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Statistics as Evidence: Teaching Critical Thinking through the Introductory Statistics Course

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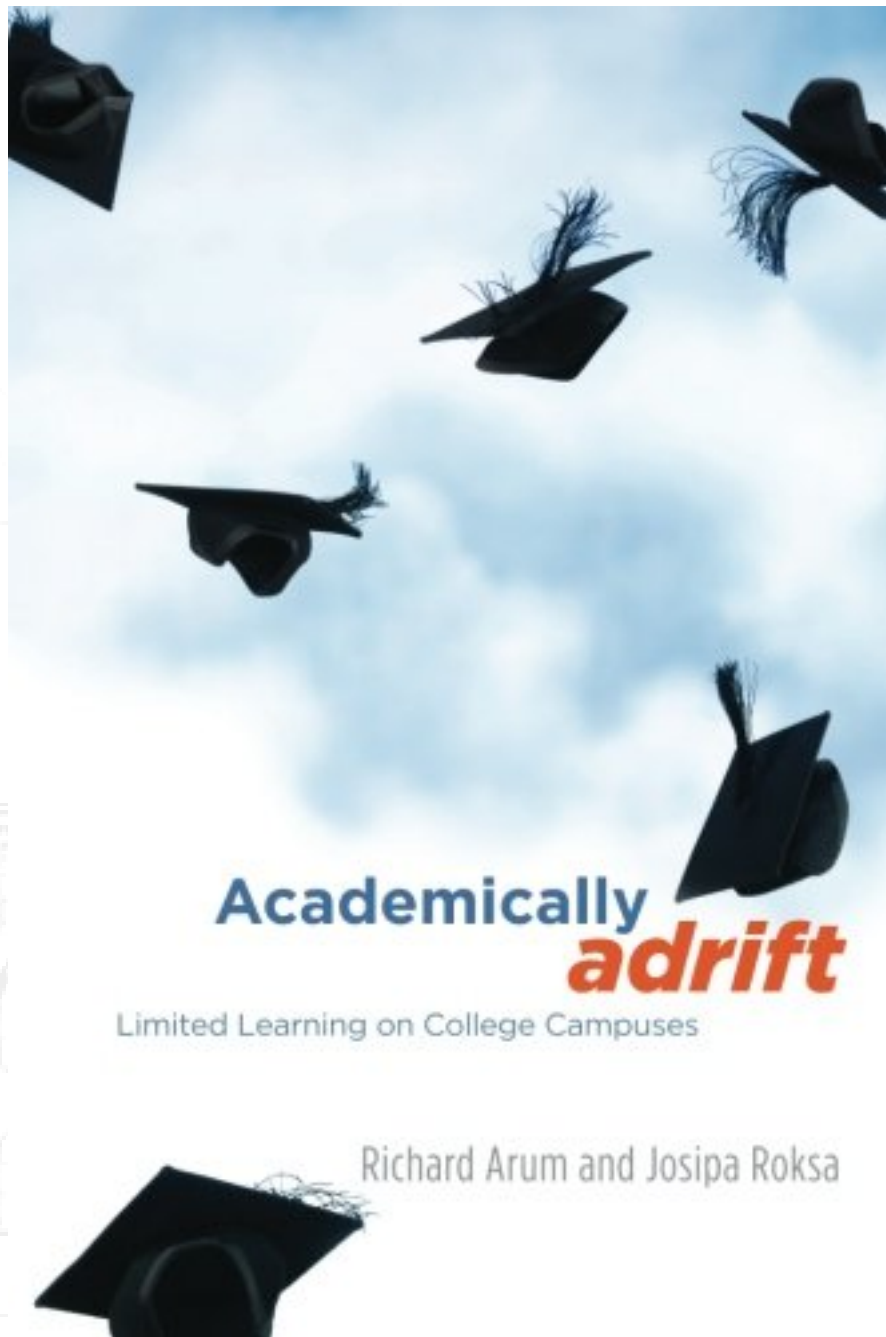
Critical Thinking Definition



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I like to keep things simple. My favorite definition is by John Dewey, American Philosopher and Education Reformer.

“The essence of critical thinking is suspended judgment.”



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Crisis in Critical Thinking

- Academically Adrift (2011)
- Small to nonexistent gains in
 - Critical thinking
 - Complex reasoning
 - Writing skills
- Over ENTIRE College experience!
- A real eye opener!

Hit a Wall About 4 Years Ago



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- Over the years numerous innovations
- Students got math part, not “statistics” part
- Asked to apply knowledge - relatively clueless
- Texts more biz examples, students no biz context
- Needed to change things
 - Developed Statistics as Evidence (SAE)
 - Got rid of textbook

Statistics as Evidence (SAE)



- 10 homework assignments centered around different key statistical concepts
- Consist of series of prompts and reading materials that need to be analyzed
- Deliverable – a 500 word written analysis ready to discuss in class
- Must visit the Writing Center

Student Learning Approach



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Quasi-Socratic



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Key Statistical Concepts

(Or my entire course!)



