MODELING AND SIMULATION VIA CATALST

An Alternative Option for High School Students

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CATALST

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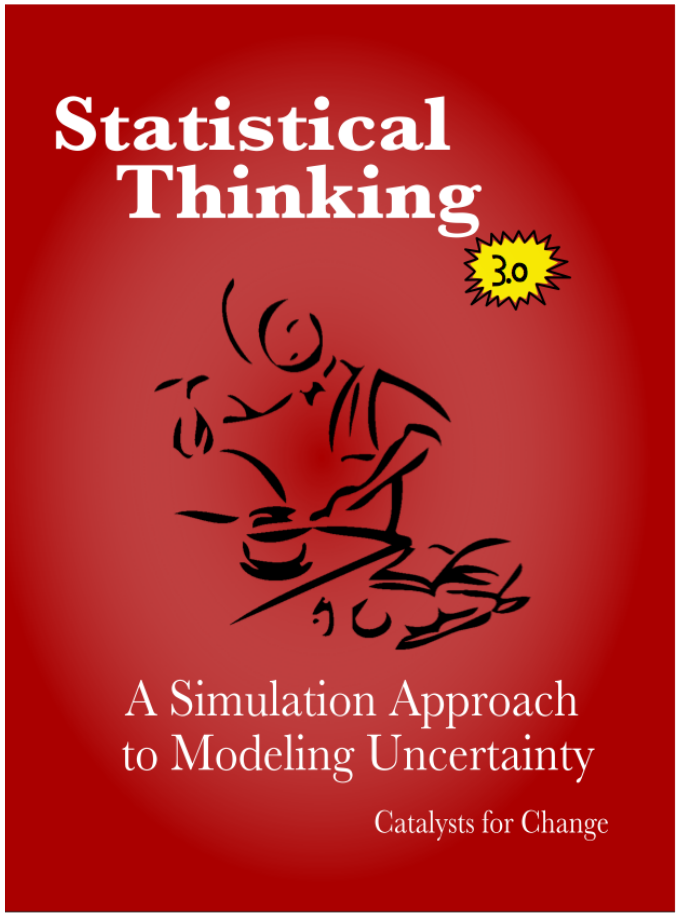
Inspired by ideas of George Cobb (2005, 2007) about randomization-based inference

Promotes statistical thinking by teaching students to "cook" rather than only "follow recipes" (Schoenfeld, 1998)

Immerses students in the **nuts-and-bolts of statistical inference** from the first day via focus on modeling and simulation.

CATALST Curriculum



Build probability models; Simulate from models to answer questions
Modeling and Simulation Unit

Randomization test as method to model variation due to chance; Appropriate inference based on design
Comparing Groups Unit

Bootstrapping as method to estimate standard error; Interval estimation
Sampling and Estimation Unit

For more detailed information about the CATALST curriculum see Garfield, delMas, and Zieffler (2012)

Developing Students' Understanding of Modeling and Inference

Model
(*Build a probability model to examine a hypothesis or answer a question*)

Simulate
(*What happens under repeated experiments?*)

Evaluate
(*Use results of simulation as evidence*)

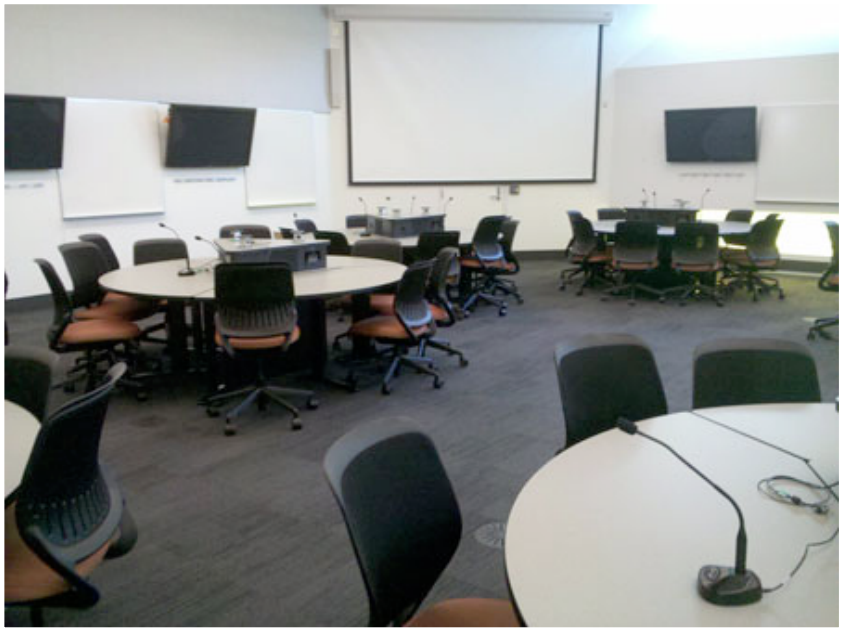
How many 3's would you expect when rolling a die ten times?

