Eclectic Or Electric?
Neurons, Videos, and What Students Say About Their Own Learning

Dr. Jill Terra and Dr. Shannamar Dewey
INSPIRE Convening, October 15th 2022
Overview of Today's Goals

• Understand the **Problem, Goal & Approach** of intervention.

• Have a sense of the scope of **research-supported methods** used in our intervention as well as our team's iterative process, challenges and growth experienced.

• Appreciate **results and limitations** of mixed-method research on effectiveness of intervention.

• Apply lessons learned throughout this experience to INSPIRE, direct and/or make future higher education policies and research questions.
The Problem: Minoritized Students Disproportionately Removed From Allied Health Pathways & Careers

• Reflective of what is seen across institution types and location in the U.S.

• Students from minoritized communities have high motivation and desire to help their communities.

• Lack of representation in healthcare leads to disparity in outcomes.

Percentage of students that pass Anatomy at Butte College by self-reported ethnicity (students reporting unknown are excluded). N=2,115
An Important Question: Why Do Students Fail Anatomy?

• New Language
• Fast Pace/High Volume of Material
• Requires a lot of memorization
• Previous educational experiences have not required this volume of memorization
• Fixed mindset about who succeeds in science: "I'm not good at science."
Think About Your Last College Class...

What Was Your Go-To Studying Method?

- Reading over your notes
- Studying with a friend
- Cramming for tests
- Highlighting the Text/Notes
- Flash cards
- Something Else
Our Question

If students understand the basics of how the brain learns

*and* can apply that understanding to specific, science-supported, studying strategies

will this connect their motivation with methods to reach success?
Project Approach: Interactive, Adaptable Learning
Science Videos & Assignments

Intersegmental Team of Researcher/Educators

Lesson 1 Videos: *Biology of Learning*
Lesson 2 Videos: *Jumpstart to Smart Studying*
STEM Success With Interactive, Adaptable Learning Science Videos: Team Members

- Shannamar Dewey, Ph.D., PI, Butte College, Chico, CA
- Jill Terra, Ph.D., Co-PI, Butte College, Chico, CA
- Maris Thompson, Ph.D., Co-PI, California State University, Chico, Chico, CA
- Al Schademan, Ph.D., Team Member, California State University, Chico, Chico, CA
- Natalia Caporale, Ph.D., Co-PI University of California, Davis, Davis, CA
- Nena Anguiano, Co-PI, Butte College, Chico, CA
- Christopher Westbay, Butte College, Chico CA (Honorary team member)
Project Hypotheses

Participation in the video intervention will increase student:

1) knowledge and understanding of the biological mechanisms of learning and memory and related study strategies,

2) self-efficacy, science identity, and sense of belonging, and

3) academic performance

These increases will lead to a decrease in DFWs and a reduction in performance equity gaps.
Everything But The Kitchen Sink: A Science-Based Learning Intervention

Interactive = Active Learning
- Generative Questions
- Reflective Questions
- Formative Questions
- Values Affirmation

Adaptable
- Choices in activities
- Optional supportive content:
  - Data analysis and graph reading
  - Basic components of Cells

- Racially and ethnically diverse student narrators speaking about their own experiences in biology classes
Meet Our Student Narrators!! 😍😍

Roccio    Aaishah    Peto    Andy    Moshe

Jasmin    Fred    Amanda    Kimberly    Vanna
Lesson 1: Biology of Learning

| Title | V1: Introduction, Values and Growth Mindset | V2: The Brain is Amazing! Perception and Neurons | V3: Neuroplasticity | V4: The Learning Power of Memories |

Sort Into 2 Groups

- I’m not smart enough.
- I actively seek feedback to improve.
- Challenges are what make life interesting.
- I’m not good at taking tests.
- I ask for help when I need it.
- I can’t make this any better, it is what it is.
- When I have to spend a lot of time studying it makes me feel stupid.
- When something is hard, it makes me want to work on it more, not less.
Lesson 1: Biology of Learning

| Title | V1: Introduction, Values and Growth Mindset | V2: The Brain is Amazing! Perception and Neurons | V3: Neuroplasticity | V4: The Learning Power of Memories |

In Vivo Voltage-Sensitive Dye Imaging in Adult Mice Reveals That Somatosensory Maps Lost to Stroke Are Replaced over Weeks by New Structural and Functional Circuits with Prolonged Modes of Activation within Both the Peri-Infarct Zone and Distant Sites

https://www.jneurosci.org/content/29/6/1719/tab-figures-data

brain responds to trauma in order to maintain its functionality.

