Building a Better Learning Experience:

Using Student Data to Enhance Active Learning for Neurodivergent Students

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The Plan for Today

- Introduction
- Research Study
- Share Teaching Strategies
- Questions & Discussion

My goal is that everyone leaves today with a new idea they can use in their teaching

Assumptions I Make in Sharing Data Today

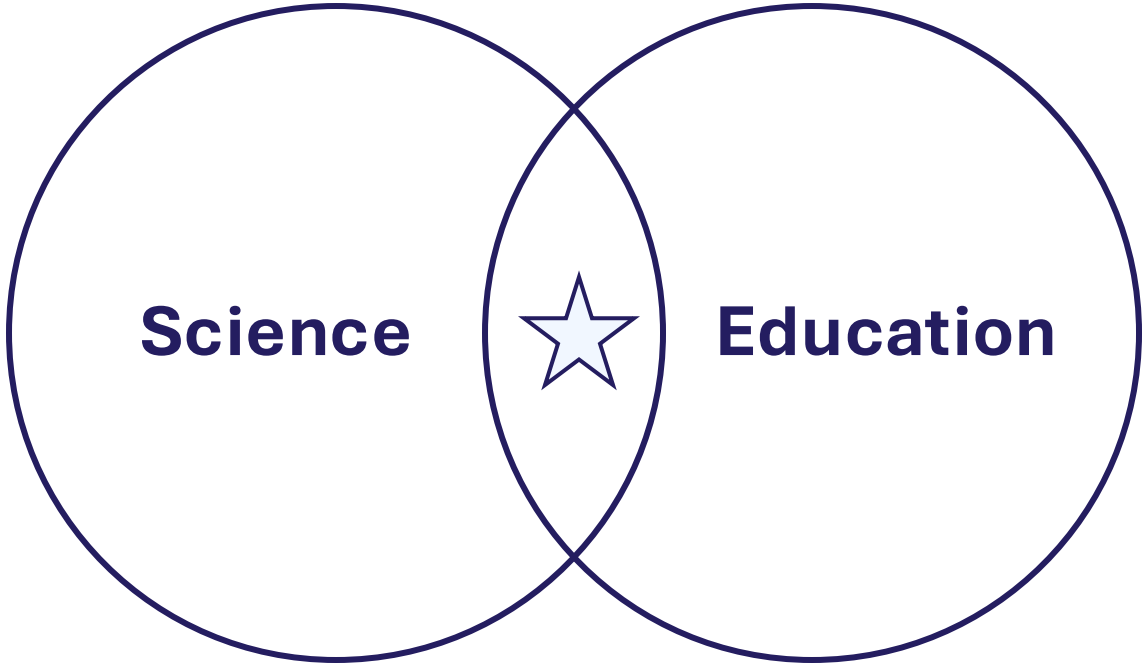
- **Everyone here sees neurodivergent students as capable of success in college courses**

- **We can support student success by**:
  - considering how we instruct students
  - changing what we can to be more supportive

- **Today I will**:
  - share research findings that can inform teaching strategies
  - explain the teaching strategy and offer additional resources

My background

Discipline-based education research (DBER)



What is discipline-based education research (DBER)?

- Addresses research questions about teaching and learning in a discipline
- Using methods, frameworks, and tools from education research and the social sciences
- My disciplinary expertise is in biology, but I tend to do research across STEM
- ***Today, I will tell you about a study related to active learning***

ChatBlast

- **How a ChatBlast Works**
  - Type your answer in the chat, but don't press enter
  - I will do a count down… then enter your answer
  - We can see the responses come through together

- **Why?**
  - ***Gives people time to think & we can see a variety of answers***

Question: How do you define active learning?

Active learning in STEM

- Active learning happens when the instructor stops talking and students engage in exercises that help them develop higher-level thinking skills

- Active-learning instruction helps students move beyond simple memorization and recall

- **Yet we are still developing our understanding of what practices work best, and for what groups of students**
  - *For example: neurodivergent students*

E.g., Andrews et al., 2019; Eddy & Hogan, 2014; Eddy et al., 2015 Freeman et al., 2014

What does the term neurodivergent mean?