Does the effect of sleep deprivation last, or can a person "make up" for sleep deprivation by getting a full night's sleep in subsequent nights?

Pedagogy

CATALST *is* cooperative learning

- Course is taught in Active Learning Classroom
- Students teach themselves in groups of 3–4 through discussion/activities (**minimal lecture**)
- One laptop per group is required
- Instructor leads discussions, poses questions, introduces/wraps up activities



Instructors

CATALST teachers *are* "navigators" not "pilots"

- Course is taught with minimal lecture
- Students teach themselves rather than being "told" things
- Primary purpose of instructor is to raise questions and lead student discussions
- Visit the course at the University of Minnesota (to see it in action)

Technology

CATALST *uses* TinkerPlots™

- The course activities, homework, and assessments have been written for TinkerPlots™
- The visual capabilities of the software seem to be linked to student learning
- Other statistical programs (Fathom, R) *may* be suitable alternatives, but would need to be approved by the faculty coordinator
- Graphing calculators would not be a suitable replacement for TinkerPlots™

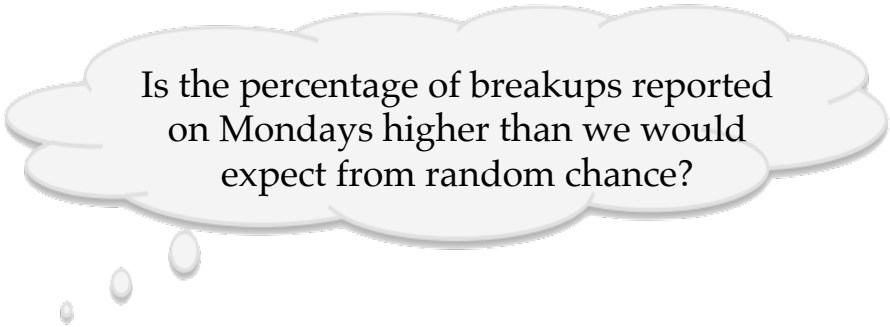
Activity Demo with TinkerPlots™

Monday Breakups

- One piece of data that members of Facebook often report is their relationship status: single, in a relationship, married, it's complicated, etc.

- With the help of Lee Byron of Facebook, David McCandless—a London-based author, writer, and designer—examined changes in peoples' relationship status, in particular, breakups. A plot of the results showed that there were repeated peaks on Mondays, a day that seems to be of higher risk for reported breakups.

- Consider a random sample of 50 breakups reported on Facebook within the last year. Of these sampled breakups, 13 occurred on a Monday.



