Physics Students' Epistemologies in the Age of the Pandemic

Summer CV-Riser
Antoinette Stone

Where are we headed?

- **What** are Student Epistemologies
- **Why** study them
- **How** were they influenced by the pandemic

What are Student Epistemologies?

Epistemology

Epistemology is the branch of philosophy that examines

- the nature of knowledge
- the processes through which we acquire knowledge
- and the value and structure of knowledge.

What are Student Epistemologies?

Epistemology and Education

If we examine the intersection of Epistemology and Education, we uncover implications for educators in all fields:

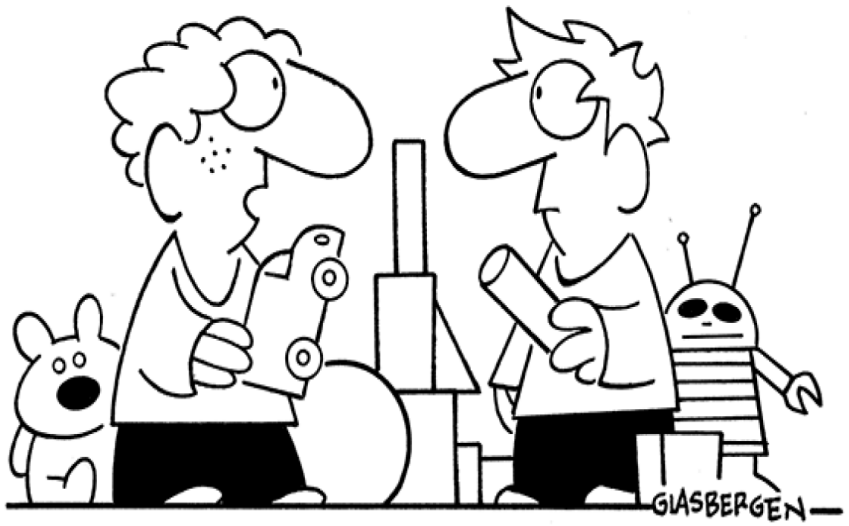
While we strive to teach students the “knowledge” that experts have discovered or constructed, many of us want, indeed expect, students to learn the *specific skills and processes* that experts employ in their journey to construct their knowledge.

We can think of these expectations as our own epistemologies.

Some researchers have referred to this expectation as the “hidden curriculum”; that part of the curriculum that is not in the syllabus. *(Redish 1998)*

What are student epistemologies?

Student Personal Epistemologies or “Cognitive Expectations”



“When I grow up, I want to be an app.”

As it turns out. Students come to our classrooms with their own “epistemic profile”; their own personal epistemologies. *(Lonka, 2020)*

Each student, whatever the discipline, brings to the classroom, based on his or her own set of experiences in the world, a set of attitudes, beliefs, concepts and assumptions – *Cognitive Expectations* – about what sorts of things they will learn, what skills will be required, and what they will be expected to learn. *(Redish, 1999)*

What are student epistemologies?

Student Personal Epistemologies or “Cognitive Expectations”

"If I ever go to Japan, I'm sure the pilot will be able to find it, so why do I have to know where it is?"

Quick summary from the research:

Students bring with them their experiences of the world which lead them to develop many concepts about how the world functions. *(McDermott and Redish 1999)*

These concepts often do not match with what they are supposed to learn, or how they are supposed to learn in a physics class making their overall learning difficult. (Hidden curriculum) *(Redish, 1998; Hestenes, 1972)*

The research suggests that these cognitive expectations can, and often do, influence their study strategies as well as their conceptual development *(Hammer 1994; Hofer, 2012)*

Why study student epistemologies?

Student Personal Epistemologies
or “Cognitive Expectations”

Can these “cognitive expectations” be used to inform our teaching strategies and overall classroom pedagogies?

For example, active engagement strategies that reward making sense and modeling instead of memorizing equations may be useful in changing an incorrectly held belief (cognitive expectation) resulting in a shift in a personal epistemology

“If we are to achieve our goal of increasing students’ appreciation and understanding of science, we need to look at how our students view science and how we could use these initial conceptions to our advantage in our science classroom” – (*Mistades, 2007)*

Problem based learning pedagogy *(Sahin 2009)*
Workshop physics *(Redish, 1998)*
Liberal arts major versus business major epistemological shifts after taking an introductory physics class *(Mistades, 2007)*
Epistemological shifts in (mathematical) knowledge after employing a pedagogy that focused the class on mathematical proofs *(Solomon 2006)*

Why study student epistemologies?

Student Personal Epistemologies or “Cognitive Expectations”

If we believe that student expectations can inform our teaching strategies, then it would be useful to be able to measure those expectations

A survey tool – The **M**aryland **P**hysics **E**xpectation **S**urvey (MPEX) is a tool designed to calibrate shifts that students might experience as a result of completing a class.

The tool is a questionnaire which uses a Likert-style score (agree-disagree) to probe student expectations.

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

The questionnaire is administered pre and post semester instruction for the express purpose of measuring changes or shifts in epistemologies that may result from a specific teaching strategy or pedagogy.

Why study student epistemologies?

Student Personal Epistemologies or “Cognitive Expectations”

Questions are clustered into 6 major domains

1. Independence - Shift from authoritarian learning to independent learning

2. Coherence - Shift from viewing the “physics” as knowledge in pieces to an integrated view

3. Concepts - Shift from memorization practices to using concepts in modeling

4. Reality link - Shift from “plugging in to calculator” to making physics sense

5. Math link - Shift from viewing math as theory to math as a toolbox

6. Effort - Shift from resignation or giving up to “its ok to be wrong”

A full description of the development, validation and calibration of the tool *(Redish, 1998)*

Why study student epistemologies?

