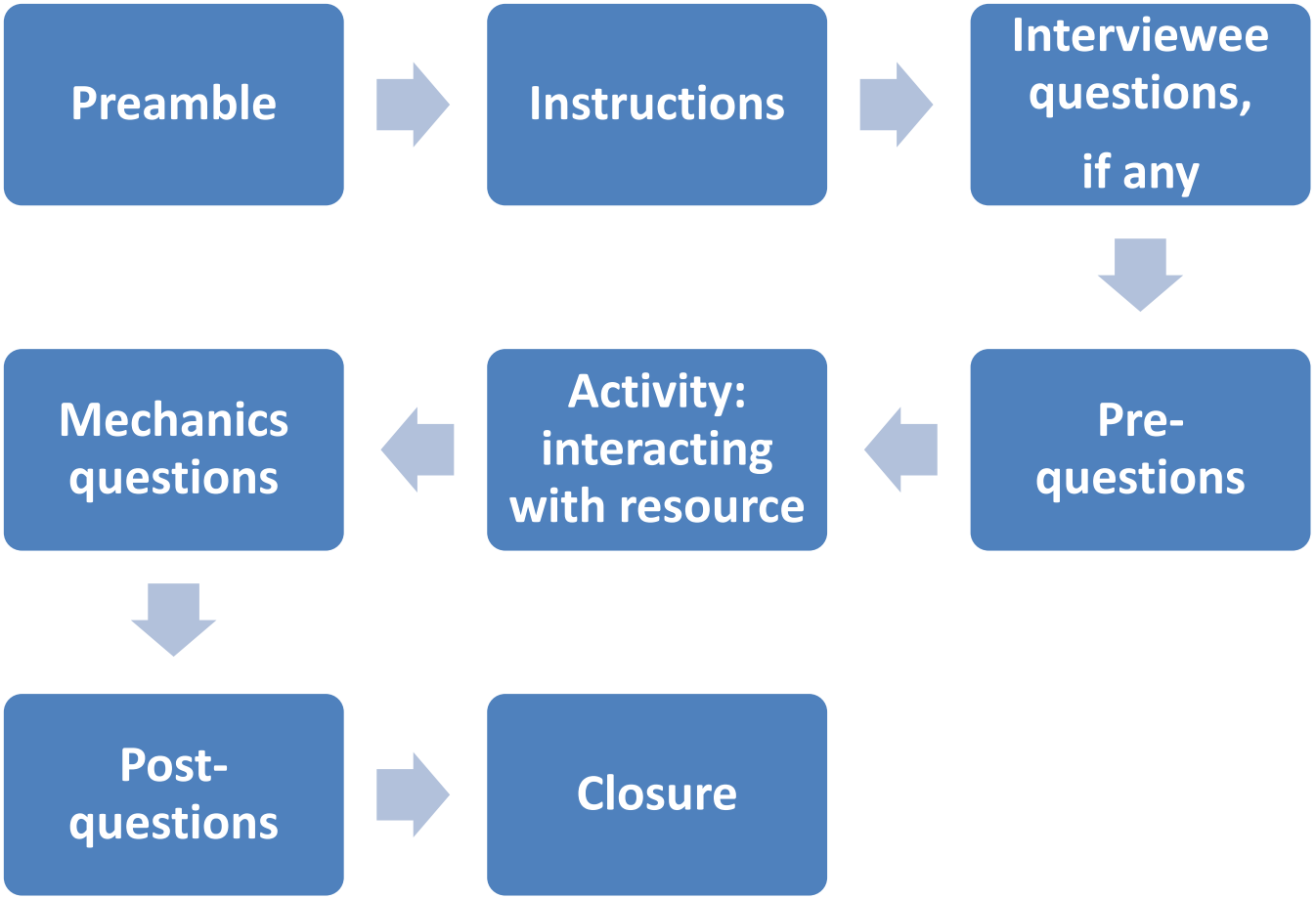
- What is a confidence interval?
- How often do CIs contain the true mean?
- How are CIs affected by changes in sample size?



Web Visualizations: Improvement Process Using Feedback



Web Visualizations: "Think Aloud" Student Interviews



Interview Feedback Use: To Improve Resources & Instructional Material

2015 Nov

Pilot "Think Aloud" interviews for two web visualizations (STAT 200)

2015 Dec - Jan

Improve resources based on observations & student feedback

2016 Jan

2nd "Think Aloud" interviews for improved web visualizations (BIOL 300)

Ongoing

Improve resources, plan instructional material, trial new resources [2, 3]

"Think Aloud" Interviews: Observations

Need for overview and questions to prime students	• *"…initially I don't know what the next steps so I'm just following and I don't know what's going on at first."*
Need for balance in pace	• *"… I don't know how many [samples] they want us to do… very confusing…"* • *"The process to add a button to calculate a lot of sample means at once could come a bit earlier."*
Need for consistency with use of terminology	• *"<Unbiased estimate of the mean>? Which mean? Population mean? True mean?"* • *"…vary a lot from one to the next…between what?"*

Student Feedback: What's Working

Graphics, visualization & interactive features

- *"Very practical, as if you are doing real research. … Graphics are clean. Not messy. Very visually stimulating. Colourful. Interesting."*
- *"[Helps] visualize the definitions learned in class. … Solidifies what we learned in class."*

Visualizing abstract concepts

- *"… good visual way of understanding the difference between the variability for sample means and the individual lengths."*
- *"Intuitive. Shows how mean and std. dev. relate. … Really helps to see how sample size affects the mean. Same with standard deviation."*
- *"Like how fish changes to bar graph, sliders, drop down thing."*

Student Feedback: To Improve Resources Further

Amount of guidance – within or accompanying resource

- *"…give a question first and do all the play around first and then discover the situation… [If] you have to follow all the steps and when you have a question … it's really too obvious…"* *[STAT 200, Nov 2015]*
- *"More questions would be helpful. Ask us before we do it, and then let us do it. That helps me think. "* *[BIOL 300, Jan 2016]*
- *"Like it if [there were] more questions, testing us a bit more. Bit more trickier… "* *[BIOL 300, Jan 2016]*

References & Acknowledgements

References

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- [2] Lane, D. M., Peres, S. C. (2006), "Interactive Simulations in the Teaching of Statistics: Promise and Pitfalls" ICOTS-7 http://www.ruf.rice.edu/~lane/papers/interactive-simulations.pdf
- [3] Maxwell, J., Stang, J., "Making the most of demonstrations, videos, animations, or simulations in lectures and laboratories", (based on a workshop offered at the UBC Annual Science Education Open House on April 13, 2015) http://www.cwsei.ubc.ca/resources/files/Demo_WorkshopSummary_CWSEI-EOY2015.pdf

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- Mike Whitlock, Professor, Zoology, Web Visualizations Resource Lead & Bio 300 instructor.
- Thor Veen, Zoology, BIOL 300 Instructor.
- Eugenia Yu, Statistics, STAT 200 instructor.

- To find out more about the resources, please contact **Nancy Heckman** (nancy@stat.ubc.ca)