Activity Demo with TinkerPlots™

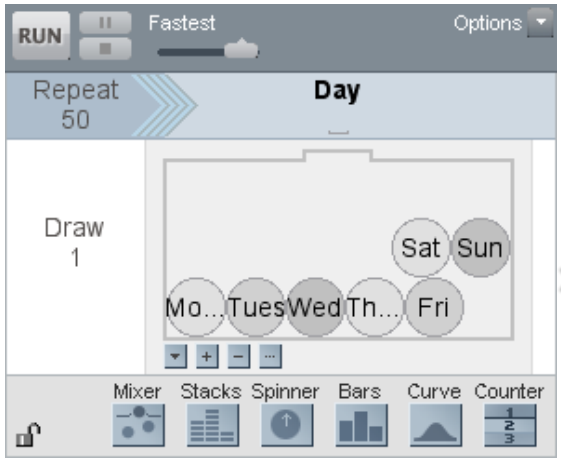
Monday Breakups

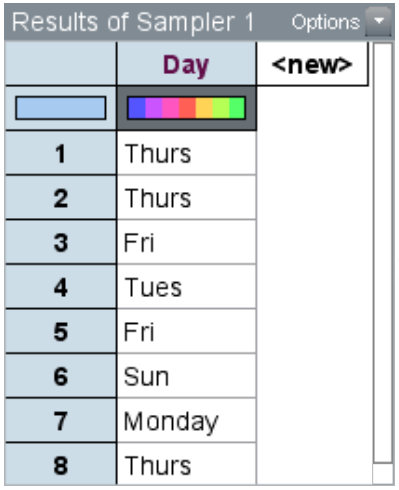
Video

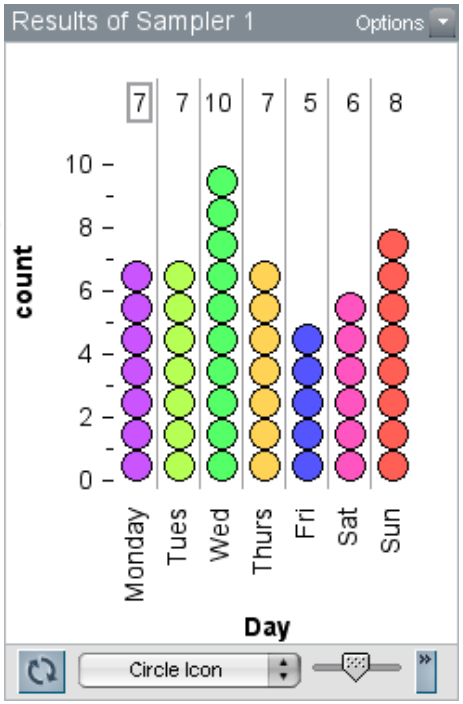
https://youtu.be/E452qdLm5E0

Activity Demo with TinkerPlots™

Monday Breakups
Simulate – One Trial

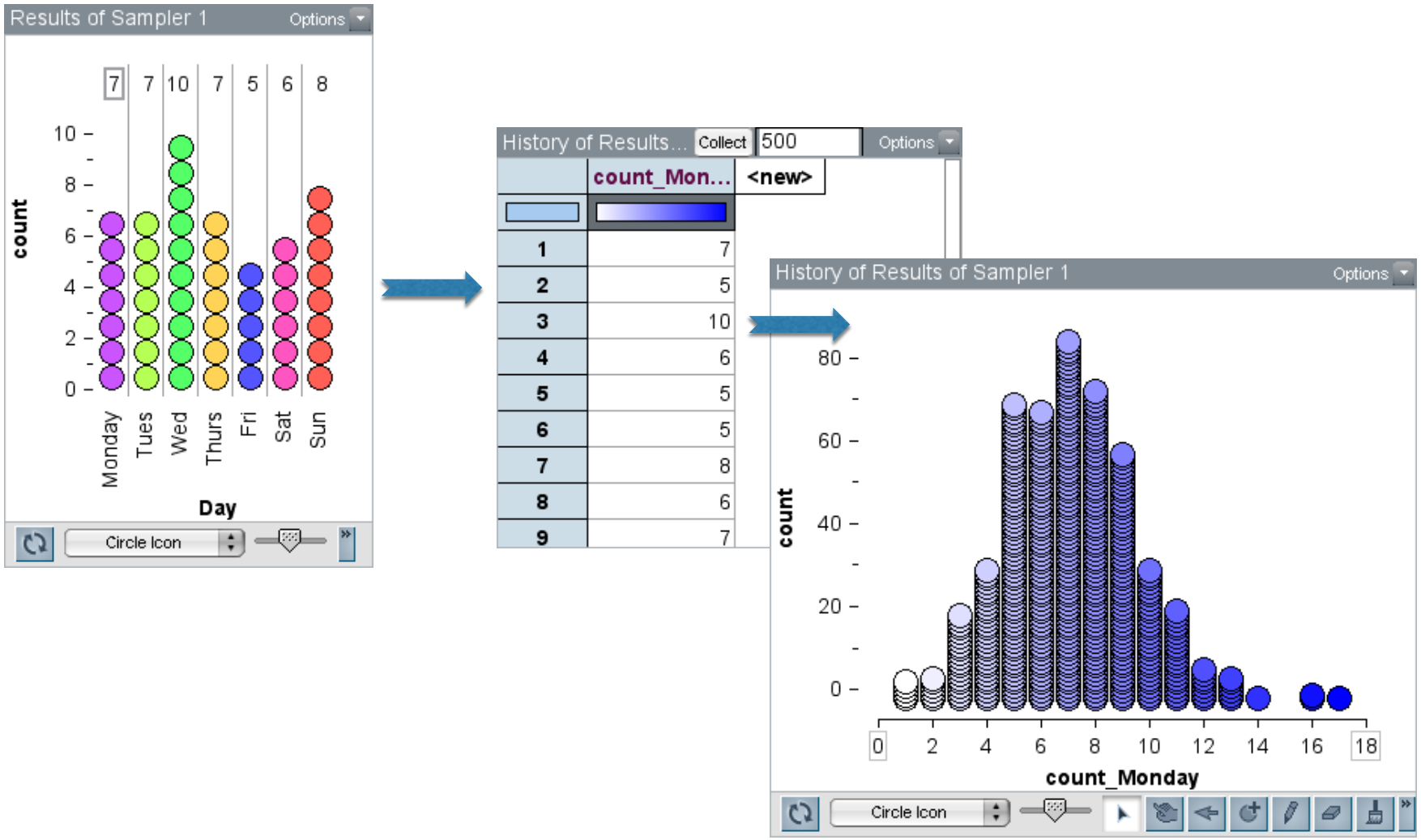






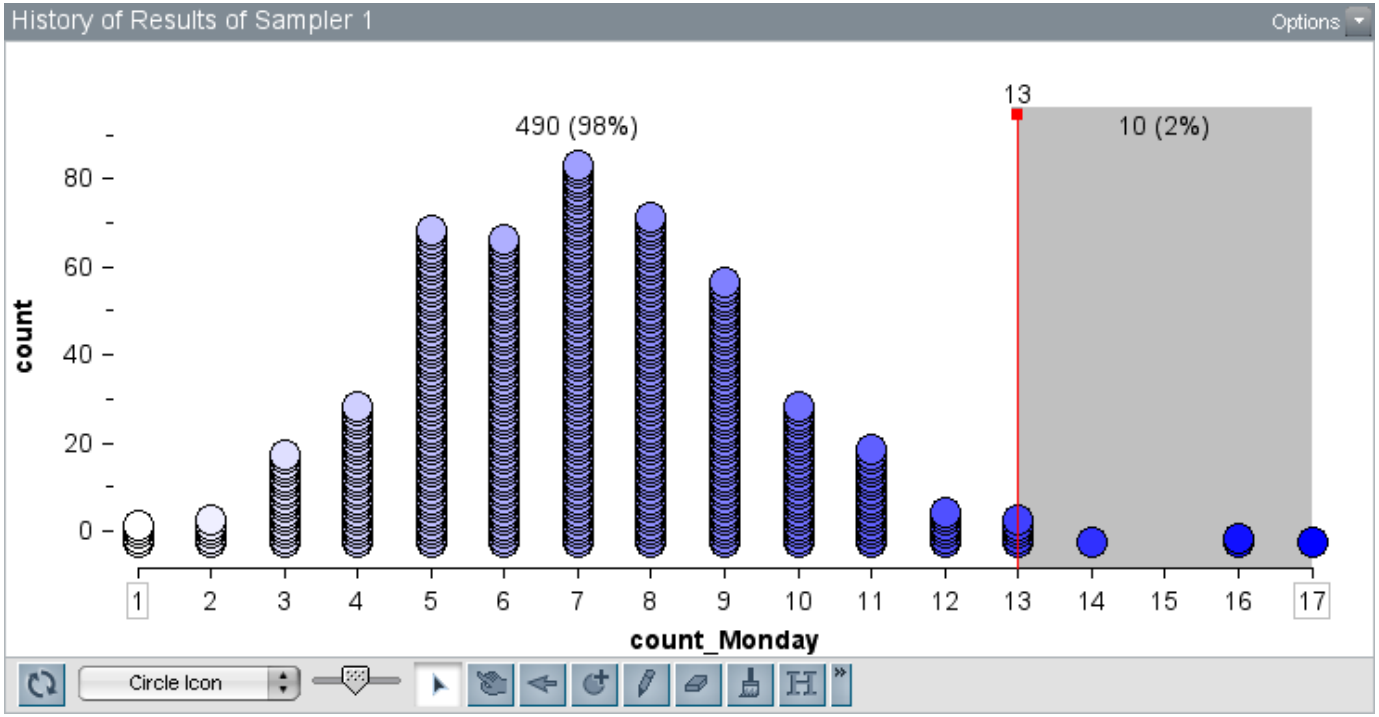
Video
https://youtu.be/E452qdLm5E0

Simulate – 500 Trials