- **Term first coined by Kassiane Asasumasu**
  - Multiply neurodivergent activist

- **Refers to having a brain that diverges significantly from societal standards of "normal"**

- **Umbrella term**
  - Many folks associate the term with being autistic
  - But folks (diagnosed & not) with various conditions use the term

Walker, 2014

A Need for Empirical Studies

- **Not yet fully known how neurodivergent students experience active-learning practices**

- **For some students, it could be beneficial**
  - Example: Less lecture & opportunities for engagement

- *Some practices (like group work) may increase interactions*

James et al., 2020
Gin et al., 2020
Pfeifer et al., 2020; 2021

Motivation for the Study

- We wanted to conduct a study that offered insight into student perceptions of active learning

Perceptions are important <u>because</u>

- Each participant is the expert about their own experiences
- STEM courses designed with limited input from neurodivergent students

Research Question

How does active learning affect neurodivergent students' perceptions of learning?

Pfeifer et al., 2023. *CBE-Life Sciences Education*

Study Design

- **Data were collected as part of a larger study on self-advocacy**
  - How STEM majors access and use accommodations in courses?
- **Formed a partnership with an institutional Disability Resource Center (DRC)**
- **I interviewed 25 STEM majors with ADHD and/or SLD**

RESEARCH Open Access

Speaking up: a model of self-advocacy for STEM undergraduates with ADHD and/or specific learning disabilities

Pfeifer et al., 2020

Inside and Out: Factors That Support and Hinder the Self-Advocacy of Undergraduates with ADHD and/or Specific Learning Disabilities in STEM

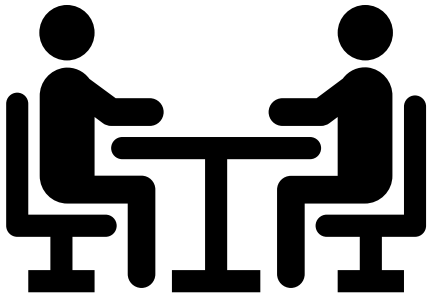
Pfeifer et al., 2021

The Interview

- Students discussed experiences in active-learning courses

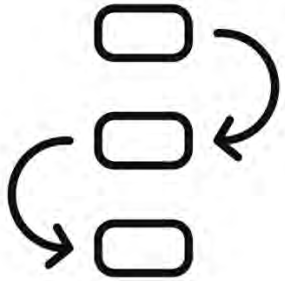
Example Interview Questions

- **Do you learn better in a STEM course that uses lecture or active learning? Why do you think this is?**



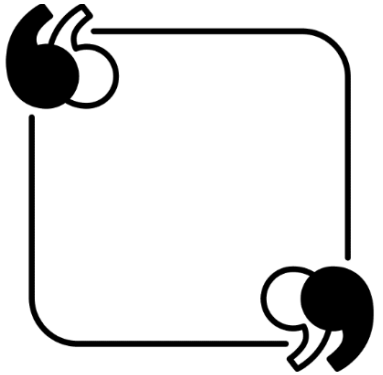
Interview Analysis

- **Used qualitative methods to analyze data**
  - Reading the interview transcript
  - Identifying salient data
  - Through discussions, we come to consensus



- **We did this analysis as a neurodiverse team**

- **Output of analysis:**
  - Participant quotes
  - Summary of major ideas (themes)



Generalizability Considerations

- **Most said active learning best supported their learning**
- The results **do not** make claims about the efficacy of a single practice
- Reporting student perceptions of active learning

Results

- **Participants reported varied perceptions of active learning**

> With my ADHD, it's great to get some energy out. Distractions are there for everyone and you can work through them easier than in a lecture where if you get distracted you miss stuff.
> —*Brett*

Pfeifer et al., 2023

Varied Perceptions of Active Learning

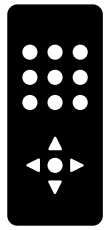
I don't like active learning. I kind of hate it when they put me in there…It really bothers me…It was a stressful class.

- *Jessie*

Why are participants reporting such varied perceptions?