- Who ya gonna trust?
- Truth and statistics
- Information is beautiful
- Data detecting
- Living in an uncertain world
- Data Catches the (Google) Flu
- Polls and punditry
- Correlation and causation
- Prediction Babble



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Who ya gonna trust?

There are Three Kinds of Lies -
Lies,
Damn Lies,
and Statistics

Variously attributed to
Prime Minister Benjamin Disraeli and Mark Twain

Why are Statistics “Lies?”

- **Advocacy** - 1st SAE NRA vs Brady
 - In debate we try to “win” not find the truth
- **Definition** - Unemployment rate - BLS
 - Only those actively seeking work
- **Context** - Stand alone numbers useless
 - Is the August rate of 6.1% good or bad?
 - <http://www.bls.gov>
- **Cherry picking** – Selective choice of data
 - Climate change skeptic – cooling last 15 years

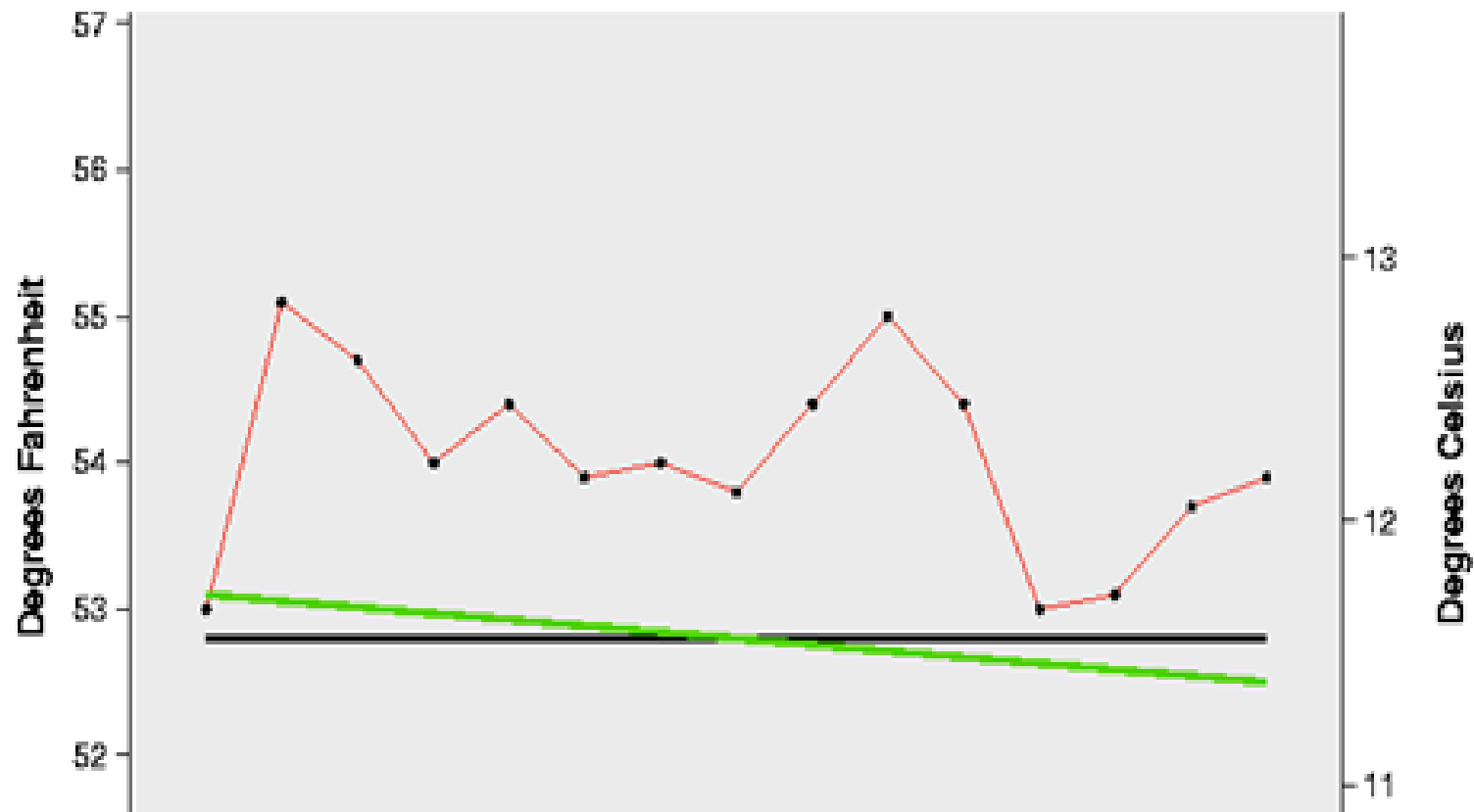


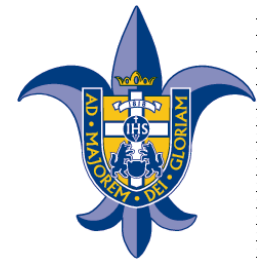
Climate Skeptic



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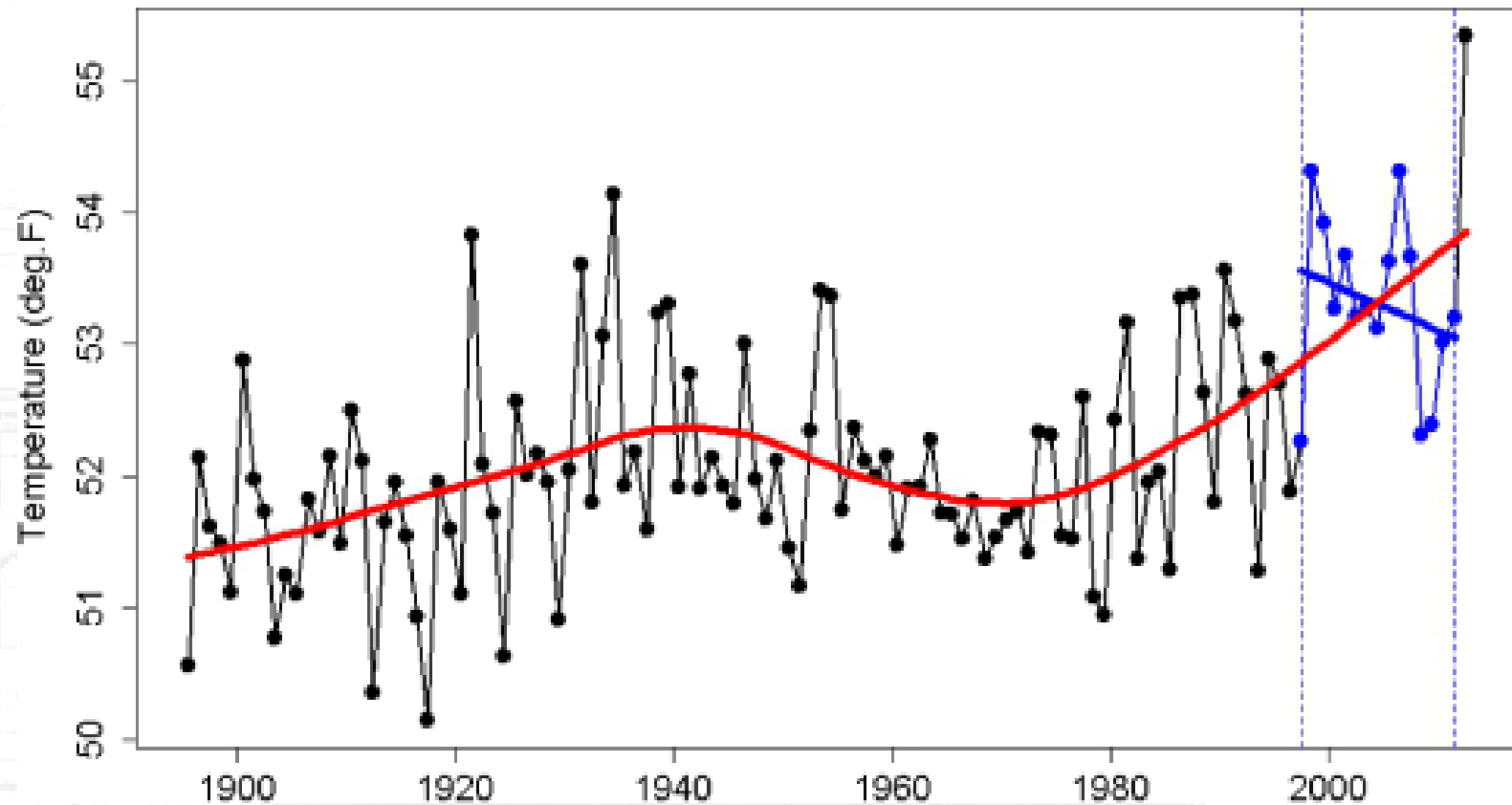
- Actual Temperature
- Average Temperature
- Trend





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Climate Cherry Picking



Truth and Statistics

Deduction

Induction

Data (facts, phenomena)