Activity Demo with TinkerPlots™

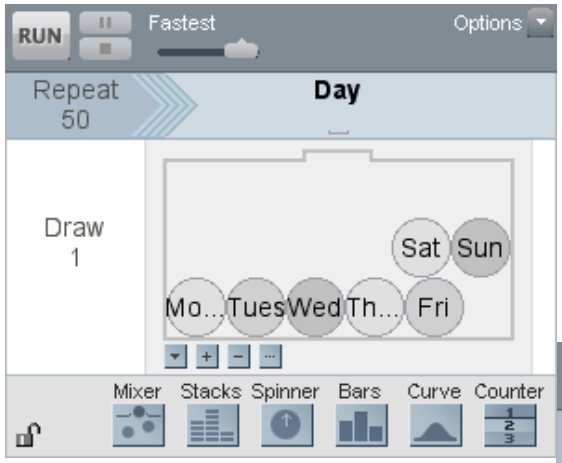
Monday Breakups
Evaluate

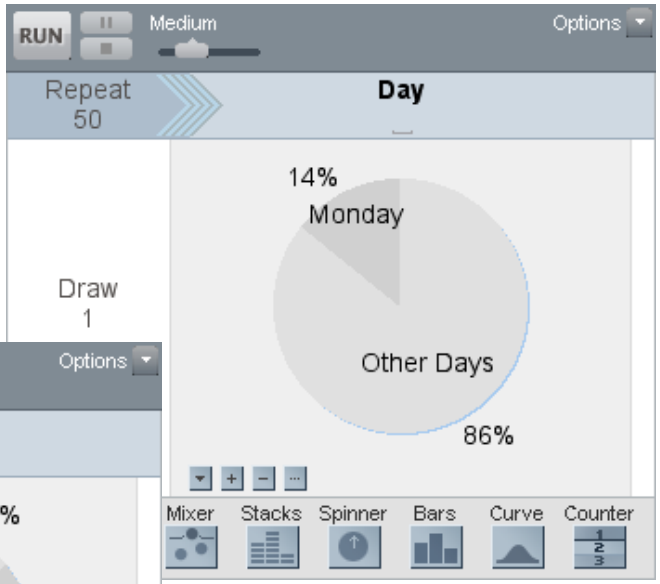


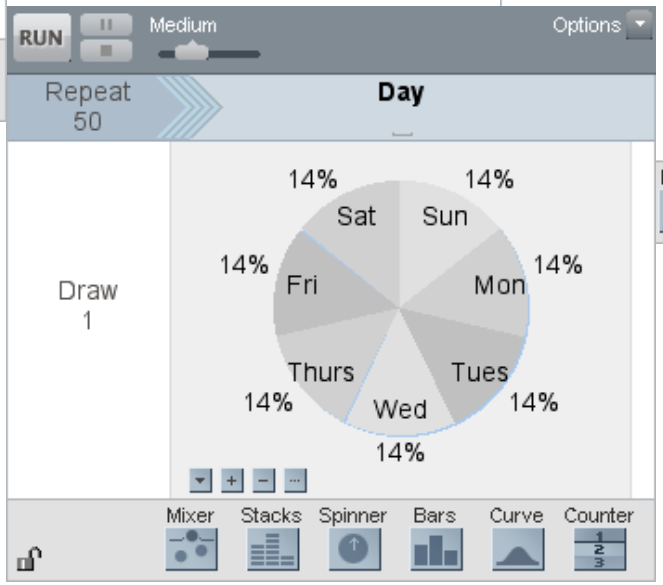
$p = 0.02$

Alternative Models from Students

Monday Breakups







CATALST in the High School

CATALST and the Common Core State Standards

- CATALST course aligns very well with several of the *Statistics and Probability Common Core State Standards for Mathematics*