Student Personal Epistemologies
or “Cognitive Expectations”

Some survey items are shown below

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

17. Only very few specially qualified people are capable of really understanding physics - *Independence Cluster*

19. The most crucial thing in solving a physics problem is finding the right equation to use - *Concepts Cluster*

29. A significant problem in this course is being able to memorize all the information I need to know -*Coherence Cluster*

If students “agree”, or “strongly agree” with the items above, the response is considered “Unfavorable”

Why study student epistemologies?

Student Personal Epistemologies or “Cognitive Expectations”

Some survey items are shown below

1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

5. Learning physics made me change some of my ideas about how the physical world works - Reality Cluster

26. When I solve most exam or homework problems, I explicitly think about the concepts that underlie the problem. -Concepts Cluster

31. I use the mistakes I make on homework and on exam problems as clues to what I need to do to understand the material better - Effort Cluster

If students “agree”, or “strongly agree” with the items above, the response is considered “Favorable”

Why study student epistemologies?

Student Personal Epistemologies
or “Cognitive Expectations”

The survey was administered at the beginning of the semester and again at the end, in spring of 2021.

Why Spring of 2021?

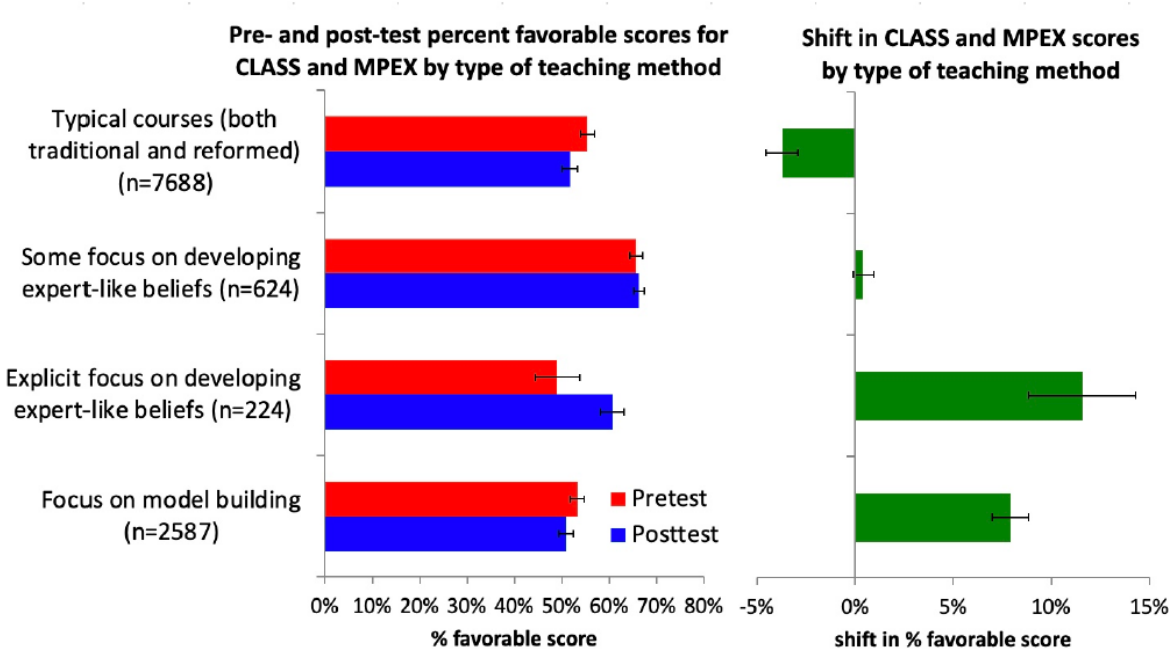
A bit of common history

- Most of us went remote, essentially overnight, in March of 2020
- A sizable group continued remote throughout the 2020-2021 AY
- Most of us became zoom experts
- Most of us developed asynchronous and supplemental tools
- Most of us watched our classrooms turn into computer screens
- Most of our classroom dialogue became silent “chats”

A pretty strong argument for that claim that there was a clear shift in pedagogy nationwide.

How/were student epistemologies influenced by the pandemic?

Research questions:
Did the new pedagogies influence student's epistemologies?
If so, how?
Were the gender differences?
Were there other factors other than a shift in pedagogy?

