How groups of students are differentially impacted by active learning

Sara E. Brownell
Associate Professor
School of Life Sciences
Arizona State University
sara.brownell@asu.edu
@brownell_sara
@ASU_BioEdLab
Teacher-centered lecturing

Student-centered active learning
Let’s do some active learning (virtually)...
Think about the following:

What **positive** impacts might active learning have on students?
Let’s do some active learning (virtually)...
Share your ideas in the chat:

What positive impacts might active learning have on students?
Let’s do some active learning (virtually)... Think about the following:

What negative impacts might active learning have on students?
Let’s do some active learning (virtually)...
Share your ideas in the chat:

What **negative** impacts might active learning have on students?
Why do active learning?

Summary data from >200 studies in undergraduate STEM

Concept test = Test of conceptual knowledge (e.g. natural selection, meiosis, genetics, hydrophobic interactions)

Freeman et al. 2014, PNAS
Less failing and more learning

Summary data from >200 studies in undergraduate STEM

Concept test = Test of conceptual knowledge (e.g. natural selection, meiosis, genetics, hydrophobic interactions)

Freeman et al. 2014, PNAS
What don’t we know about active learning?

• How it “works” across a variety of different institutions, courses, content, and instructors

• How different types of activities benefit different groups of students

• Who is benefiting the most from active learning?

• How is active learning changing the group dynamics of a classroom?
Active learning generally increases interactions among students and between students and instructors.
Student identities may be more apparent in active learning classrooms where we ask students to work together.
Student identities

- LGBTQ+
- Ethnicity/race
- Family income
- International student
- Gender
- Religious affiliation
- First generation status
- Socioeconomic status
- English as a second language
- Mental health
Are there inequities in biology classrooms based on student identities?

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Family income
Are there inequities in biology classrooms based on student identities?

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LGBTQ+ identity

LGBTQ+ - An umbrella term which embraces minority gender and sexual orientation identities including but not limited to

- Lesbian
- Gay
- Bisexual
- Transgender
- Queer
- Intersex
- Asexual

The term is meant to be inclusive of individuals who do not identify as straight or cis-gender.

Each individual's identity is different and we use the term to reference the community as a whole but not to imply that individual experiences are the same.
Unique attributes of LGBTQ+ identity

• Potentially invisible identity
• Awareness and saliency of identity can change over time
• Stigmatized identity
Set out to explore LGBTQ+ identities in active learning biology classrooms

Recruited students from one upper-level, high enrollment, active learning biology course

7 LGBTQ+ participants
• Lesbian (1)
• Gay (2)
• Bisexual (1)
• Transgender, female to male (2)
• Asexual (1)
Methods

We conducted 2 semi-structured interviews with each LGBTQ+ student and will present major themes

Pseudonyms were used to protect student identities
Findings

1. LGBTQ+ students do not perceive overt discrimination, but they do not perceive the biology classroom community broadly as a welcoming or accepting space for their identity

Cooper and Brownell. CBE Life Sciences Education. 2016
Sharing one’s LGBTQ+ identity with the biology community is perceived to be inappropriate

- Margaret (bisexual): “I mentioned that I was bisexual to show that this matters to me because I feel like I’m part of this community and he was like ‘We don’t need to know your dirty secrets, and we don't need to know your personal life.’ That was the first time I was like ‘Really? I can’t even mention this?’ I don't think he used the word abnormal, but he said like atypical, like ‘We don’t need to know about people who fall outside of the norms.’”

Cooper and Brownell. CBE Life Sciences Education. 2016
Students worried about their identity not being taken seriously by others, that they could lose social and academic status, or be negatively judged for their identity

- Allan (gay): “The risks [of coming out] that I usually see are [other students] view me as less of a person or they view me as not even their equal, not intelligent, not their intellectual equal, and they don't want to work on projects or anything with me by virtue of being gay.”
Students worried about instructors coming out

- Josephine (gay): “That’s their personal life. You know what I mean? I feel like a gay professor coming out to students could in a lot of situations just be kind of weird. Although when I think about it, I know a ton of my straight professors who are married or they have children.”
Findings

1. LGBTQ+ students do not perceive overt discrimination, but they do not perceive the biology classroom community broadly as a welcoming or accepting space for their identity.

2. Active learning classrooms increase interactions among students as well as between students and instructors, increasing the relevance of LGBTQ+ social identities in the classroom.

Cooper and Brownell. CBE Life Sciences Education. 2016
Increased interaction with other students in an active learning classroom increases the opportunity for students to be identified due to their LGBTQ+ identity.

