TEACHING AS RESEARCH SHOWCASE:

"CONCEPT INTEGRATION IN A STUDIO FORMAT OF SIGNALS AND SYSTEMS"

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PART I

Concept Inventory Assessment

<u>Research question:</u> Are students truly learning concepts in Signals and Systems?

Background: My Class

- BE 401: Signals and Systems in Biomedical Engineering

- 160 junior-level students

Last Year: Lecture Hall
- 3 hours of lecture (Instructor #1)
- 1 hour of "small group" sections (Instructor #2)
- 1 hour of discussion/homework help (TAs)
- Optional MATLAB office hour (TA)
- Optional regular office hours (Instructors + TAs)

This year: Studio Classroom
- ~~Online lectures (1 Instructor)~~
- 4 hours of studio learning (2 Instructors and 2 TAs)
- Optional office hours (Instructors and TAs)

<u>Disclaimer:</u> This course rearranged structure half-way through the semester. Because of this, incomplete data were collected, and the scope of our investigation was greatly limited

Assessment: Signals and Systems Concept Inventory (SSCI)

SSCI: test of conceptual knowledge of signals and systems
No calculations required
Authors: Buck and Wage
Methods: Administer the SSCI before and after the course

The post-class test was not mandatory, thus far fewer students showed up. There might be a selection bias here (e.g., high-achievers might have attended in higher proportions)
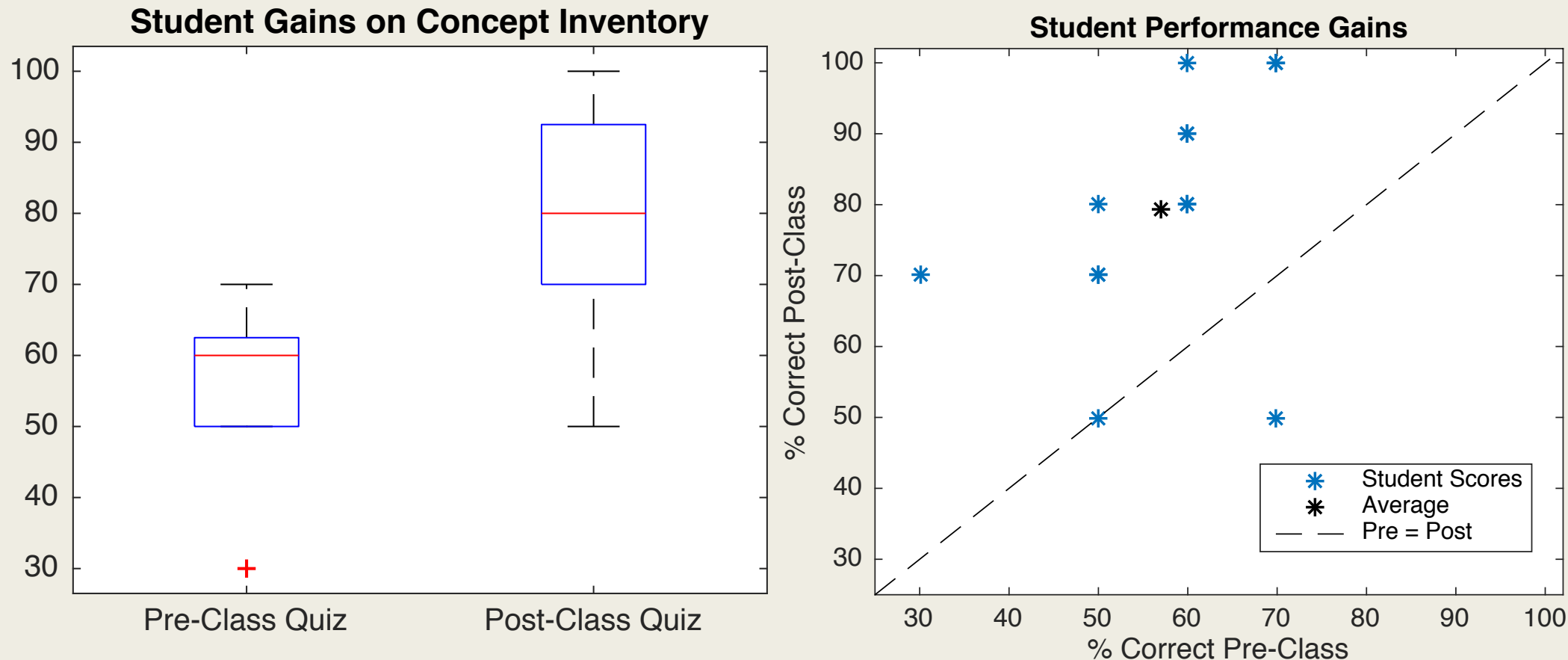