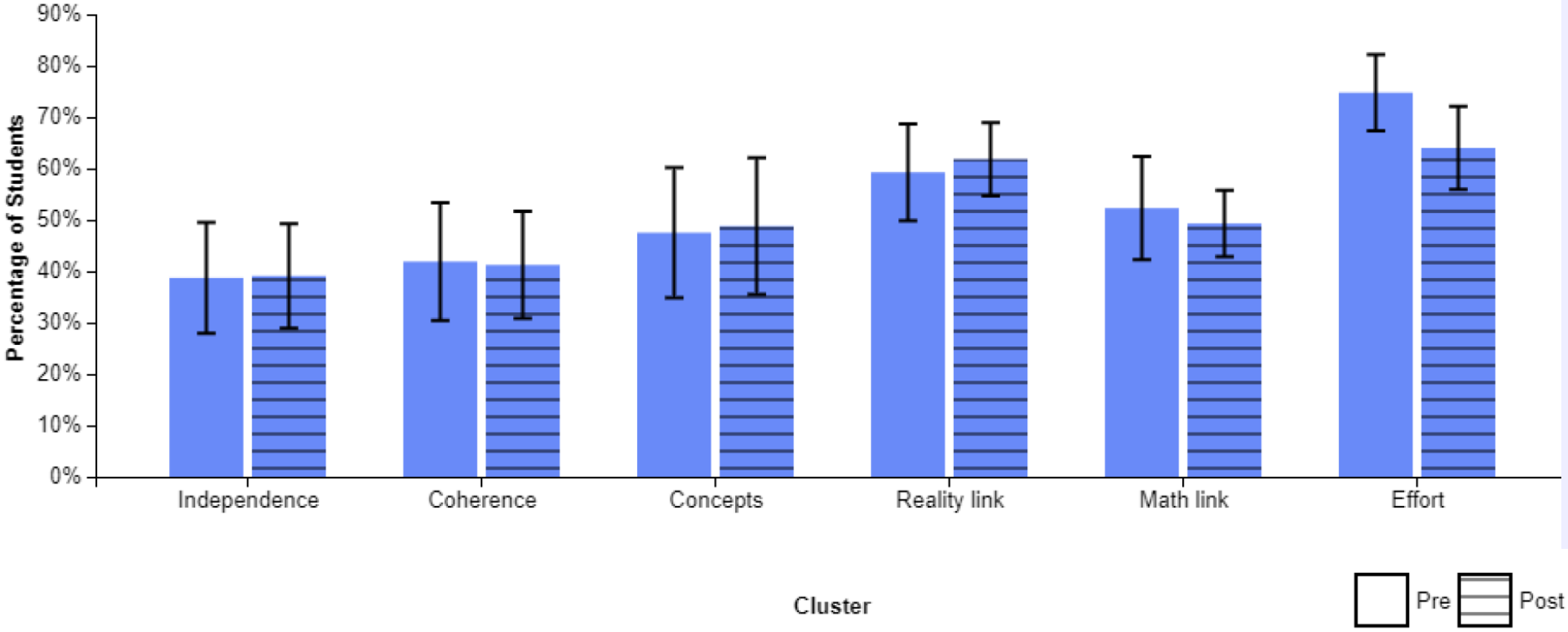


Active engagement strategies utilized in the remote environment

- Clicker questions via zoom polling
- Breakout rooms to promote active peer engagement
- Asynchronous supplemental tools such as pre-recorded video lectures and recorded zoom sessions