- Allan (gay): “In a lecture there’s not as much time to talk about personal stuff. You’re mostly sitting there taking notes. That’s all we’re expected to do in a traditional learning class, so it doesn’t matter if I know [other students’] sexual orientations or political orientations or anything like that. But in active learning, almost 90% of the time we discuss the biology problem and move onto something personal like ‘Where did you go to high school? What’s your major?’ And I always think that’s going to build into the questions that I don’t want to talk about.”
Increased interaction with other students in an active learning classroom increases the opportunity for students to be identified due to their LGBTQ+ identity.

- Josephine (gay): “In traditional classes, a lot of people just show up and sit there. But before and after an active learning class, I feel like a lot more people talk with people around them and I feel like that’s because you form closer connections because you talk. And then there can be these moments where you are basically confronted with a statement or a question that either is implying or questioning some sort of sexuality or gender construct that maybe doesn't apply to you or you disagree with. And then you have to make a decision like ‘What am I going to say?’”
Increased interaction with other students in an active learning classroom increases the opportunity for students to be identified due to their LGBTQ+ identity.

• Alex (trans): “In a traditional lecture class, I normally just pick a seat not close to people and mind my business. I don’t think about being transgender, because it’s a ‘get in, get out’ kind of thing. I mean sit and pay attention for as long as you can. I don’t really talk to the other people around me. I don’t just look at them and go, ‘Hey I’m Alex and I’m transgender.’ So I would only probably come out to the people in the active-learning one. In this active-learning class, first day, I just said to my group, ‘Hi I’m Alex, I’m transgender, please call me “he” even though I look like a “she.”’”
Student concern regarding gender identity may increase cognitive load in active learning classrooms

- Mar (transgender): “Even though I present in a way that makes me feel comfortable, my social anxiety unfortunately makes me take into account how other people see me. In discussion based courses I think it’s rougher for my emotional state when I feel like I need to talk to people but I feel uncomfortable doing that because I don't know what their perception of me is. I worry ‘Do they like me? Do they think that I’m stupid? Am I trying too hard to let them know that I’m queer? Is that something that they’re going to think is ridiculous? Are they one of those people that wants to know?’ and ‘Do I want those people to know?’”

Cooper and Brownell. CBE Life Sciences Education. 2016
Are there inequities in biology classrooms based on student identities?

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- Family income
- Socioeconomic status
- International student
- English as a second language
- Gender
- Mental health (Anxiety)
- First generation status
Anxiety has recently increased in prevalence among college students (ACHA, 2017; CCMH, 2017).

Upwards of 45% of college students report that they regularly struggle with anxiety (Cooper, unpublished data).

24% of students report that anxiety negatively affects their academic performance (ACHA, 2017).
Impact of anxiety on college students

Yerkes-Dodson law: performance increases with stress and anxiety, but only up to a moderate level (Yerkes and Dodson 1908; Teigen 1994).

High levels of anxiety have been shown to negatively affect student motivation and performance (Bostoni, 2004; McKeachie, 1984; McKeachie 1951; Tiegen, 1994; Vitasari 2010).

Students with high anxiety levels are less likely to persist in introductory biology than students with low anxiety (England et al., 2017).
How does active learning influence student anxiety?

Active learning courses have been shown to increase student anxiety (England et al., 2017).

However, active learning courses have also been shown to decrease student anxiety (Okebukola, 1986; Harper & Daane, 1998).

Yet no studies have identified why active learning affects student anxiety.
Research question

What specific aspects of large-enrollment active learning science classes influence student anxiety?

Cooper et al., 2018, Intl J STEM Ed
Methods

Recruited students who were enrolled in large-enrollment active-learning biology courses at a large R1 institution.

Conducted hour-long semi-structured interviews with 52 students about how their anxiety levels were affected in large-enrollment active learning college science courses.

Cooper et al., 2018, Intl J STEM Ed
Methods

We used inductive coding to review all interviews and identified aspects of active-learning practices that influenced student anxiety (Bruan and Clark, 2006).

Codes were organized into themes, which I will present.

Pseudonyms were used to protect student identities.
When we interviewed students about active learning and anxiety, they commonly discussed 3 practices.

**Clicker questions**
Interactive response tools that instructors can use to pose a question to the whole class that students answer individually using their clickers

**Group work**
Students interacting with at least one other student during class

**Cold call/Random call**
Instructors calling on a student who has not volunteered to answer a question during class

*Cooper et al., 2018, Intl J STEM Ed*
Findings

1. Active learning provides students with opportunities to compare their knowledge with others, which can either increase or decrease their anxiety.