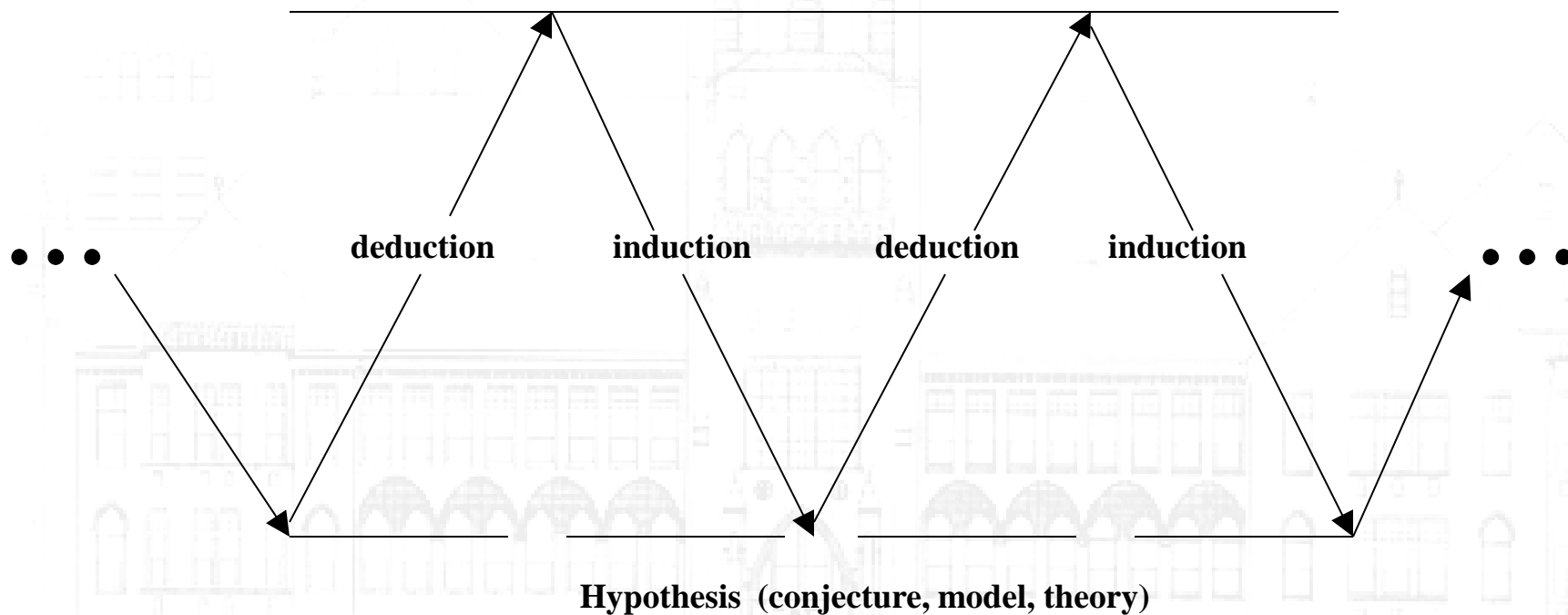
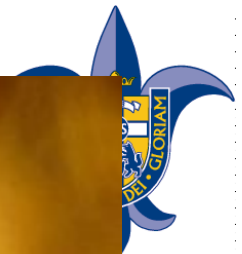


FIGURE 1.1. The iterative learning process.



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Smoking and Lung Cancer

- Lung cancer: Once a very rare disease
- WW I: Free cigarettes to improve “morale”
- Surgeons: Heavy smokers = higher cancer rate
- Research Studies:
 - **Retrospective** - looking back from cancer patients
 - **Prospective** - following patients forward with controls
 - **Laboratory** – carcinogens effect on mice, rabbits, etc
- 1960: only 1/3 MDs thought smoking causal
- Surgeon General 1964: Based on 7,000 articles
 - Smoking **CAUSES** lung cancer

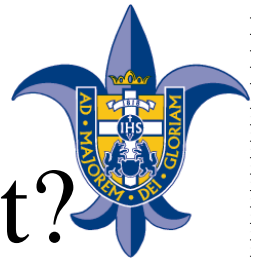


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"HEART HEALTHY"
RED WINE:
IS IT TRUE?

survivingcollege.com



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Is Red Wine Good for your Heart?

- Evidence is mixed
 - Antioxidants may protect blood vessels
- Any alcohol in moderation may be heart healthy
 - Raises HDL “good” cholesterol?
 - Reduce LDL “bad” cholesterol?
 - Reduces blood clots, prevents artery damage?
- Doctors hesitant to encourage drinking
 - High blood pressure, liver damage, obesity, cancer
- Red wine only helpful if combined w/ exercise?
- No causality - jury is still out!



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Information is Beautiful

- Pie graphs are now classified as the worst graph!
- Visualization is new trend – Wind Map, Science
- <http://hint.fm/wind/>
- <http://tabletopwhale.com>
- Infographics are the rage – Caffeine, Rape
- <http://www.informationisbeautiful.net/visualizations/caffeine-and-calories/>
- <http://www.informationisbeautiful.net/visualizations/rape-a-lack-of-conviction/>



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Data Detecting

“Always approach a case with an absolutely blank mind. Form no theories, just simply observe and draw inferences from your observations.”

“It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to facts.”

“There is nothing more deceptive than an obvious fact.”

“Data! Data! Data! I can’t make bricks without clay.”