Spring 2021

Shifts by cluster



Summary

Average Shift[2]
-1.6%
± 1.7%

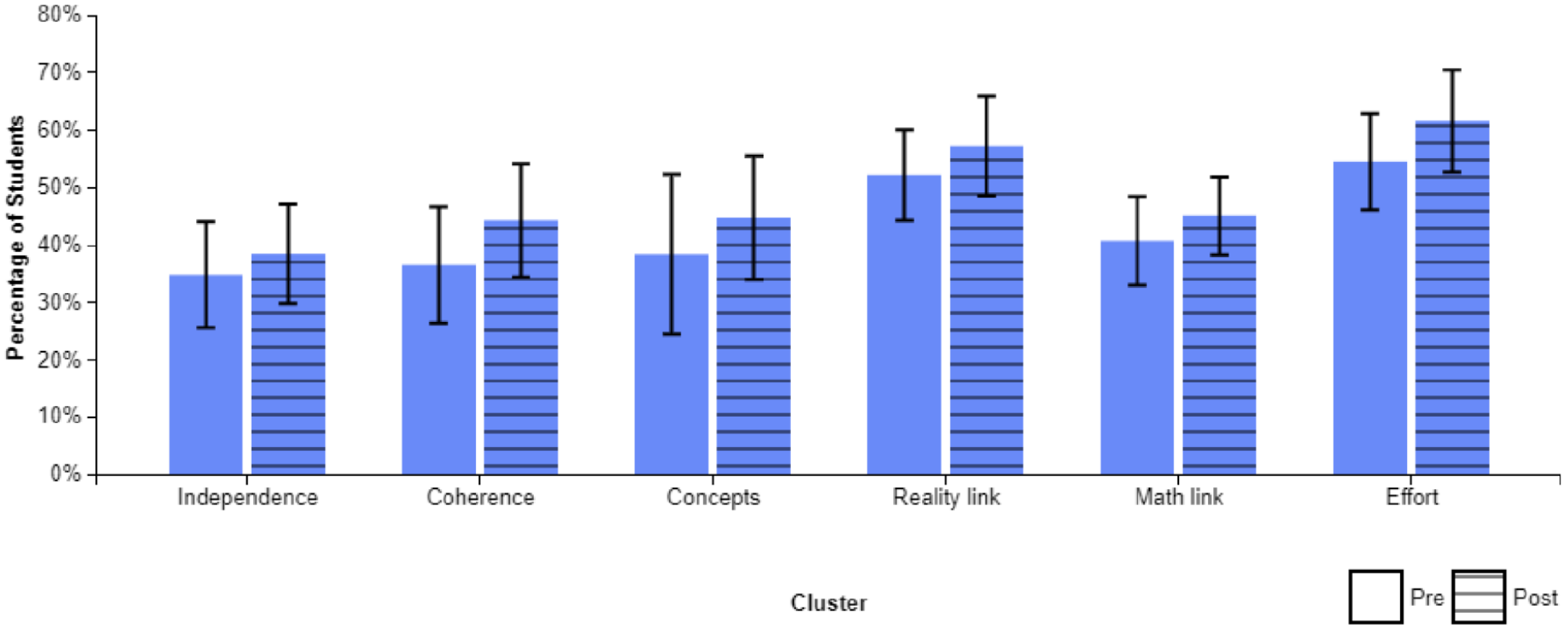
Effect Size[3]
-0.12

Average Percent Favorable[4]
Pre 48%
± 2%
Post 46%
± 2%

N (matched)
61

Fall 2021

Positive shifts by cluster



Summary

Average Shift[2]
5.4%
± 1.6%

Effect Size[3]