Eight weeks after stroke (red X)
Which Study Method Worked Better Here?

- **Method A**
- **Method B**

Proportion of Idea Units Recalled

- 0.8 at 5 Minutes
- 0.7 at 2 Days
- 0.6 at 1 Week

Retention Interval
Which Study Method Worked Better Here?

![Bar chart showing the proportion of idea units recalled at different retention intervals for two study methods: Study, Study vs. Study, Test. The chart indicates that the Study, Study method generally results in higher recall rates across all retention intervals.]
Lesson 2: Jumpstart to Smart Studying

<table>
<thead>
<tr>
<th>Title</th>
<th>V1: Metacognition</th>
<th>V2: R &amp;R</th>
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We asked several of our student narrators to share their experiences with cramming! Which story would you like to listen to?

- I'd like to hear Amanda's story.
- I'd like to hear Fred's story.
- I'd like to hear Jasmin's story.
- I'd like to hear Kimberly's story.
- I'd like to hear Pepe's story.
- I'd like to hear Vanna's story.

[SUBMIT]

Graph:
- Percentage Correct (%)
  - Study Once
  - Recall Once
  - Repeated Massed
  - Repeated Spaced

Method of Study
Mixed Methods Study Design

- **Fall 2021/Spring 2022:**
  - 4 control sections (n=100)
  - 7 experimental sections (n=175)
  - 3 Anatomy Instructors

- **Data Collection:**
  - Students completed surveys at the beginning and end of the class credit.
  - Students were invited to participate in focus groups (see qualitative section)

- **Data Analysis of Surveys**
  - Comparing students Pre/Post Likert Scale Responses using Mann Whitney Statistics (paired responses, n=52 control, 72 experimental students).
  - Comparing population responses in the Pre and Post surveys
  - Analyzing specific responses using qualitative methods in Post Surveys (n=95)

- **Data Analysis of Focus Groups**
  - Grounded Theory Approaches
Quantitative Results: Study Habits Impacted

"Did watching the videos influence how you plan to study for this class / other classes? If so, how?"

- "I changed not cramming it all at once and spacing it out."
- "I now space out my study sessions and I started the retrieval method."
- "Watching the videos did not influence how I plan to study"

Treatment Group Students Also Reported Using Less Cramming

(N=95)
Quantitative Results: Students Shifted Away From A Fixed Mindset

Agree/disagree:

- You have a certain amount of intelligence, and you can't really do much to change it.
- You can learn new things, but you can't really change your basic intelligence.

Identified learning as mediated by changes in brain anatomy to a higher degree than control group students.
Quantitative Results – Trend For Higher Grades in Treatment Group, But Confounded By Prior GPA Trend

This is an issue of sample size
Quantitative Results-The Challenge of Low Ns

• No significant change observed in sense of belonging or in self-efficacy.
  ➔ Stay tuned for a different story from interviewed students!

• No change in D/F/W rates

• Incoming GPA was only factor that predicted outcomes in Anatomy for study year
Qualitative Methods And Results

- **12 Focal Interviews** conducted Spring 2021, Fall 2021, Spring 2022
  - 37 total students: 23 Treatment, 14 Control

- Amended semi-structured interview protocol

- Constant comparative analysis performed using Atlas.ti software and thematic analysis around 6 a priori themes from interview questions
Qualitative Data Analysis:
388 Participant Quotes Coded As Follows:

- Academic Preparedness: 24
- Changes in Student Studying/Learning Behaviors: 63
- Purpose for Learning: 9
- Group Work Assignment: 19
- Most Helpful Aspects of the Course: 37
- Impacts to Sense of Belonging: 15
- Student Relati: 4
- Student Experiences in Anatomy: 30
- Suggest Improve for Videos: 12
- Videos - Helpful Elements: 59
- Videos - Unhelpful Elements: 12
- Video Effects on Student Views of Themselves as Learners: 32
- Student Strengths: 39
- Student Challenges: 43
- Videos - Helpful Elements: 59
Students Demonstrated An Understanding Of The Biology Of Learning

• Deepened understanding of neuroplasticity and how the brain creates new neural pathways and long-term memories

• Targeted use of more active study strategies (self-quizzing using Quizlet, self-generated study maps)

• Spoke about their academic performance using growth mindset language

“Even if you don't do well on one test, you know, you can change...and your brain can grow”
Which of the following conclusions was not supported by the quantitative data?