N = 168

Pre-Class Test

N = 13
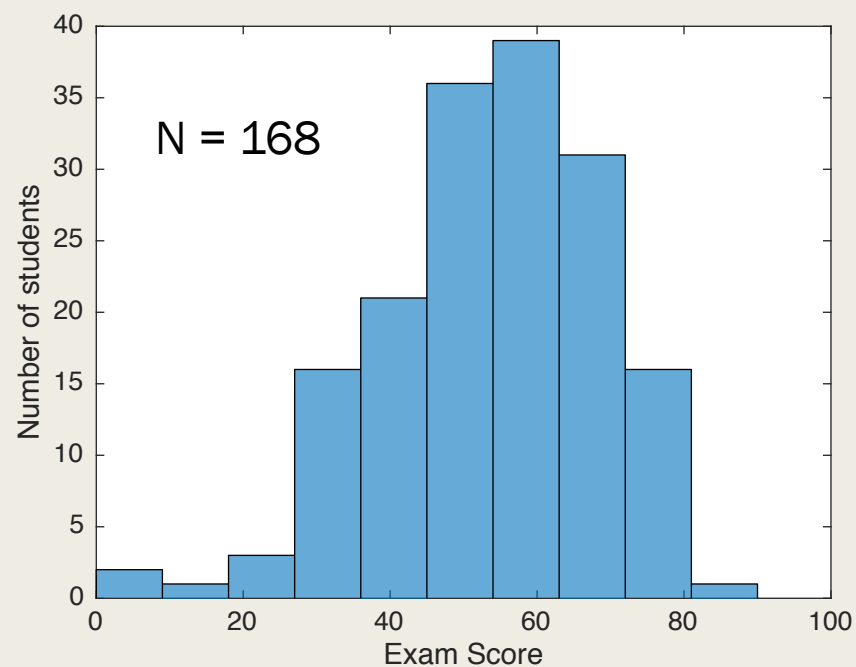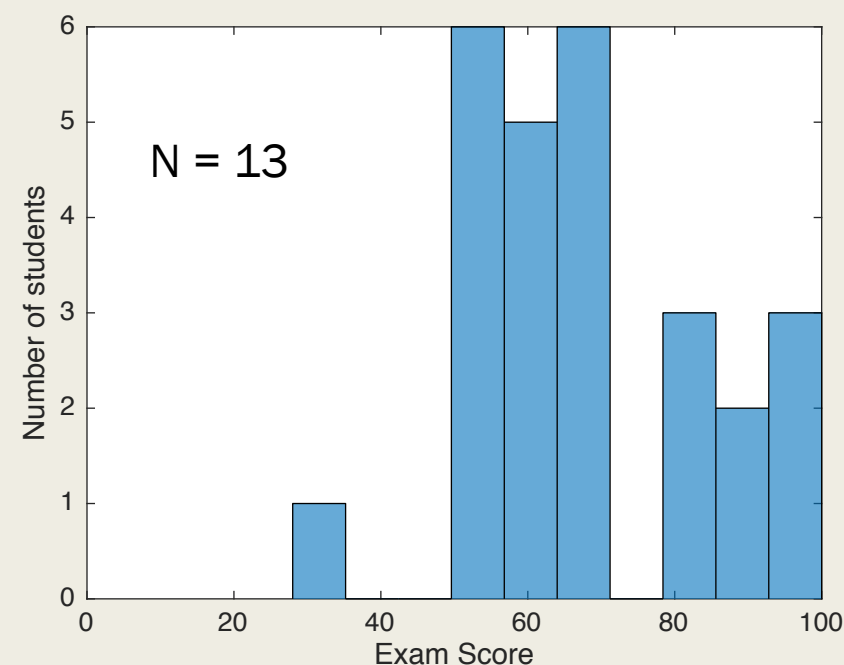
Post-Class Test

Individual gains from N=13 subset

Most students performed better on the post-class test, which was expected. Further analysis will be done to determine which types of questions had best and worst performance.

Conclusion and Future Directions

- No conclusions because we prioritized teaching over the research
- – *Course structure changed: no mandatory post-course exam*

- Going forward:
- – *Identify which questions had the highest and lowest scores – does this tell us about our teaching?*
- – *Compare scores across more cohorts (semesters) of students*
- – *Help verify the exam (collaborate with Buck/Wage)*
- – *Incorporate more conceptual questions into course assessments*

PART II

Word Mapping Intervention

<u>Research question:</u> How much benefit, if any, do students gain from generating their own explicit, visual representations of connections between concepts rather than being taught those connections (passively)?

Methods: Concept mapping intervention

What is concept mapping?

- An assessment tool

- Tests the concept integration "richness"

How I administered the intervention:

1. Presented an example map using familiar concepts ("professions in academia")

2. Presented a word bank of ~40 words from the course

3. 25 minutes of individual concept mapping

4. 5 minutes of informal peer evaluation

5. 30 minutes of expert-led concept map at the blackboard (led by me)

How I assessed individual's concept maps:

- *Counted as 3 correlates of "richness*

- *number of nodes (concepts)*

- *labeled edges (relationships)*

- *unlabeled edges Plot scores according to exam scores*

Hypotheses

- Individual maps represent students' a priori knowledge and should correlate to exam scores