0.42

Average Percent Favorable[4]
Pre 37%
± 2%
Post 43%
± 2%

N (matched)
67

Female; Fall 2021
N=36

Summary

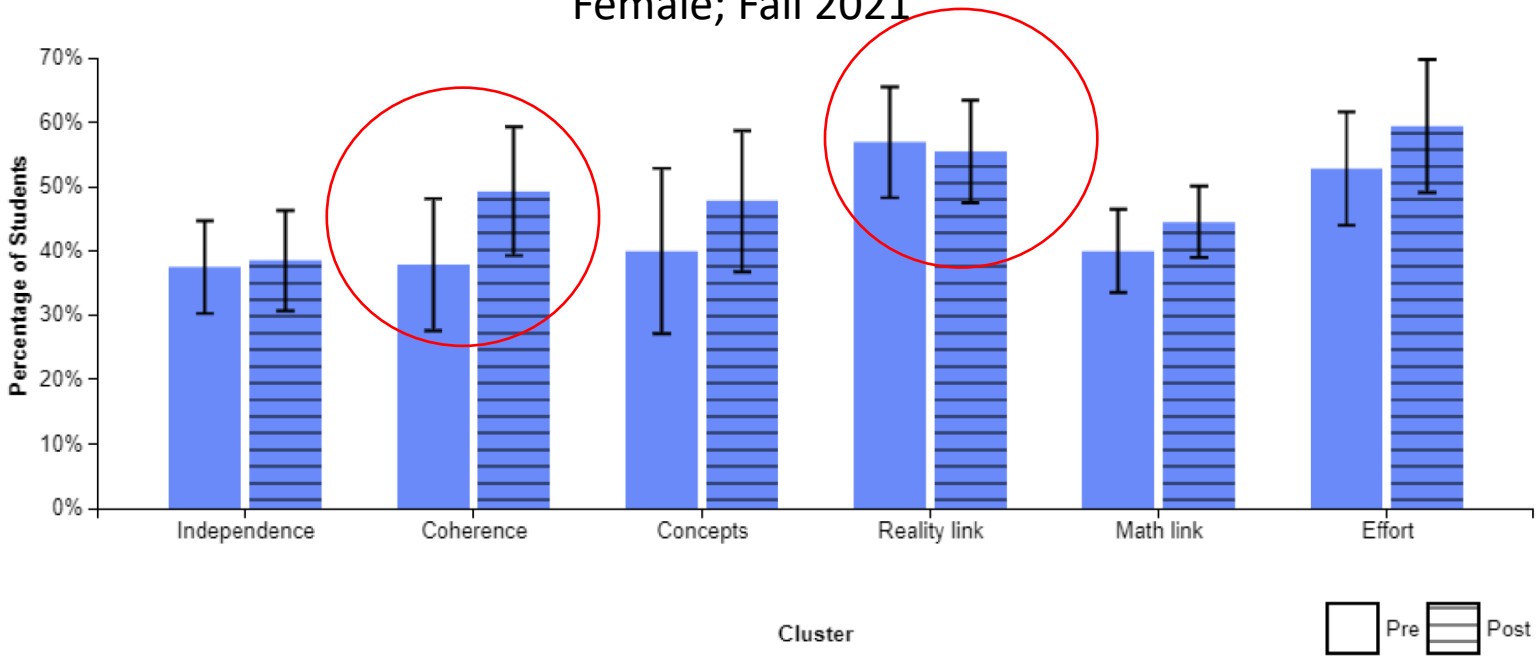
Average Shift[2]
4.0%
± 2.1%

Effect Size[3]
0.32

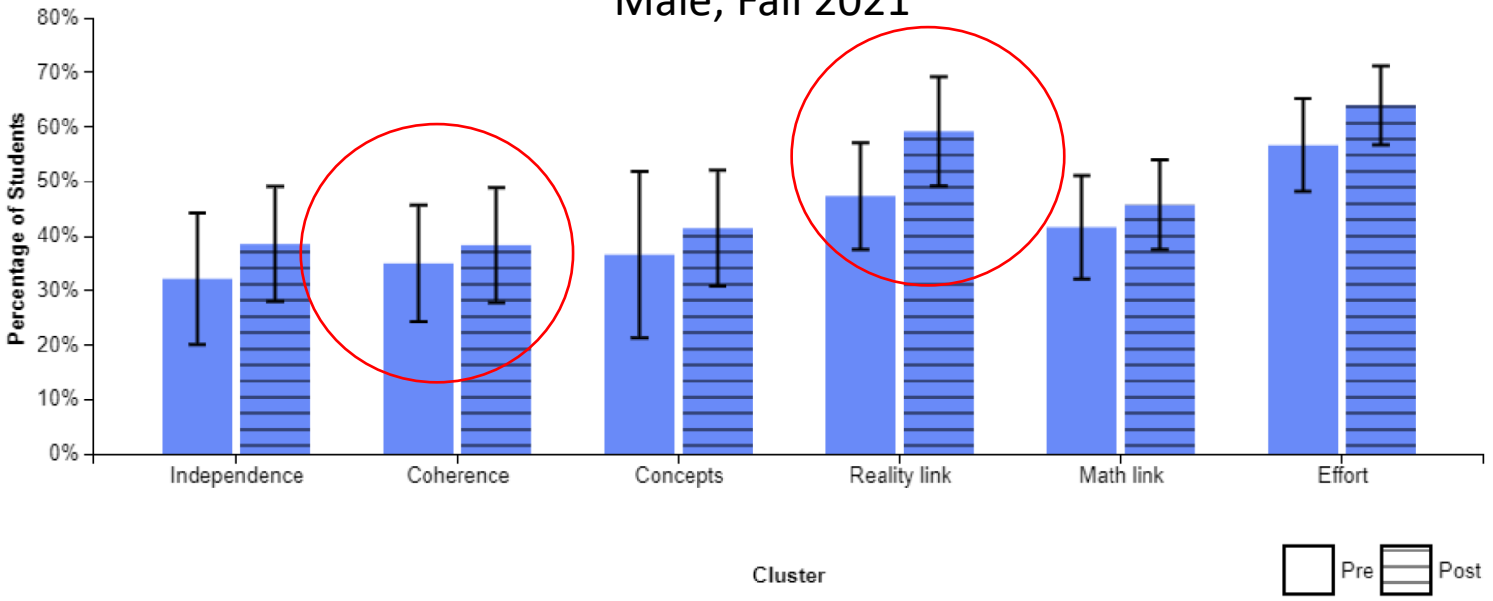
Average Percent Favorable[4]
Pre 38%
± 2%
Post 42%
± 3%