  - *Making Inferences and Justifying Conclusions* (Standard S-IC)
  - *Interpreting Categorical and Quantitative Data* (Standard S-ID).
  - *Mathematical probability theory* (Standards S-CP and S-MD)
  - While the first two have direct connections to the CATALST curriculum, the last is addressed via simulation modeling rather than using formal mathematical derivations.

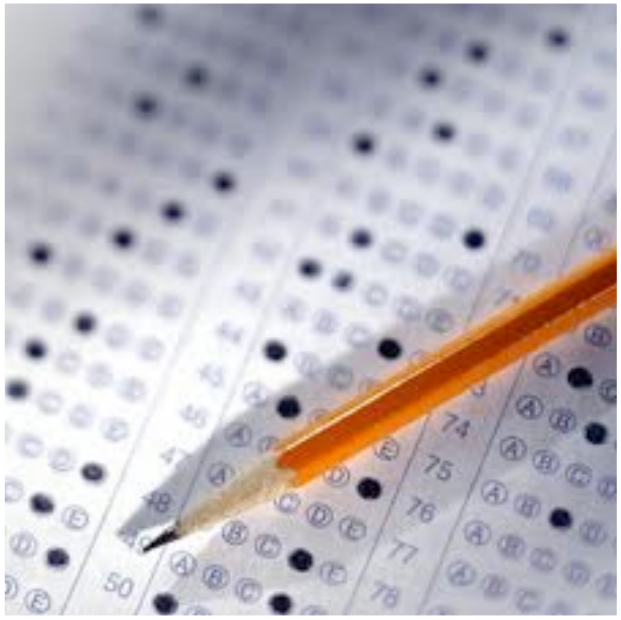
CATALST in the High School

CATALST *is not* a replacement for A.P. Statistics

- A.P. Statistics spends a good deal of the curriculum on descriptive statistics, probability models, survey design, and experimental design

- CATALST focuses on statistical inference throughout the entire course and makes use of descriptive statistics, experimental design, and probability models

