Is coffee good for your health?
Meat is unhealthy, meat is okay: Why science keeps overturning what we thought we knew

Don’t be surprised that scientists keep updating their advice.

By Julia Belluz and Brian Resnick | Oct 4, 2019, 1:20pm EDT
Why is it hard to know things in diet-science?
Why is it hard to know things in education?
Don’t we just need a lot of randomized control trials???
Motivation and Identity

CS398
Research around a known problem: IRT

What do we know about learning?

Problems nobody has attempted
Coming Up...

• Homework for this coming week: brainstorm 3 projects *individually*. For each one fill out info-sheet

• Homework next week: generative grading

• Following week: refine project choices with our help
Today

• The stakeholders in “education”

• Projects in the face of the unknown

• Get started on homework
Stakeholders in education
What is knowable?

- IP-CC  What we know about climate change
- IP-BEST What we know about ecology
- IP-SEE  What we know about education
- USA    Context matters

This leaves a lot of room for opinions.
It has given undue influence to Ai-Ed community.
Some Reflection
Anxiety, depression & suicides among young people rising globally

Intolerance & violent extremism growing

Global wicked problems such as climate change & migration increasing

Cost of Education increasing exponentially & now a private good & no longer a social good
The brain is key to learning

The brain is a social brain: There is the rational and the emotional part

Neuroplasticity is key for learning

What is this about “the brain”
Teachers are important stakeholders 😊

- Static
- Rote Memorization
- One Size Fits All
- Listen Don’t Question
- Material Wealth & Prosperity a Key Goal
- Competitive Pitching Against Each Other
- Teachers Know It All
Aside: Talk at Faculty Lunch
People desire a tech panacea
Know what you don’t know
Education is an art as well as a science
Work in your local context?
Best book I have read on the science of learning
You need to decide on your values, and take stakeholders into account
Deep IRT

**Baseline:**  \[ p = \sigma(a - d) \]

**Issue:** ability is not a one dimensional value

**Insight:** neural nets can help us “learn” higher order interactions

**Simulation:** What simulation best captures this flaw in IRT?
Deep IRT

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**Insight**: neural nets can help us “learn” higher order interactions

**Simulation**: Three questions from two abilities
**Deep IRT**

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\[
da - d \to r \\
p = \sigma(r)
\]
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\[ p = c + (1 - c) \cdot \sigma(r) \]
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![Diagram](image.png)
Huge Gap
Huge Gap

DIRT ← -- → Real world learning
Huge Gap

Real world learning

Auto advising
Crowdsourced near peer teaching
Teacher insights from video/audio
Generating cool questions
Feedback for open-ended work

DIRT
Huge

Feedback for open-ended work

Teacher insights from video/audio

Peer grading

Crowdsourced near peer teaching

Auto advising

Taking a break?
That's ok! Just remember where we're keeping your family

DI RT

Utopia learning

Generating cool questions

Peer grading

Crowdsourced near peer teaching

Auto advising
Unit 2: Learning centered CompEdu problems
Online testing instead of RCT

Crowdsourced course construction (and business model)

Spaced repetition

Gamification and hook model
Reinforcement Learning

- Computer Adaptive Tests
- Selling Ads
- DuoLingo intervention choices
  - Adaptive handouts
  - Alternative to R.C.T.
Alpha GO mixed deep learning and core reasoning under uncertainty
Multi Armed Bandit
Which one do you give to a patient?
Multi Armed Bandit

Drug A

Drug B

Which one do you give to a patient?
Drug A

Let's Play!

Drug B

Which one do you give to a patient?
def main():
    X1, X2 = pickle.load(open('probs.pkl', 'rb'))
    print("Welcome to the Duolingo simulator. There are two interventions")

    while True:
        choice = getChoice()
        prob = X1 if choice == "a" else X2
        success = bernoulli(prob)
        if success:
            print('Success. Student stays in!')
        else:
            print('Failure. Student drops out!')
    print('')
You try intervention B, 5 times. It is successful 2 times. If you had a uniform prior, what is your posterior belief about the likelihood of success?

$$X \sim \text{Beta}(a = 3, b = 4)$$

2 successes
3 failures
Thompson Sampling
What if there are more than two options?
What if you know something about students?
What if you make several decisions before you get a “reward” signal?
Challenge: your designers have come up with 50 possible motivation interventions. How can you learn when and for whom you can use them?

Meta challenge: what are the steps in approaching this problem as research?
Future for Duo Lingo

Personalized feedback when students make mistakes

S.L.A.M.
Homework due next Thursday: design three final project proposals