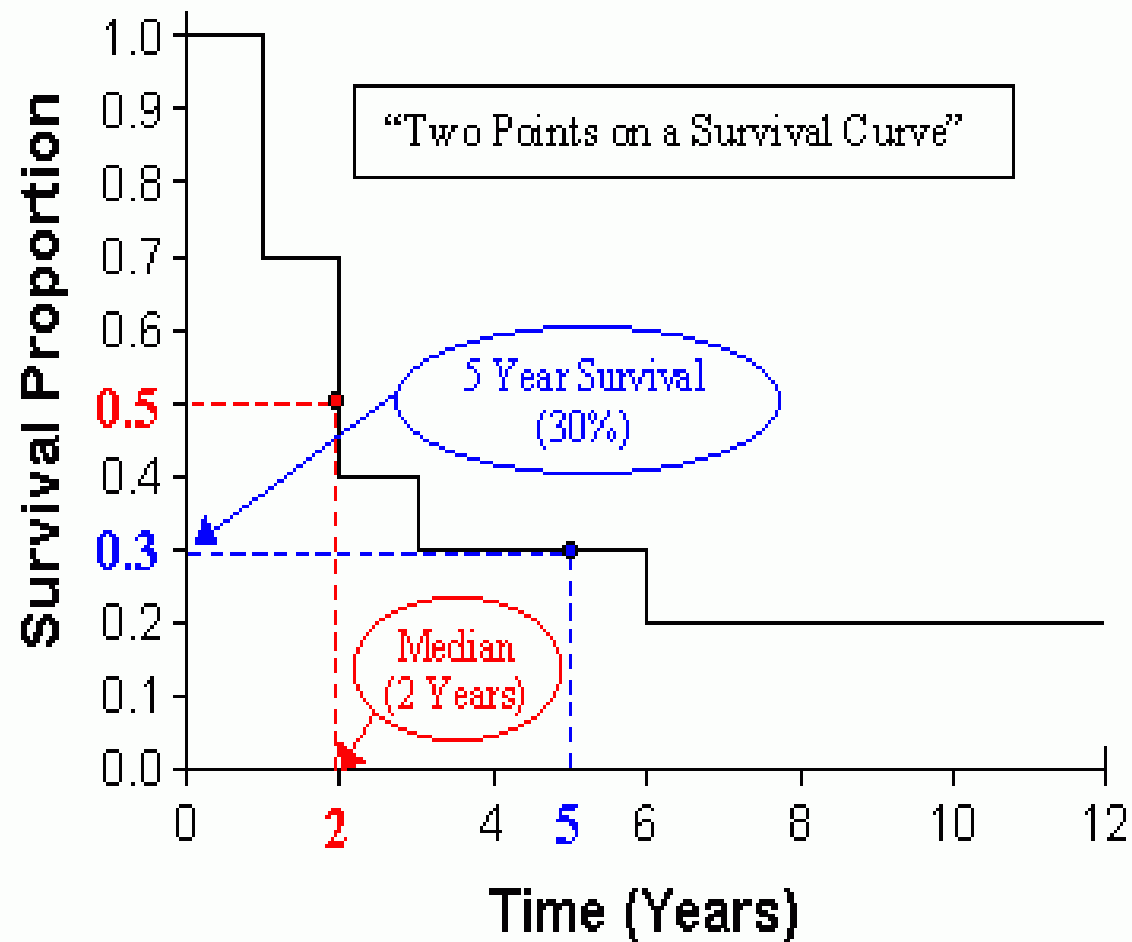
The Median is not the Message

- Stephan Jay Gould – Mesothelioma
 - Rare and serious cancer
- Doctor discouraged him from doing research
 - Median survival was only 8 months & “incurable”
- Meaning – only 8 months to live? No! (Obvious fact?)
 - Survival varies according to many different factors including whether you have a positive attitude or not
 - Data distribution had a long right tail – why not him?
- Ended up living 20 years longer

Survival Curve – Right Tail



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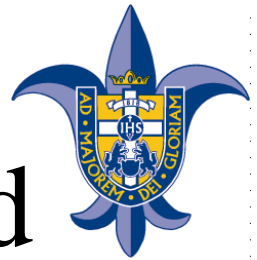
Takeaways

“The truth is in the variation. Means and medians are the abstraction.”

Stephen Jay Gould (Harvard Evolutionary Biologist)

“Statistics outline probabilities – they can’t limit possibilities.”

Steve Dunn (Patient and Author of Cancer Guide)



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Living in an Uncertain World

- Humans not good at risk/probabilistic thinking
- Need to be trained to think probabilistically
- Much of our risk perception is based on our emotional system - not our rational system
- Common Risk Perception Problems
 - Less afraid of natural – cell phones vs sun
 - Less afraid when choose – smoking
 - 9/11 personalized what had been abstract
- Night of the Grizzlies





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Hungry Horse News

25¢

44TH YEAR, NO. 53

COLUMBIA FALLS, MONTANA 59912

THURSDAY, JULY 31, 1990

Two die in Glacier grizzly attack



Kim Eberly

Kim Eberly was a bellman at Lake McDonald Lodge in his second summer in Glacier Park. He is known among fellow employees as an accomplished guitar player as was demonstrated during a talent show held earlier this summer. He was a sophomore at the University of Montana. He was a crew chief on Lake McDonald area fire squads. James Morrow photo

By BRIAN KENNEDY

ST. MARY — They had been dating for the past two weeks and decided to spend their day off camping on the east side of Glacier Park.