N (matched)
36

Female; Fall 2021



Male; Fall 2021



Male; Fall 2021
N=31

Summary

Average Shift[2]
6.9%
± 2.4%

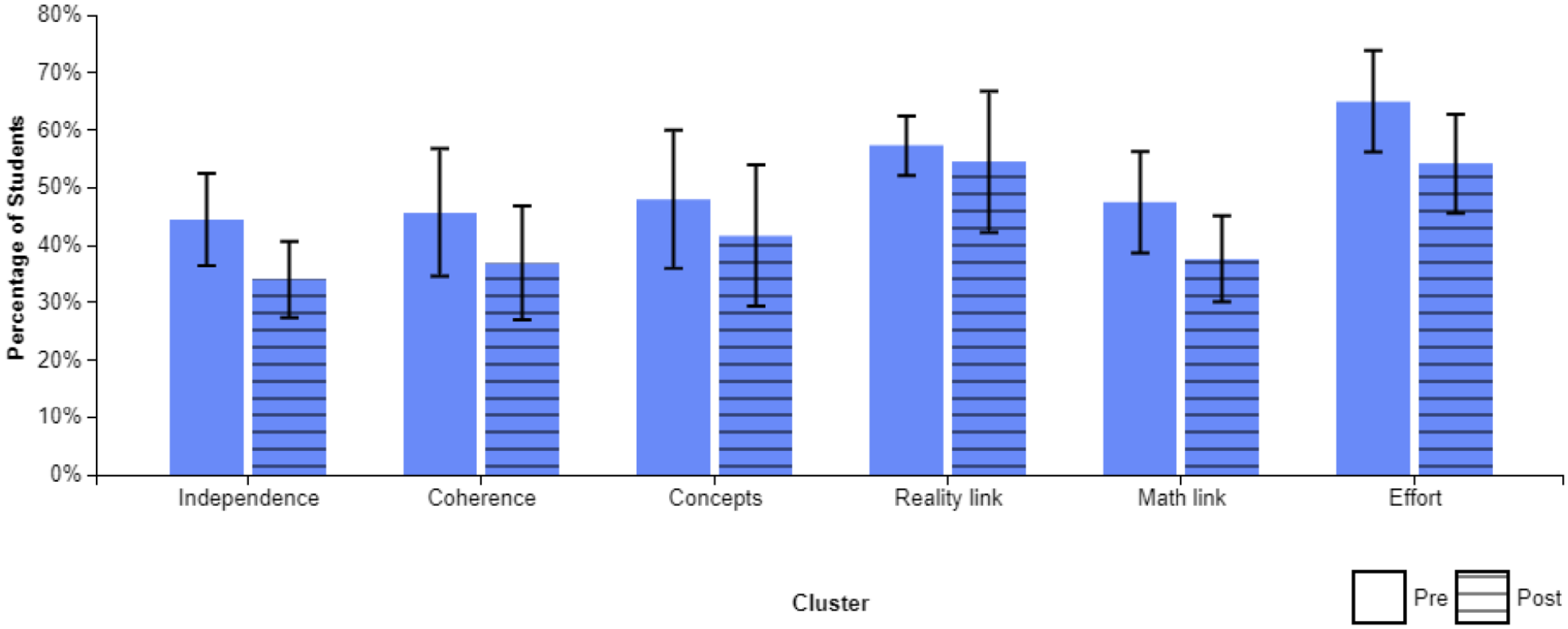
Effect Size[3]
0.53

Average Percent Favorable[4]
Pre 36%
± 2%
Post 43%
± 2%

N (matched)
31

Spring 2022

Negative shifts by cluster



Summary

Average Shift[2]
-12.7%
± 3.7%

Effect Size[3]
-0.39

Average Percent Favorable[4]
Pre 45%
± 3%
Post 32%
± 2%

N (matched)
77

Female; Spring 2022
N=53

Summary

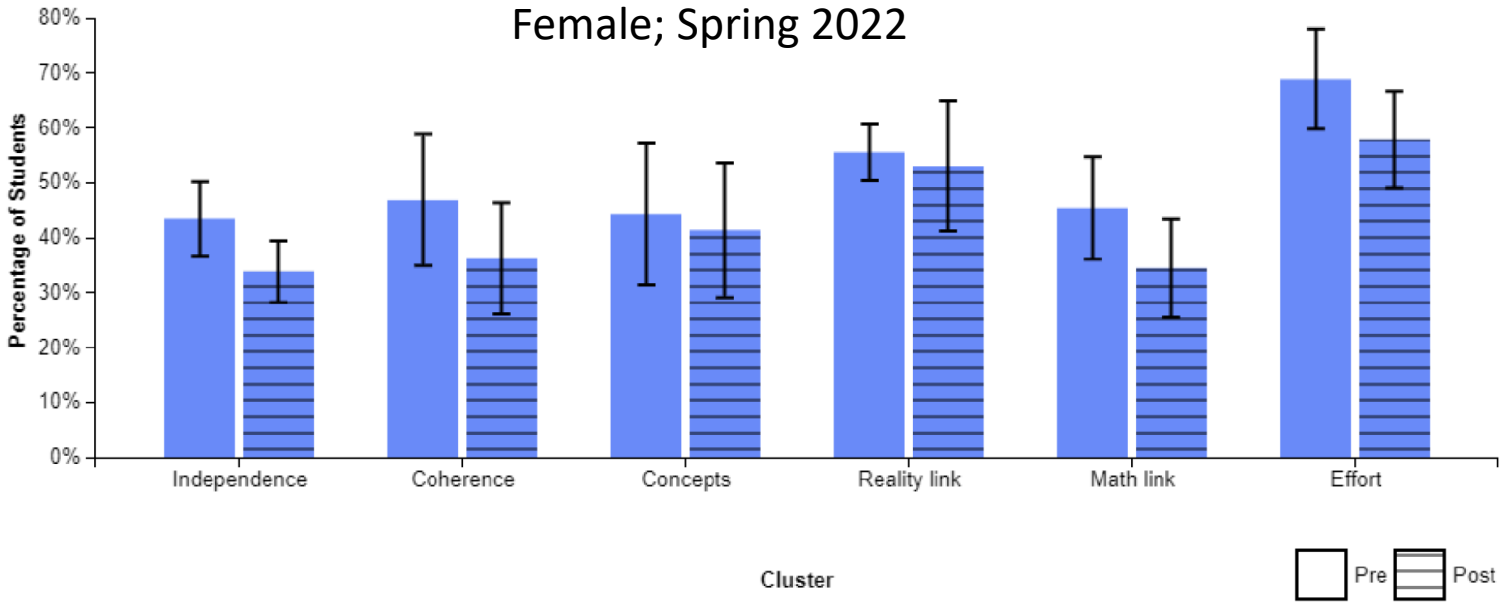
Average Shift[2]
-12.1%
± 4.2%

Effect Size[3]
-0.39

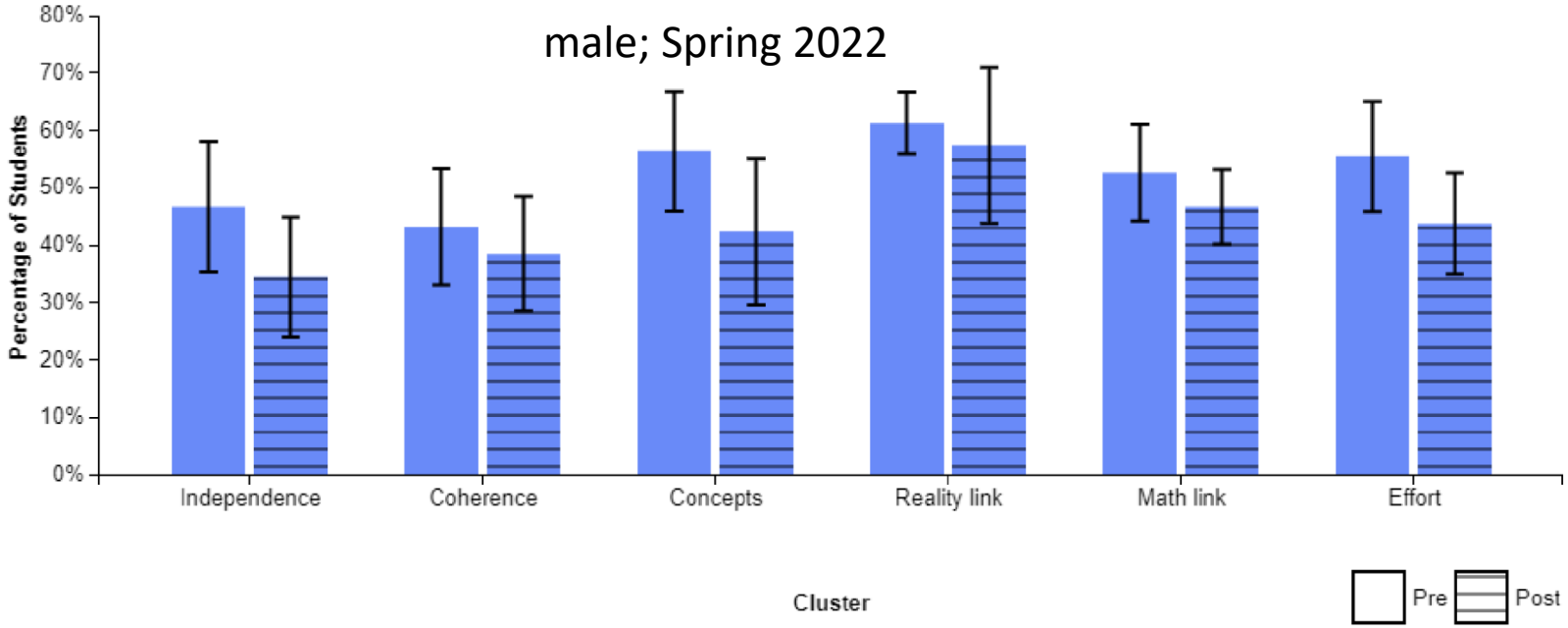
Average Percent Favorable[4]
Pre 44%
± 3%
Post 32%
± 2%