- The expert-led section should benefit all attendees, so the attendees and non-attendees should have significantly different mean exam scores
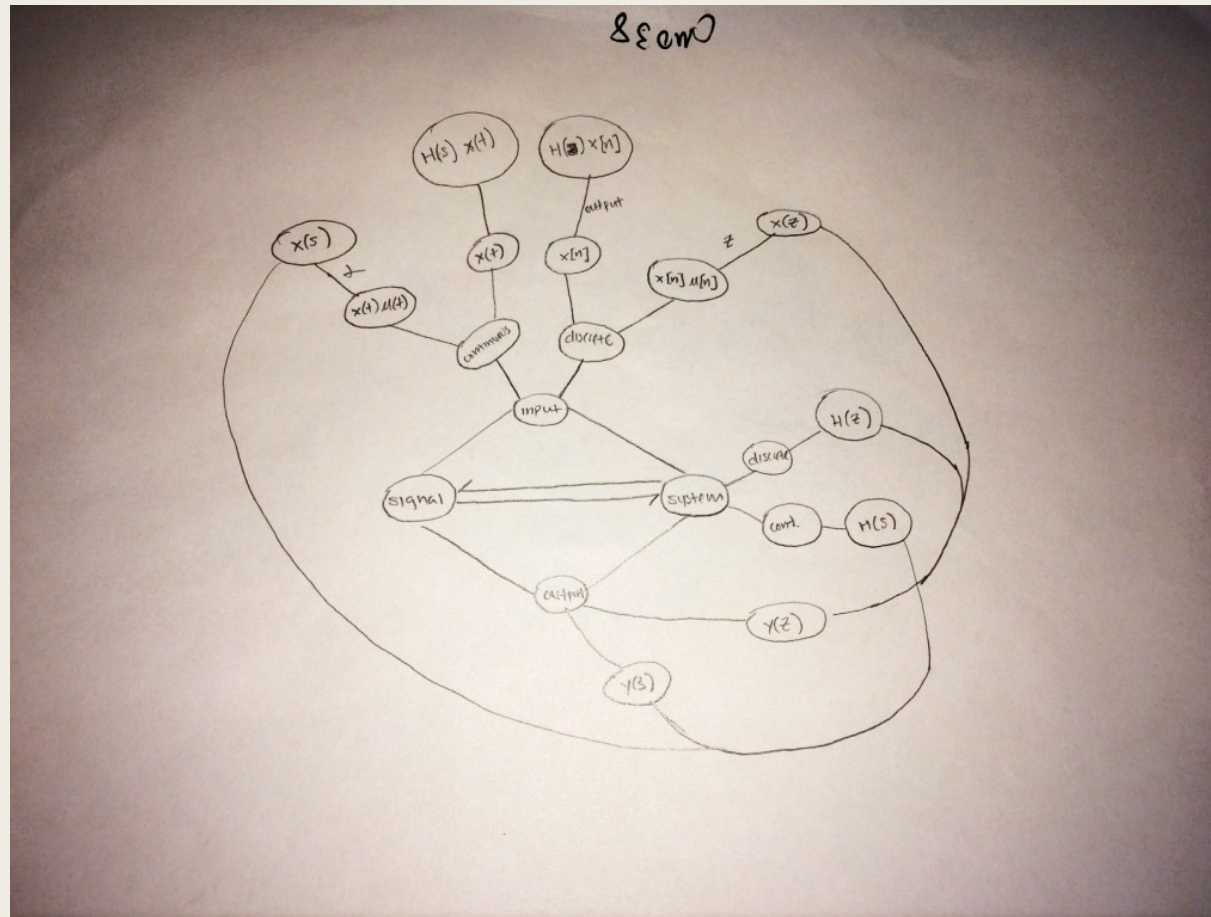
Examples of Good and Bad Concept Maps
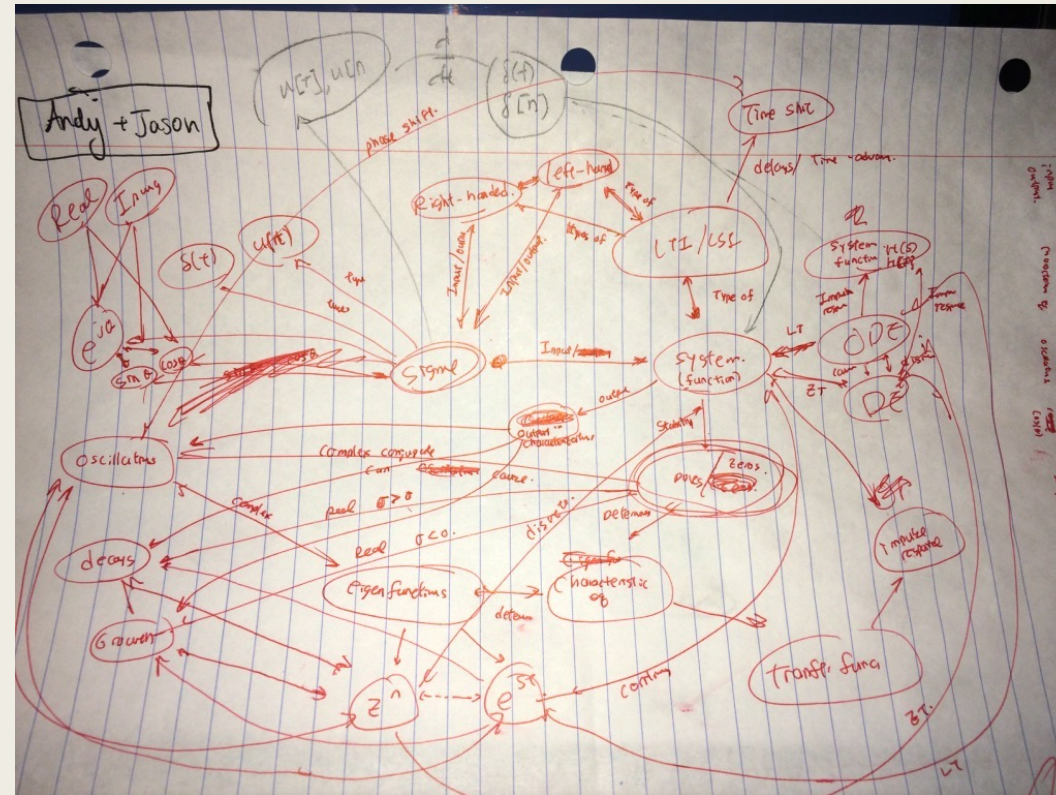
This is a concept map generated by 2 experts (two course instructors) in 15 minutes.
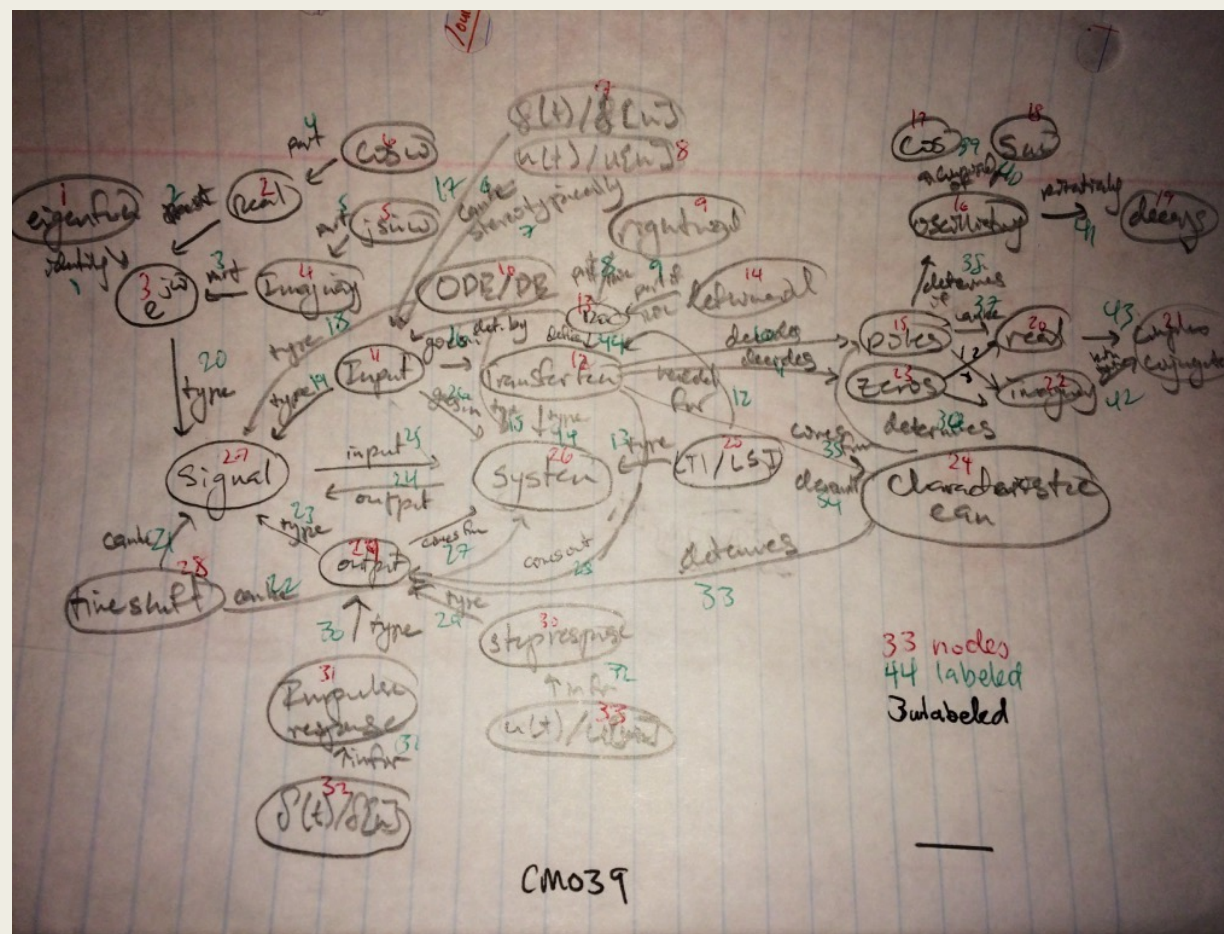
Experts given 15 minutes