Cooper et al., 2018, Intl J STEM Ed
Anne: “When I’m having trouble with [content] it’s like ‘It’s probably because I’m stupid and don’t understand.’ But then [talking with other students helps me realize] ‘OK, everyone else is struggling with the same concept.’ Or, ‘Someone else has the same question.’ So I think it probably helps with more dense concepts and subjects that are just complicated. It kinda helps students relate to other students as well.”

Cooper et al., 2018, Intl J STEM Ed
Student realizes other students struggle too

Lindsay: “I feel anxious when everyone else understands [the concept] and I don’t. When [the instructor] puts up that graph [after a clicker question] and says ‘All these people say C, and this majority says D.’ I'm usually the B people. In that moment, I'm like, ‘How are people understanding it?’ I feel so dumb. I don't understand how people get it, and I can't.”

Cooper et al., 2018, Intl J STEM Ed
Findings

1. Active learning provides students with opportunities to compare their knowledge with others, which can either increase or decrease their anxiety.

2. Students’ relationships with others in their group can either increase or decrease their anxiety.

Cooper et al., 2018, Intl J STEM Ed
Carly: “I feel less uncomfortable bouncing ideas off of [my friend in class] because when you say something to someone and it's the first thing you've ever said to them, it's makes a big impression, or it feels that way. Whereas, [my friend] has known me for a year, so I feel like even if I say something stupid, she still knows that I'm smart.”

Cooper et al., 2018, Intl J STEM Ed
Craig: “If I realize that I answered a question wrong when talking with people in my group, it makes my anxiety worse. I’m sitting there thinking ‘Oh man, the person next to me probably thinks I’m dumb because I just shared with him the wrong idea.’”

Cooper et al., 2018, Intl J STEM Ed
Findings

1. Active learning provides students with opportunities to compare their knowledge with others, which can either increase or decrease their anxiety.

2. Students’ relationships with others in their group can either increase or decrease their anxiety.

3. Fear of negative evaluation exclusively increased student anxiety.

Cooper et al., 2018, Intl J STEM Ed
Fear of negative evaluation

The fear of being negatively evaluated while participating in a social situation (Watson & Friend, 1969; Weeks et al., 2005).

Celeste: “That’s what I’m afraid of when getting called on in front of the whole class, getting it completely wrong, or not saying anything. If you don't know, you're that one person who seems stupid. That's what I feel like. Not knowing the answer makes me feel anxious, makes me feel like I’m the outcast, the stupid one.”

Parker: “[My anxiety during group work] goes back to the central theme of being judged. Some things I’ll say will keep me awake at night. It’s like, ‘Oh did I overshare? Did I not talk enough?’”

Cooper et al., 2018, Intl J STEM Ed
Fear of negative evaluation

Inhibits students’ ability to think through a science problem

Quinn: “It’s the pressure of having to answer a question in front of all your peers [that causes me anxiety]. It clouds your thinking, then you can't think at all and it just gets worse. Your heart is racing, you start to sweat, and your brain just shuts off.”

Cooper et al., 2018, Intl J STEM Ed
Fear of negative evaluation

Inhibits students’ ability to articulate their thoughts about science

Serena: “Being random called, that level of anxiety, it just throws me. [When anticipating being called on by the instructor] I knew the answer in my head, but just being in that moment [being called on], I just wasn't able to put those thoughts into a clear, coherent sentence. It just made me feel bad and sick to my stomach. It doesn't really help you because then you're just inhibited.”

Cooper et al., 2018, Intl J STEM Ed
Conclusions

How students think their knowledge compares to other students’ knowledge and students’ relationships with their group mates influence their levels of anxiety in active learning classrooms.

Identified fear of negative evaluation as a novel construct in science active-learning classrooms that exclusively increased student anxiety.

Cooper et al., 2018, Intl J STEM Ed
Do these findings transfer to small-enrollment courses?
Repeated this in-depth interview study with 29 students from 9 community colleges.

Recruited 29 students from 9 community colleges who were enrolled in active learning science courses ranging from 24 – 48 students.

We developed the interview script based on our initial study.

Probed what factors affect student anxiety in small enrollment active learning science classes.

Surprisingly, we found very similar findings.

*Downing et al., CBE LSE 2020*
Take homes

• Student identities such as LGBTQ+ identity and anxiety influence student dynamics in the classroom
• These data indicate that we need to be more attentive to how students are interacting and how we are structuring the student-centered instruction – there may be unintended impacts of active learning
• This doesn’t mean that I am advocating for not teaching with active learning. This means that with active learning approaches, new challenges arise that we need to be cautious about.
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- Gender
- Mental health (Anxiety)
ASU Biology Education
Research Lab: Past and Present

Katey Cooper
Virginia Downing
**Take homes**

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**Questions? Please write in the chat!**
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