N (matched)
55

Female; Spring 2022



male; Spring 2022



male; Spring 2022
N=22

Summary

Average Shift[2]
-14.2%
± 7.8%

Effect Size[3]
-0.39

Average Percent Favorable[4]
Pre 47%
± 5%
Post 33%
± 4%

N (matched)
22

What happened in spring of 2022?

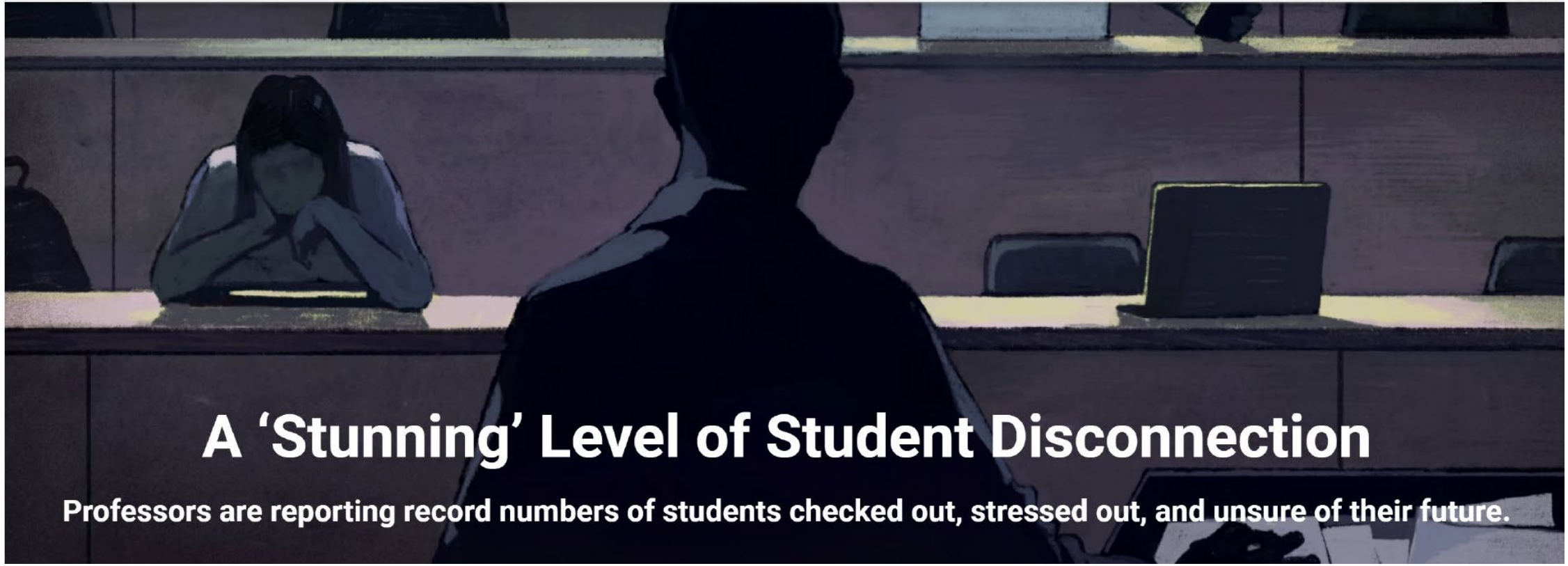
Student Personal Epistemologies or “Cognitive Expectations”

The survey was administered at the beginning of the semester and again at the end, in Spring of 2022.

A bit of common history

- Most of us went remote, essentially overnight, in March of 2020
- A sizable group continued remote throughout the 2020-2021 AY
- Most of us developed asynchronous tools
- Most of us in very short order became zoom experts
- Most of us watched our classrooms turn into computer screens
- Most of our classroom dialogue became “chats”
- ***A sizable group experienced disengagement, malaise, and resignation – largely reported in the spring of 2022***

Chronicle of Higher Education April 5, 2022



Beth McMurtrie Senior Writer

The New York Times | https://www.nytimes.com/2022/05/13/opinion/college-university-remote-pandemic.html

GUEST ESSAY

My College Students Are Not OK

May 13, 2022, 5:00 a.m. ET

By Jonathan Malesic
Mr. Malesic is the author of "The End of Burnout." He teaches first-year writing at Southern Methodist University and lives in Dallas.

https://www.nytimes.com/2022/05/14/opinion/college-university-remote-pandemic.html

My College Students Are Not OK

May 13, 2022, 5:00 a.m. ET

In my classes last fall, a third of the students were missing nearly every time, and usually not the same third. Students buried their faces in their laptop screens and let my questions hang in the air unanswered. My classes were small, with nowhere to hide, yet some students openly slept through them.