Examples of Good and Bad Concept Maps

This is a student-generated map on the on the mediocre side. There are 19 nodes and no labels on the edges

Student given 25 minutes
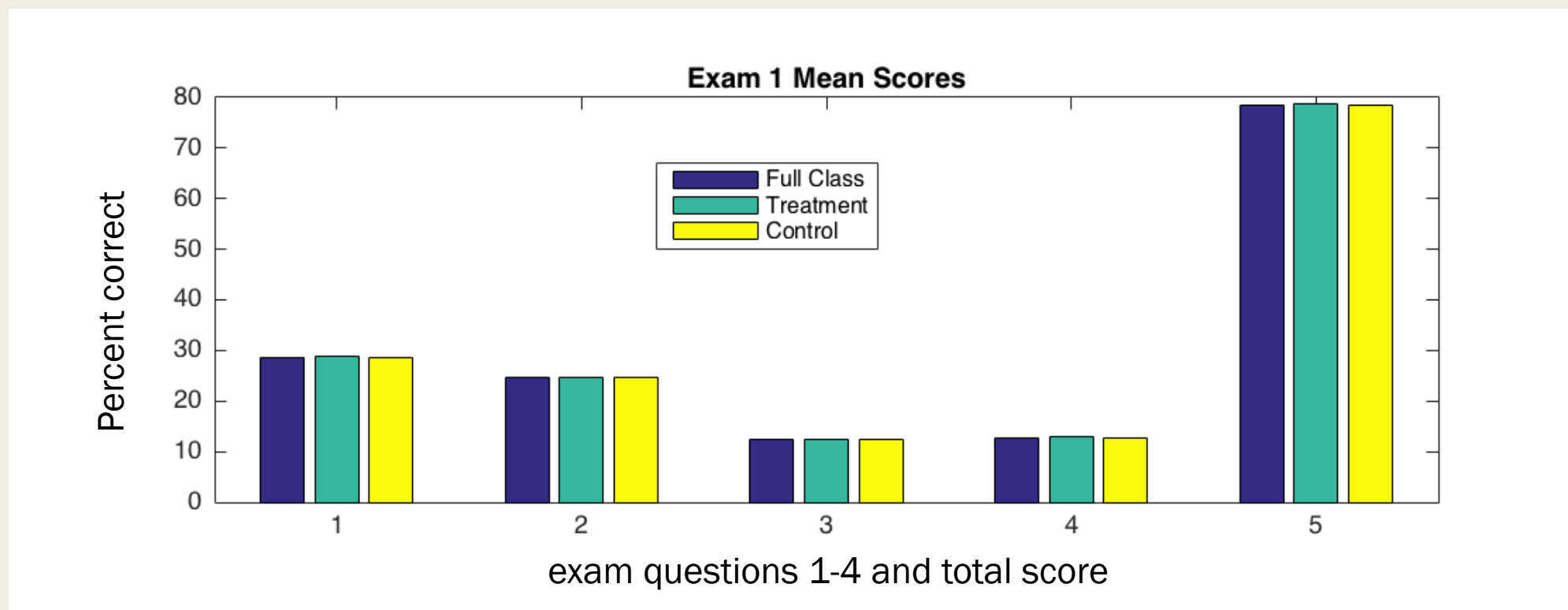
Examples of Good and Bad Concept Maps

This is a rich concept map. Connections are labeled with relationships.