Both were 19-year-old college students and both worked at Lake McDonald Lodge.

Jane Ammerman of Stillwater, Minn., and Kim Eberly of North Lawrence, Ohio left the lodge last Tuesday afternoon with heavy packs. They told friends they were going to Waterton and would return Thursday.

Rick Squires, a tour bus driver, from Mary Glacier picked them up on Going to the Sun Road at Avalanche Creek and drove them over Logan Pass to St. Mary.

There he let them off on the dirt road leading to the St. Mary KOA Campground where they told Squires they were going to camp.

But they didn't. Instead, they walked down the road to the St. Mary River and turned west to Divide Creek along which they hiked upstream for about 75 yards. There they set up camp at an undesignated campsite on a sandbar inside the park. They had no permit. Divide Creek forms the boundary between Glacier Park and the Blackfoot Indian Reservation.

Later they went to St. Mary Lodge to look for Dan Merbels, Jane's high school friend from Stillwater. Eberly and Ammerman were seen that evening in the upstairs lounge listening to music.

The events that followed are unclear. Park authorities have not found anyone who saw them alive again after Tuesday night. They most likely never made it to Waterton but stayed in the St. Mary area and camped again Wednesday night at their site beside Divide Creek.

Sometime around 4 a.m., Thursday morning they were awakened by a grizzly bear. No one knows exactly what happened because there were no witnesses.

"It appears they were sleeping on top of their tent or alongside of it," said Joe Shellenberger, Glacier Park management assistant. "Because everything was thrown around the camp, it's difficult to reconstruct what happened."

"It appears she was bitten first because of the amount

of blood at the site. Then, Kim either diverted its attention or tried to protect the girl because the bear then went after him, knocking him across the creek (Divide Creek)."

Autopsy reports show Eberly was hit hard in the face with the bear's paw. He also suffered lacerations on his arms and heavy puncture wounds in the chest area.

The bear then went back to the campsite and dragged Ammerman 60 yards downstream. Shellenberger said she was "badly mauled." The autopsy stated death for both was due to hemorrhaging and trauma.

Blackfoot tribal wardens, who helped remove the bodies later that day, said the "soft, muscle portions were eaten" on the girl.

She was found about 12:30 p.m. that day by Scott Brewster who was fishing on the south side of St. Mary River. It was his first visit to Glacier Park.

"I was fishing with my father-in-law and we started working our way up Divide Creek," said Brewster, an Air Force Sergeant at Malmstrom Air Force Base in Great Falls. "He fished out a pair of pants with the belt still on. We thought that was pretty weird."

"Then we fished out a tent that was in the creek. Just a little ways further up I discovered a body, face down half in and half out of the water."

"My first thought after seeing the body was that something had been chewing on it either before or after the person had died. And there I am standing there with my fishing pole."

The two removed the wallet from the pants they'd found and went to the St. Mary Sporting Goods store to report it.

Jim Leigh, who manages the store, saw them coming. "They looked as if they were angry and were quite shocked," he said. "I could tell something was definitely wrong. They took me into the back room and said they had just found a dead body in the water. They were white like they were in shock."



Jane Ammerman

This summer in Glacier Park was Jane's first in Glacier Park where she was a dining room waitress at Lake McDonald Lodge. She liked to ski and hike, and as the sign above shows, she liked to have fun. She had recently become interested in backpacking. She was planning to return to the University of Minnesota this fall.

(continued on page 3)

GLACIER NATIONAL PARK



Bear Country



All Wildlife Is Dangerous
Do Not Approach Or Feed



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NIGHT OF THE GRIZZLIES

*A breathtaking, thrilling,
fascinating book... suspense that
makes it impossible to put down.*