- Students shifted away from a fixed mindset.
- Students understand that learning comes from changes to the brain.
- Students have an increased sense of belonging.
Students Related To Narrators As Role Models That Increased Their Sense Of Belonging

- Relatability as former students who struggled and overcame obstacles
- Normalizing feelings of self-doubt or questions of belonging
- Encouragement of growth mindset approaches to studying
- Connection to their minoritized status
- Role in engagement/interaction with the videos
“I mean, like, seeing that they were in the same boat eventually. And then also seeing how they got out of it, or how they got out of that rut that had them stuck there with that mentality that they couldn't get rid of. But they just follow through, push through and like stayed strong throughout their semester classes, and were able to finish. So I think, knowing that it's possible that it's going to end eventually. I mean, it's only one semester of anatomy, like you've gone through multiple. So, I think that having that encouragement of like you can do this, you know, just so take some dedicated time. Them telling us kind of released my anxiety a little bit.”
What Did We Learn?

- Unity in our shared drive to help students
- *Walking the walk*: commitment to engage, learning new things, embracing the effort, openness to other's ideas
- Group meeting structure matters:
  - Regular larger group meetings
  - Paired meetings for creating, editing, data analysis, or individual work
- Iterative Process: Pilot Spring 2021 (Lesson 1); learning & modifying
- Leveraging existing resources
  - *Butte College Media Production Specialist*, **Chris Westbay**
  - Atlas.ti software, **Al Schademan** (Chico State)
Thoughts And Questions For The Future

• **Next steps:** Evolve the culture and course pacing in Biology department(s) to adopt intervention
  • Do we have enough (compelling) data for systemic change?

• Do we have enough evidence for systemic change at other institutions?

• Publish work and promote the videos to other Anatomy instructors.

• Early dissemination shows interest in using the lessons as they are; and/or a methods paper for producing student videos.
"No matter what, I can still learn."
Credits and Citations

This entire project was inspired by the book "Make it Stick, the Science of Successful Learning" Brown, P., Roediger III, H. & McDaniel, M. (The Belknap Press of Harvard University Press, 2014)

Select Works Cited: Equity Gap-Closing Methods in Videos


Works Cited: Video Activities

L1V1: Mindset Activity Figure adapted from: Blackwell et al, "Implicit Theories of Intelligence Predict Achievement Across an Adolescent Transition: A Longitudinal Study and an Intervention", Child Development, January/February 2007, Volume 78, Number 1, Pages 246 – 263

L1V2: Cell Activity Image adapted from, "Final stem cell differentiation (1)" by Haileyfournier, is licensed under CC BY-SA 4.0

L1V3: Neuroplasticity Activities and Images adapted from: Brown et al, "In Vivo Voltage-Sensitive Dye Imaging in Adult Mice Reveals That Somatosensory Maps Lost to Stroke Are Replaced over Weeks by New Structural and Functional Circuits with Prolonged Modes of Activation within Both the Peri-Infarct Zone and Distant Sites", Journal of Neuroscience 11 February 2009, 29 (6) 1719-1734; DOI: https://doi.org/10.1523/JNEUROSCI.4249-08.2009t


L2V2: Test Affect Figure adapted from: Roediger et al, "Test-Enhanced Learning Taking Memory Tests Improves Long-Term Retention", Psychological Science, (RECEIVED 2/4/05; ACCEPTED 3/24/05; FINAL MATERIALS RECEIVED 4/13/05), Volume 17—Number 3 255 –


Works Cited: Presentation Image Credits

Neuron Image slide 1: “Finding a Cure for ALS”, By Oregon State University, Modified, is licensed under CC BY-SA 2.0

Boating Image slide 26: Boat Success, is licensed under CC BY-SA 4.0
Challenges, Considerations