Student given 25 minutes

Results: Group Scores

Hypothesis: Expert-led instruction should increase average exam score for treatment group

Exam 1 Mean Scores

Percent correct

Legend:
- Full Class
- Treatment
- Control
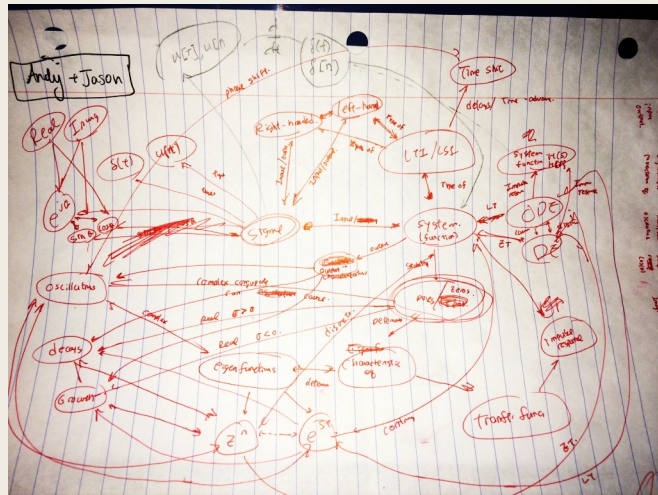
exam questions 1-4 and total score