—Chicago Tribune



JACK OLSEN



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CORRELATION OR CAUSATION

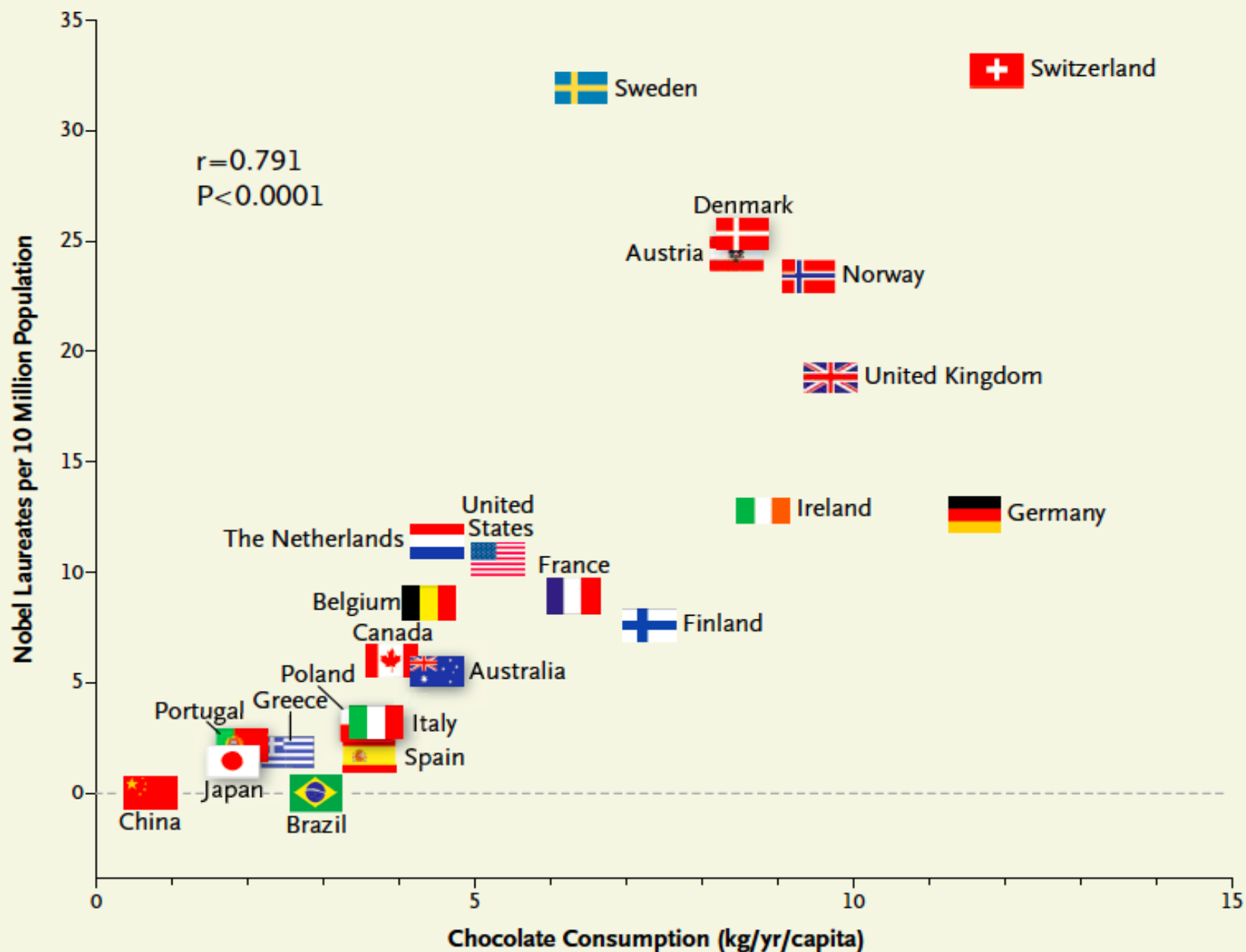
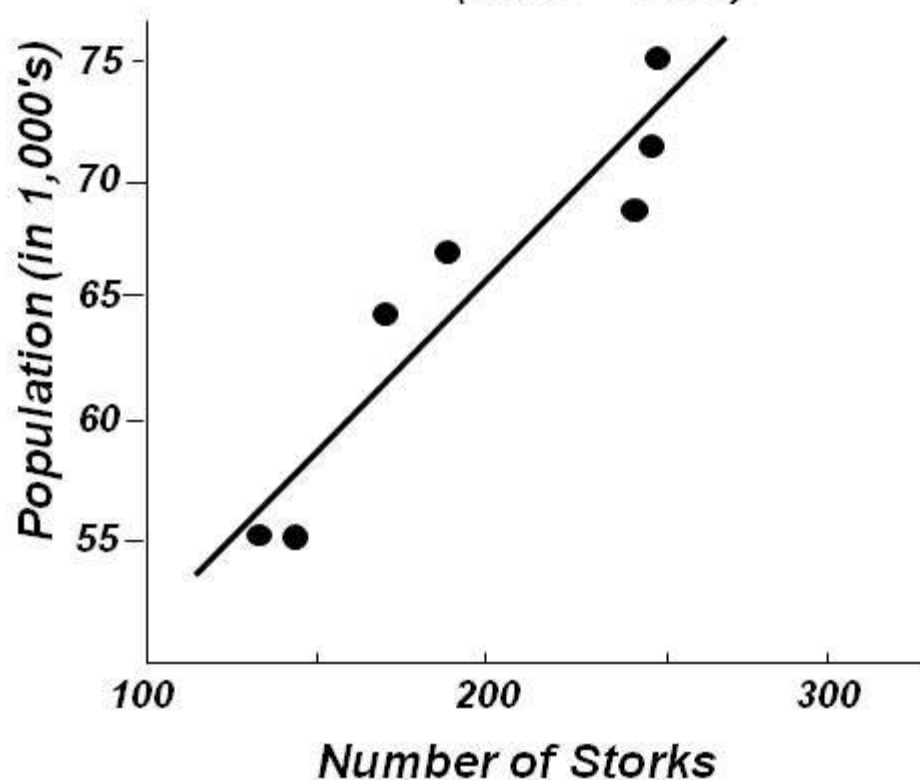


Figure 1. Correlation between Countries' Annual Per Capita Chocolate Consumption and the Number of Nobel Laureates per 10 Million Population.