- Students who are not "A.P.-level" students can be successful in CATALST



CATALST in the High School

Experience at Mounds View High School

Pilot fall semester of 2011-12

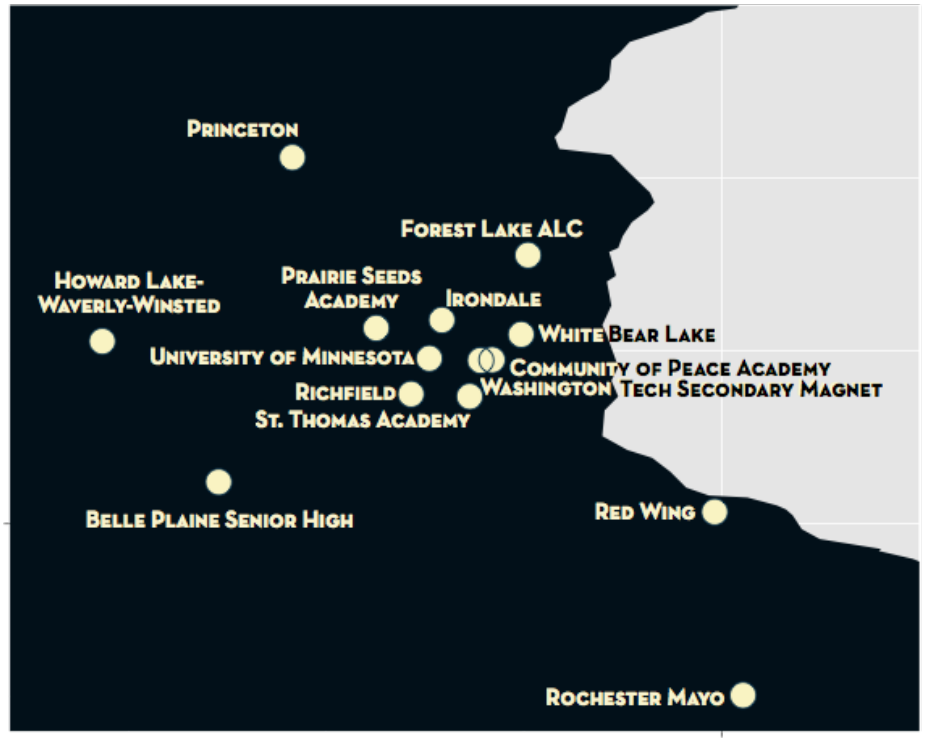
Repeated fall semester of 2014-15

CATALST in the High School

Experience at Mounds View High School

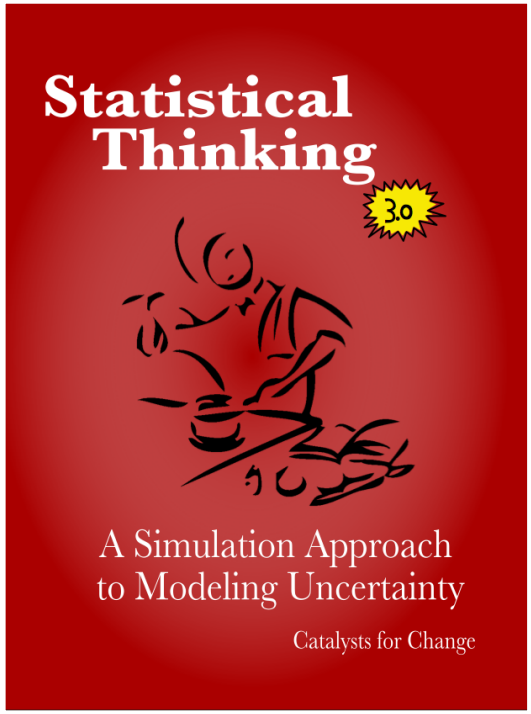
- High school students can successfully learn statistics with CATALST.
- Students are able to carry out a randomization test, bootstrapping, compute a *p*-value, and interpret the meaning of the *p*-value.
- We were amazed that not only did the students enrolled in the "lower level" statistics course understand how to make such interpretations, but they did so months before AP Statistics students would even encounter inference.
- Simulation allowed students who had found little success with the symbolic manipulation taught in many mathematics courses an opportunity to be successful. In fact, at Mounds View, there were students who were successful in the CATALST course who had never previously passed a mathematics course in high school. Many of these students' attitudes toward statistics and mathematics were changed by this experience, and some chose to take additional mathematics and statistics courses because of their experience with CATALST.

College in the Schools



- 2015–2016 academic year CATALST is being taught in 13 MN high schools
- Concurrent enrollment at both the high school and the University of Minnesota
- Teacher workshops, classroom visits, field day opportunity, ongoing professional development opportunities
- Come visit us at the University of Minnesota to watch a class in action

Resources and Materials



Get the CATALST book for free
https://github.com/zief0002/Statistical-Thinking

Background, lesson plans, other resources
http://www.tc.umn.edu/~catalst/

TinkerPlots™
http://www.tinkerplots.com/

College in the Schools
http://cce.umn.edu/college-in-the-schools

Monday Breakups Wrap-up Video
https://youtu.be/E452qdLm5E0

Gmail

Email us for more information

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References and Further Reading

delMas, R., Garfield, J., & Zieffler, A. (2013). Using TinkerPlots™ to Develop Tertiary Students' Statistical Thinking in a Modeling–Based Introductory Statistics Class. In T. Wassong, D. Frischemeier, P. R. Fischer, R. Hochmuth, & P. Bender (Eds.), *Mit Werkzeugen, Mathematik und Stochastik lernen—Using tools for Learning mathematics and statistics* (pp. 405–420). Wiesbaden, Germany: Springer Spektrum.

Garfield, J., delMas, R., & Zieffler, A. (2012). Developing Statistical Modelers and Thinkers in an Introductory, Tertiary-Level Statistics Course. *ZDM—Mathematics Education*, 1–18.

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