34 of 160 students showed up to the one-time intervention. There is no significant differences between the concept mapping group and the controls (non-attendees) ☹
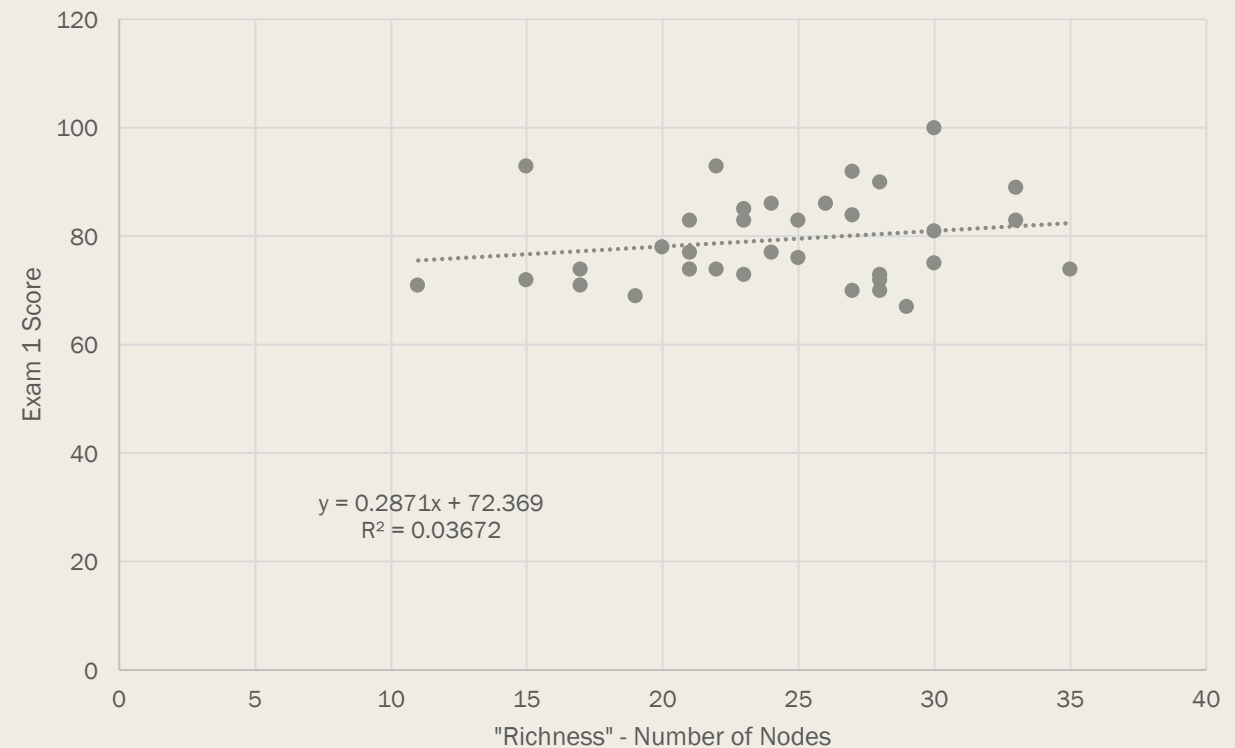
Results: Group Scores
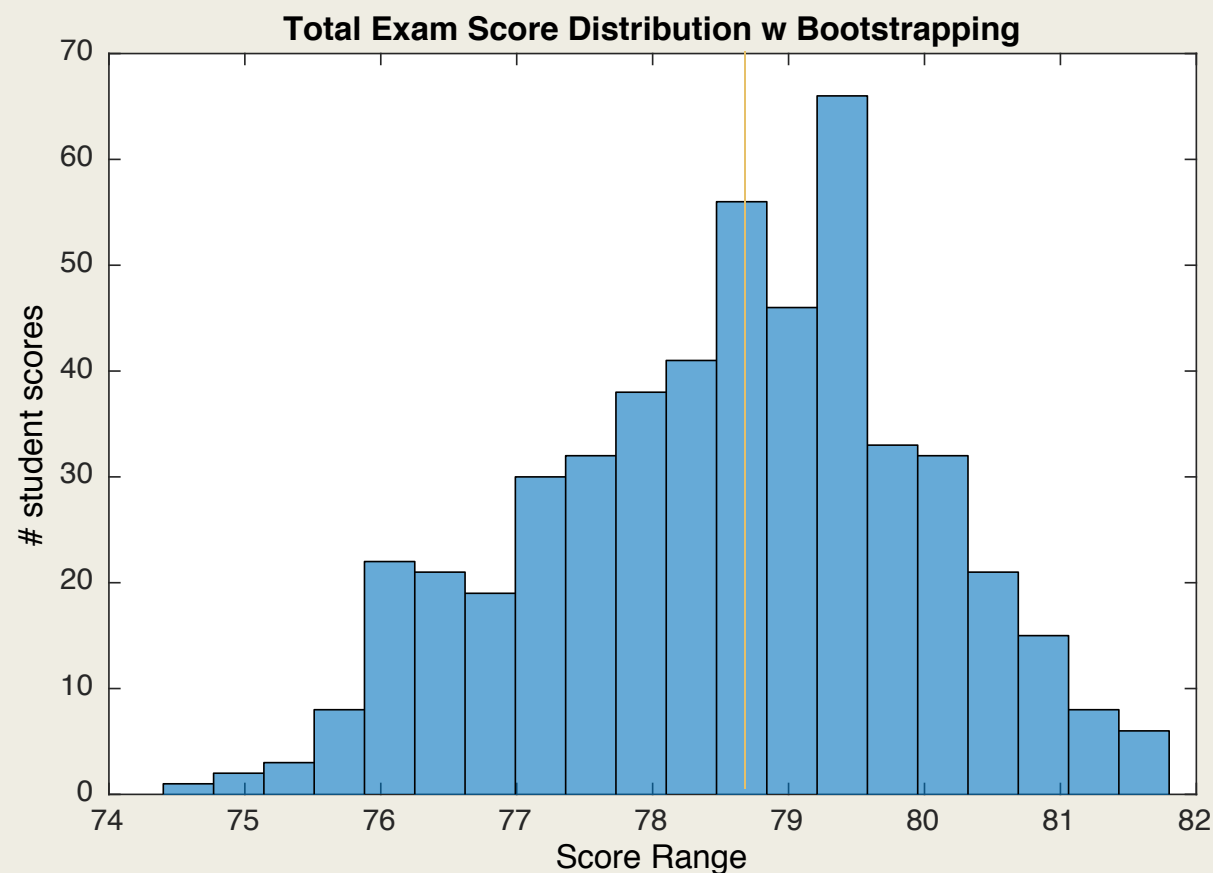
I did a bootstrap analysis on exam scores for the subset of students who attended the concept mapping intervention. The actual average score of the treatment group (yellow vertical line) was well within the confidence interval for non-signficance.
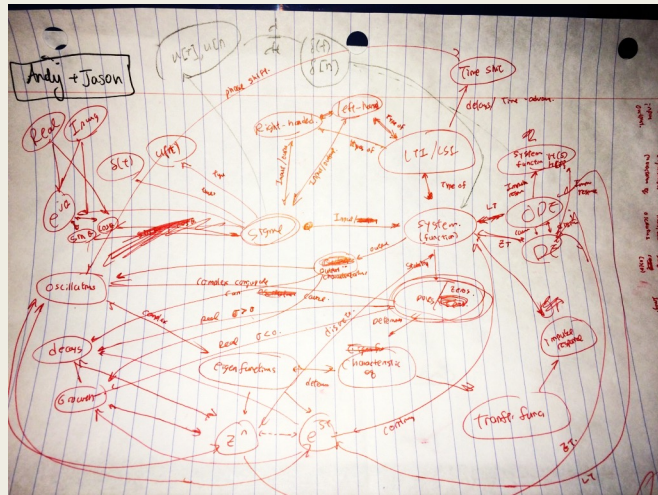
Results: Individual Scores
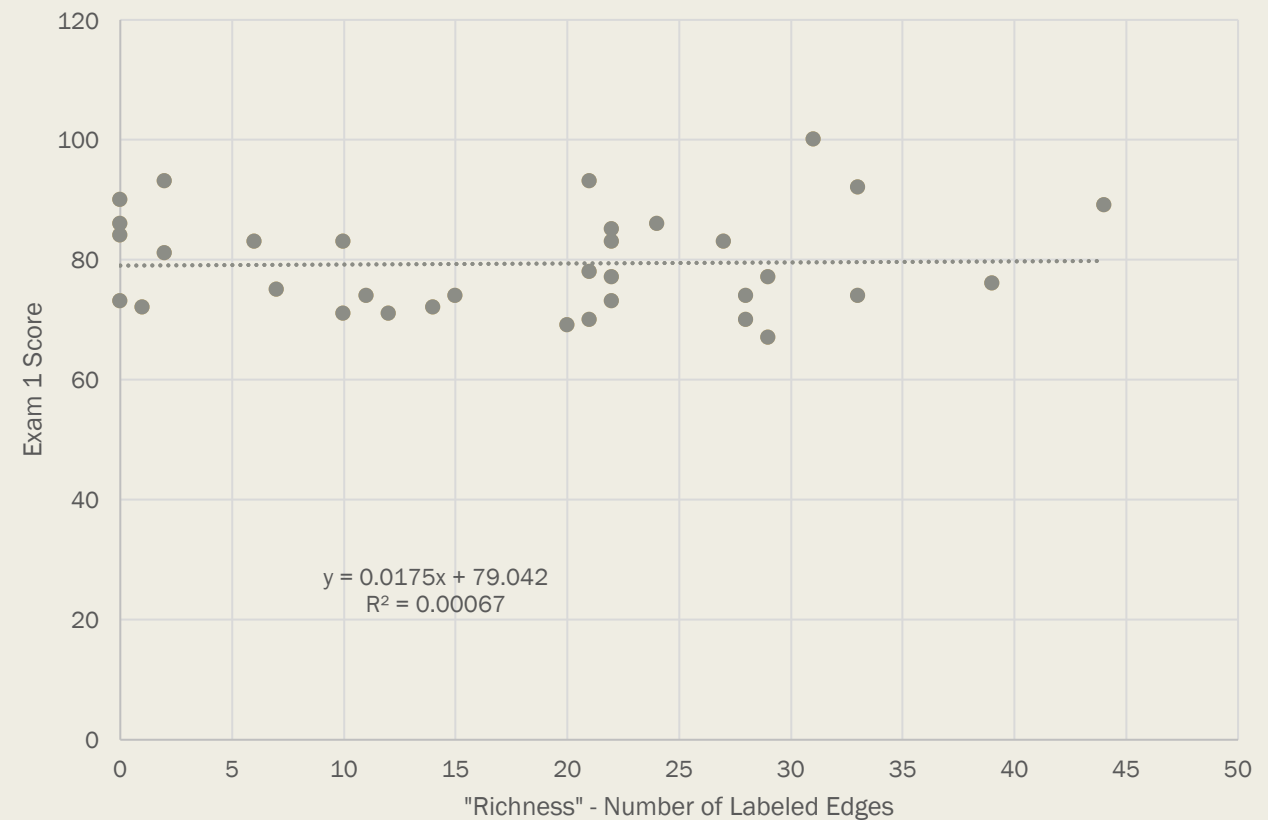