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**Population of Oldenburg, Germany, at Year's End
vs. Number of Storks Observed Each Year
(1930 – 1936)**

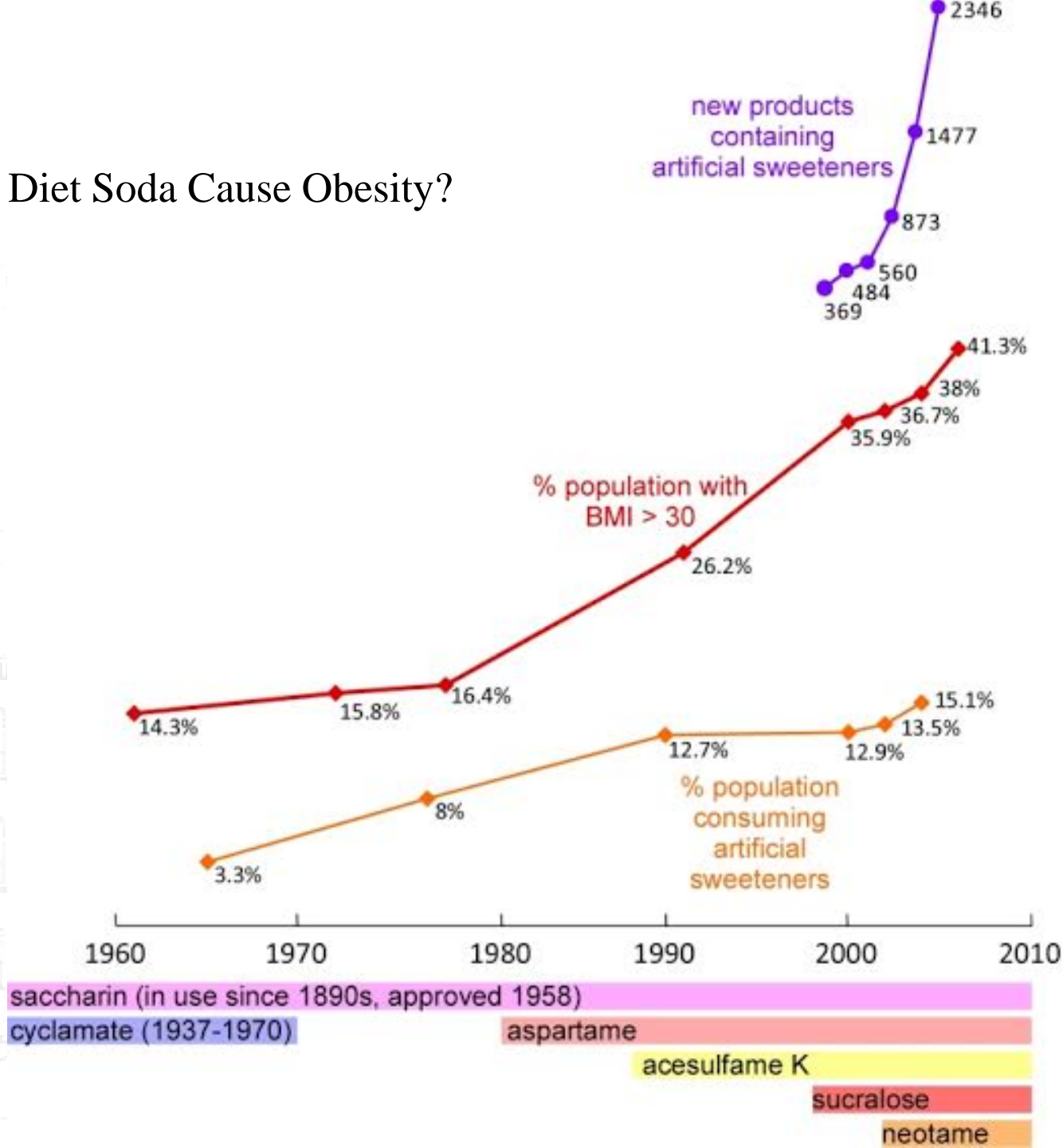


Source: *Statistics for Experimenters*,
by Box, Hunter & Hunter

Does Diet Soda Cause Obesity?



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Extra Credit Fun

- One minute video depicting Statistics as Evidence
- Had over 40 different statistical ads
- Ferristician Films Present
- <https://www.youtube.com/watch?v=QcFIXgpP-ck>
- <https://www.youtube.com/watch?v=dWGgV0WqccQ>
- <https://www.youtube.com/watch?v=a1ql3HP3-kY>

Student Comment



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“Probably my favorite aspects were the relevance of the SAE assignments to events occurring in the world around us.”

“You were also able to not just give us feedback, but critical feedback, that made us examine our own preconceived notions, challenging what we thought we knew.”

Caveat Lector



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Let the Reader Be(ar)ware