- COVID-19 Pandemic
  - Saturated online curriculum experience
  - Increased drop rates
  - Instructors' decreased participation in research
  - Nature of course experiences significant drop rate

- Limitations to Seed grant

- Does the intervention affect retention? Or academic performance in subsequent semesters?
Quantitative Results—Prior GPA Was the Only Significant Predictor of Student Outcomes in Sample

**Initial Model:**

\[ \text{Grade} = \beta_0 + \beta_1 \times \text{Prior GPA} + \beta_2 \times \text{URM} + \beta_3 \times \text{GENDER} + \beta_4 \times \text{Low SES} + \beta_4 \times \text{First Gen} + \epsilon \]

**Final Model:** (through model selection in R)

\[ \text{Grade} = \beta_0 + \beta_1 \times \text{Prior GPA} + \beta_2 \times \text{URM} + \epsilon \]

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<tr>
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<tr>
<td><strong>Predictors</strong></td>
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<tr>
<td>(Intercept)</td>
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<tr>
<td>URM</td>
</tr>
<tr>
<td>PRIOR_GPA</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>( R^2 ) / ( R^2 ) adjusted</td>
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Low \( R^2 \), low sample size
Qualitative Results: Key Findings

1) Effective curriculum, pedagogy and assessment practices in the anatomy course:

   Accessibility of instructors, positive student professor relationships, instructional supports like pre-recorded video lectures, assessment practices such as graded note taking, study guides, and practice exams.

2) Positive impact of the adaptive videos based in brain science. Students demonstrated a deeper understanding of:

   How the brain functions and how memory consolidation happens, the scientific principles of neuroplasticity, growth mindset and long term memory consolidation, both the how and the why of effective study strategies.

3) Student agency in utilizing effective study strategies that worked best for their own learning.

4) The brain-based science videos were therefore powerfully additive to an already effective anatomy course that implemented evidenced based science curriculum, pedagogy and assessment.
Um, I liked that there were personal experiences in there. It wasn't just like a teacher telling you “This is what's helpful. This is why you should do it”. It was more of “This is what happened to me. And once I learned that there was another way Like I should do that instead, if that makes sense. So I liked those. And I liked how it was interactive. Because it forced me to actually pay attention. Because sometimes, when a video goes, I stop paying attention. So knowing that I had to pay attention and answer questions in the video really helped. And I liked that a lot.
Qualitative Results: Mindset Quote

“I enjoyed just learning more in the beginning of the videos when they started talking about the fixed mindsets and the growth mindsets. That was something that I really enjoyed because as an adult learner, I would say that's probably one of the biggest things that we're always hung up on, is you know, you can't teach an old dog new tricks kind of thing. And so I just enjoyed them saying that even people who experience strokes, or parts of the brain where they have injuries, that even if they receive the right training and repetition that they can grow beyond that having other parts of the brain pick up those tasks. So it just goes to prove to you that we don't have to stay so fixated, that no matter what our age is, what our circumstances are, that we have the ability to overcome that and get more into a growth mindset versus fixed.”
So, at the beginning when I saw the videos and how our long term memory and short term memory works. I decided to actually focus on that and pay attention and break everything down into pieces and I've realized that that actually sticks better if I break it down into chunks, and learn, and focus on smaller portions to learn, then I can at the end be able to put it all together, And I do the same for lab and lecture, when it comes to lecture I focus on a short portion of it, understand that before I implement the rest of it
Lesson 2: Jumpstart to Smart Studying

| Title | V1: Metacognition | V2: R &R | V3: Spacing it Out | V4: Embracing Effort and Mixing it Up |

### Spacing Out Study

- **Study Strategy 1** and **Study Strategy 2**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Correct (%)</th>
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<tbody>
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</table>

**Practice Sessions**

- P1
- P2
- P3
- P4
- P5
- P6
- P7
- P8

**Problems**

- F1
- F2
- F3

**TEST**

<table>
<thead>
<tr>
<th>STUDY TOPIC A</th>
<th>TAKE A BREAK</th>
<th>STUDY TOPIC B</th>
<th>TAKE A BREAK</th>
<th>STUDY TOPIC C</th>
<th>TAKE A BREAK</th>
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