Performance by # Nodes

$y = 0.2871x + 72.369$
$R^2 = 0.03672$

Exam 1 Score

"Richness" - Number of Nodes

The following are the individual exam scores correlated to concept inventory measures.

Results: Individual Scores

Performance by # Labeled Edges

$y = 0.0175x + 79.042$
$R^2 = 0.00067$

Exam 1 Score

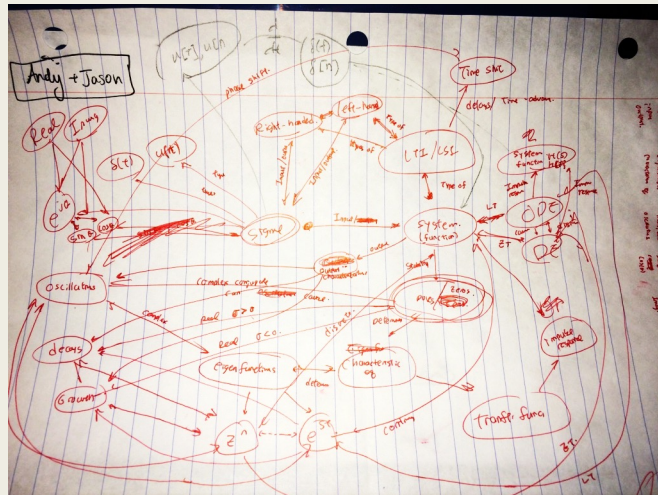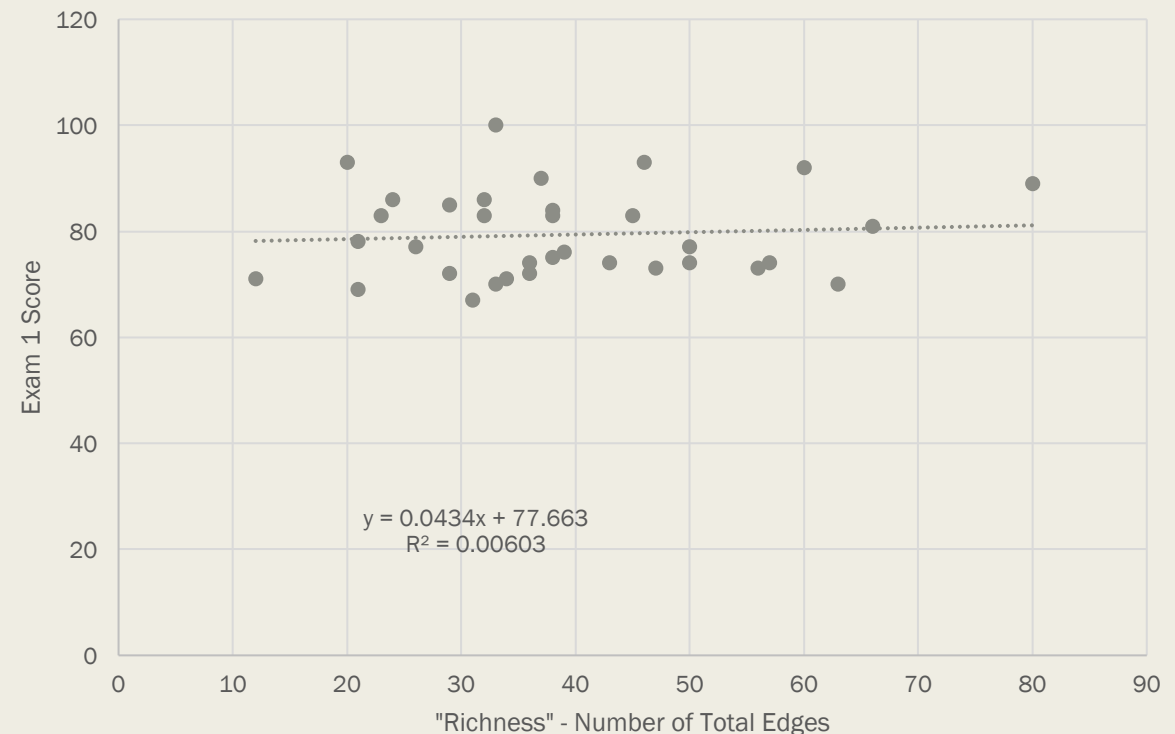"Richness" - Number of Labeled Edges

The following are the individual exam scores correlated to concept inventory measures.