By several measures — attendance, late assignments, quality of in-class discussion — they performed worse than any students I had encountered in two decades of teaching. They didn't even seem to be trying. At the private school, I required individual meetings to discuss their research paper drafts; only six of 14 showed up. Usually, they all do.

https://www.nytimes.com/2022/05/14/opinion/college-university-remote-pandemic.html

2021 FALL TERM PULSE POINT SURVEY OF COLLEGE AND UNIVERSITY PRESIDENTS

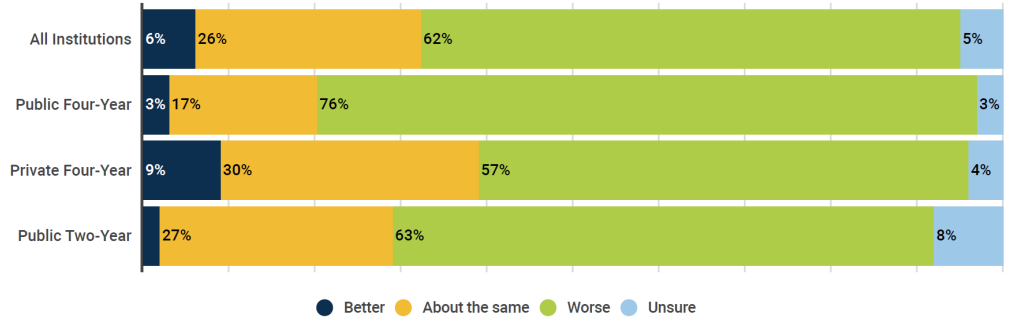
Danielle Melidona, Morgan Taylor, and Ty C. McNamee

Figure 10. Reported Change in Priority Level of Student Mental Health on Campus

2021 FALL TERM PULSE POINT SURVEY OF COLLEGE AND UNIVERSITY PRESIDENTS

Danielle Melidona, Morgan Taylor, and Ty C. McNamee

Figure 11. Reported Rating of Student Mental Health This Year Compared with Previous Years



Next steps?

Clearly some areas that need further probing:

For example:

Why were the results from fall 2021 and spring 2022 so different?
There were “relaxed” grading standards in fall of 2021. Did this have an effect?

What happened in spring?
Spring “instructor” expectations were returning to normal. What about the students’ expectations?

Was a lagging effect at play – results from prolonged social isolation? Financial effects catching up? More health impacts than previously expected?
What about the gender difference?

What about AY 2022-2023?
More surveys will be done in fall 2022 with additional student interviews pre and post.
???

References

Carey, S., Evans, R., Honda, M., Jay, E., & Unger, C. (1989). 'An experiment is when you try it and see if it works': a study of grade 7 students' understanding of the construction of scientific knowledge. *International Journal of Science Education*, *11*(5), 514-529.

Hammer, D. (1994). Epistemological beliefs in introductory physics. *Cognition and instruction*, *12*(2), 151-183.

Hestenes, D., Wells, M., & Swackhamer, G. (1992). Force concept inventory. *The physics teacher*, *30*(3), 141-158.

Hofer, B. K., & Pintrich, P. R. (2012). *Personal epistemology: The psychology of beliefs about knowledge and knowing*. Routledge.

Laws, P. W. (1991). Calculus-based physics without lectures. *Physics today*, *44*(12), 24-31

Lonka, K., Ketonen, E., & Vermunt, J. D. (2021). University students' epistemic profiles, conceptions of learning, and academic performance. *Higher Education*, *81*(4), 775-793.

Malesic, Jonathan. "My College Students Are Not OK." *The New York Times*, The New York Times, 13 May 2022, https://www.nytimes.com/2022/05/13/opinion/college-university-remote-pandemic.html.

McDermott, L. C., & Redish, E. F. (1999). Resource letter: PER-1: Physics education research. *American journal of physics*, *67*(9), 755-767.

References

Mehmet Sahin, “Exploring Univeristy Students’ Expectations and Beliefs about Physics and Physics and Physics Learning in a Problem-Based Learning Context”; *Eurasia Journal of Mathematics, Science and Technology Education, 2009, 5(4), 321-333*

Mistades, V. M. (2007). Exploring business students’ and liberal arts students’ beliefs about physics and physics learning. *Asia Pacific Education Review*, *8*(1), 100-106.

Perry Jr, W. G. (1999). *Forms of Intellectual and Ethical Development in the College Years: A Scheme. Jossey-Bass Higher and Adult Education Series*. Jossey-Bass Publishers, 350 Sansome St., San Francisco, CA 94104.

Perry Jr, W. G. (1999). *Forms of Intellectual and Ethical Development in the College Years: A Scheme. Jossey-Bass Higher and Adult Education Series*. Jossey-Bass Publishers, 350 Sansome St., San Francisco, CA 94104.

Redish, E. F., Saul, J. M., & Steinberg, R. N. (1998). Student expectations in introductory physics. *American journal of physics*, *66*(3), 212-224.

Şahin, M. (2009). Exploring university students’ expectations and beliefs about physics and physics learning in a problem-based learning context. *Eurasia Journal of Mathematics, Science and Technology Education*, *5*(4), 321-333.

Solomon, Y. (2006). Deficit or difference? The role of students' epistemologies of mathematics in their interactions with proof. *Educational Studies in Mathematics*, *61*(3), 373-393.