Results: Individual Scores

Performance by # Total Edges

$y = 0.0434x + 77.663$
$R^2 = 0.00603$

Exam 1 Score

"Richness" - Number of Total Edges
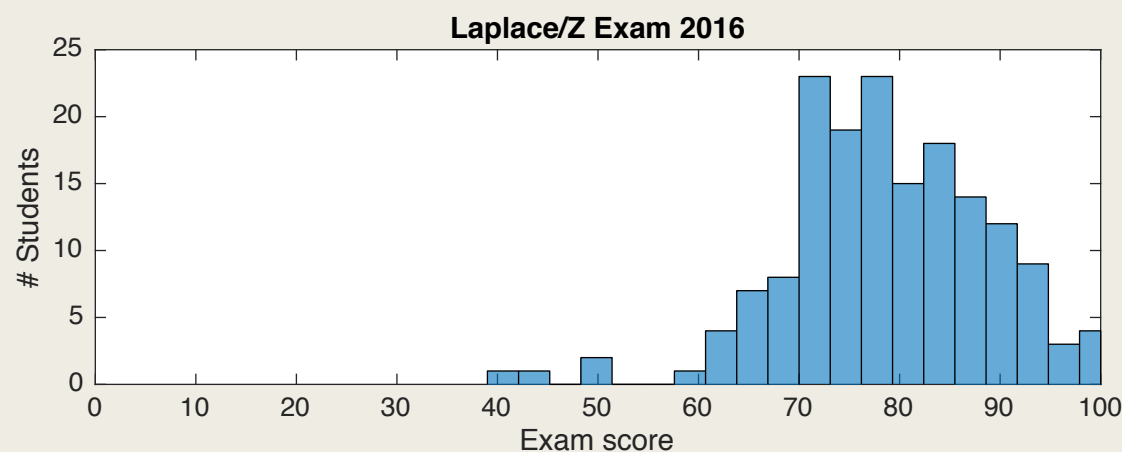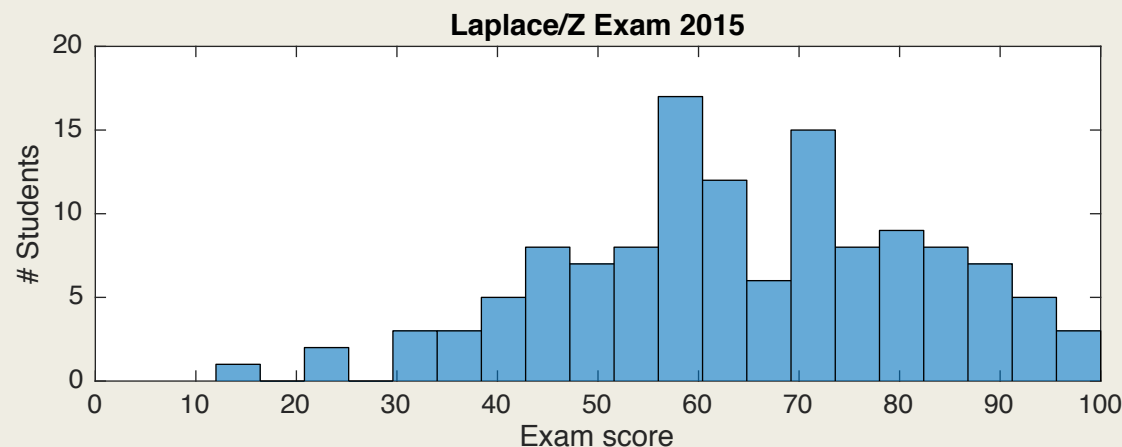
The following are the individual exam scores correlated to concept inventory measures.

Is there a ceiling effect here?

Last year's exam had a larger spread of scores. This year, Laplace and Z Transforms were taught for exam 1, and last year the material was taught for exam 3. Comparing across years, students performed much higher this year overall, and it is unclear if this is because of my intervention, different teaching strategies, different student samples, or other contributions.

Further Questions

■ Is this test more of an assessment of progress (formative) or a teaching tool?

■ Is the act of creating a concept map helping students identify and correct their own unique misconceptions or do they see it as another test?

■ What is student affect toward this?

– *Several student complaints*

– *Several student praises*

■ Is there an inherent ability for making concept maps based on student's preferred teaching style (visual vs verbal vs tactile)? Does this correlate to test-taking measures (SAT, GPA)?

Thanks!!!

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My TaR Team

- Advisor: Nick Gross, PhD

- Co-investigator: Kavon Karrobi

Boston University BE401 Course Staff

- Jason Ritt, PhD

- H Steven Colburn, PhD

- Bahar Rahsepar

- Andrew Brughera

References

- University of Minnesota, Zeilik et al (1997), and McClure et al (1999),

- Novak and Canas ("The Theory Underlying Concept Maps and How to Construct and Use Them", 2008)

- Buck and Wage, Signals and Systems Concept Inventory