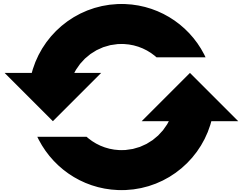
Pfeifer et al., 2023

Influential Aspects of Active Learning

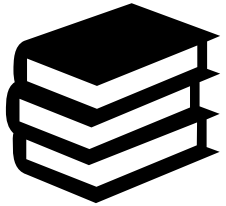


Clickers

Group work



Flipped courses



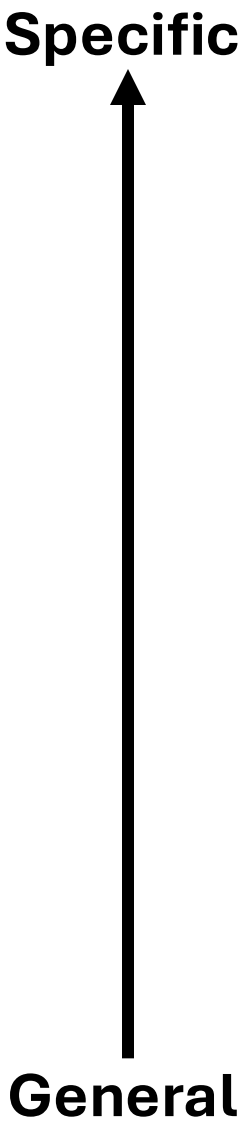
Course materials

Instructor reveals thinking:
sharing feedback

Course structure:
policies & frequent assignments

Environment:
physical space & classroom climate

Influential aspects of active learning named by participants



Each box represents an aspect

Influential aspects of active learning named by participants

Supporting perceptions of learning

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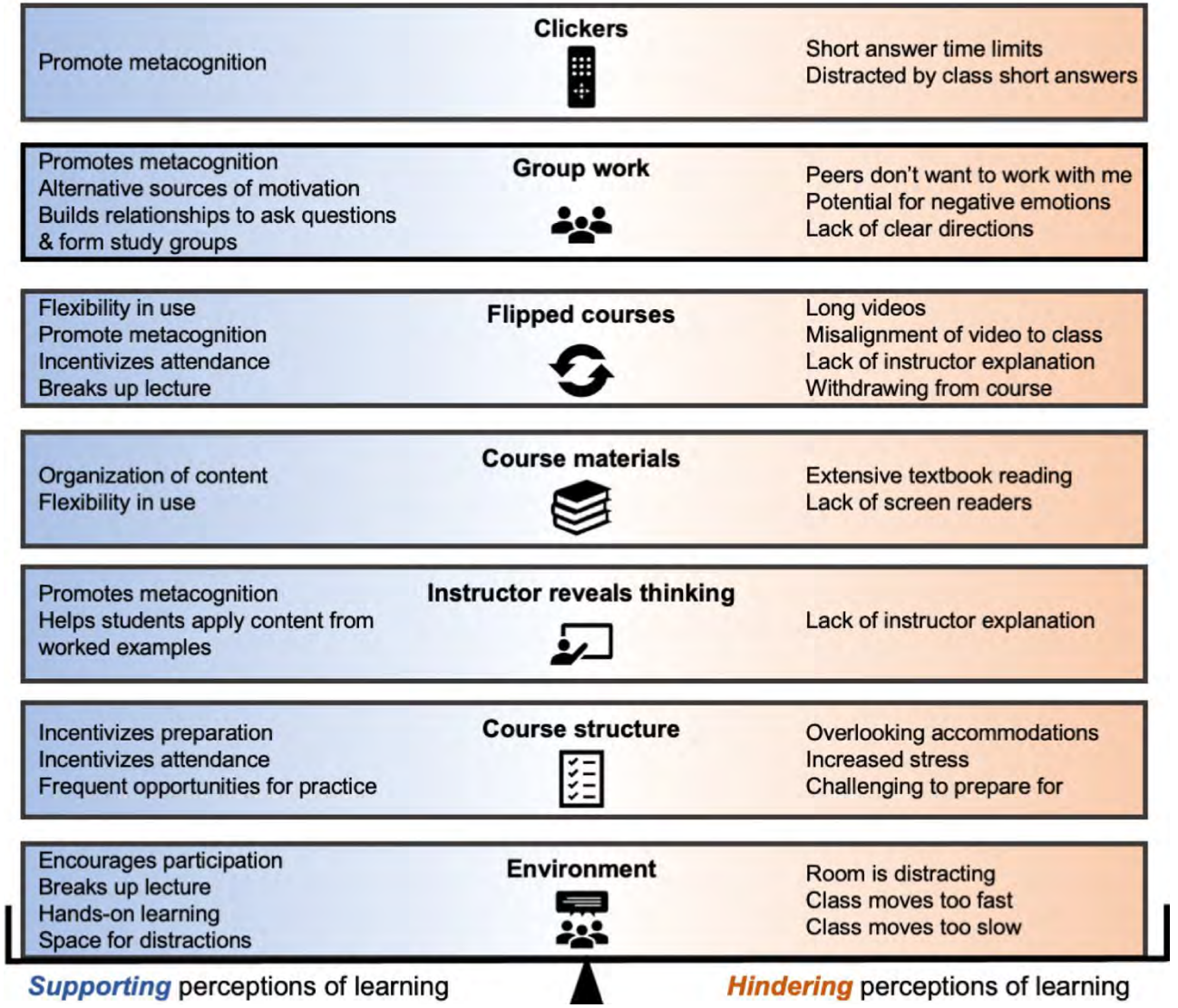

Hindering perceptions of learning

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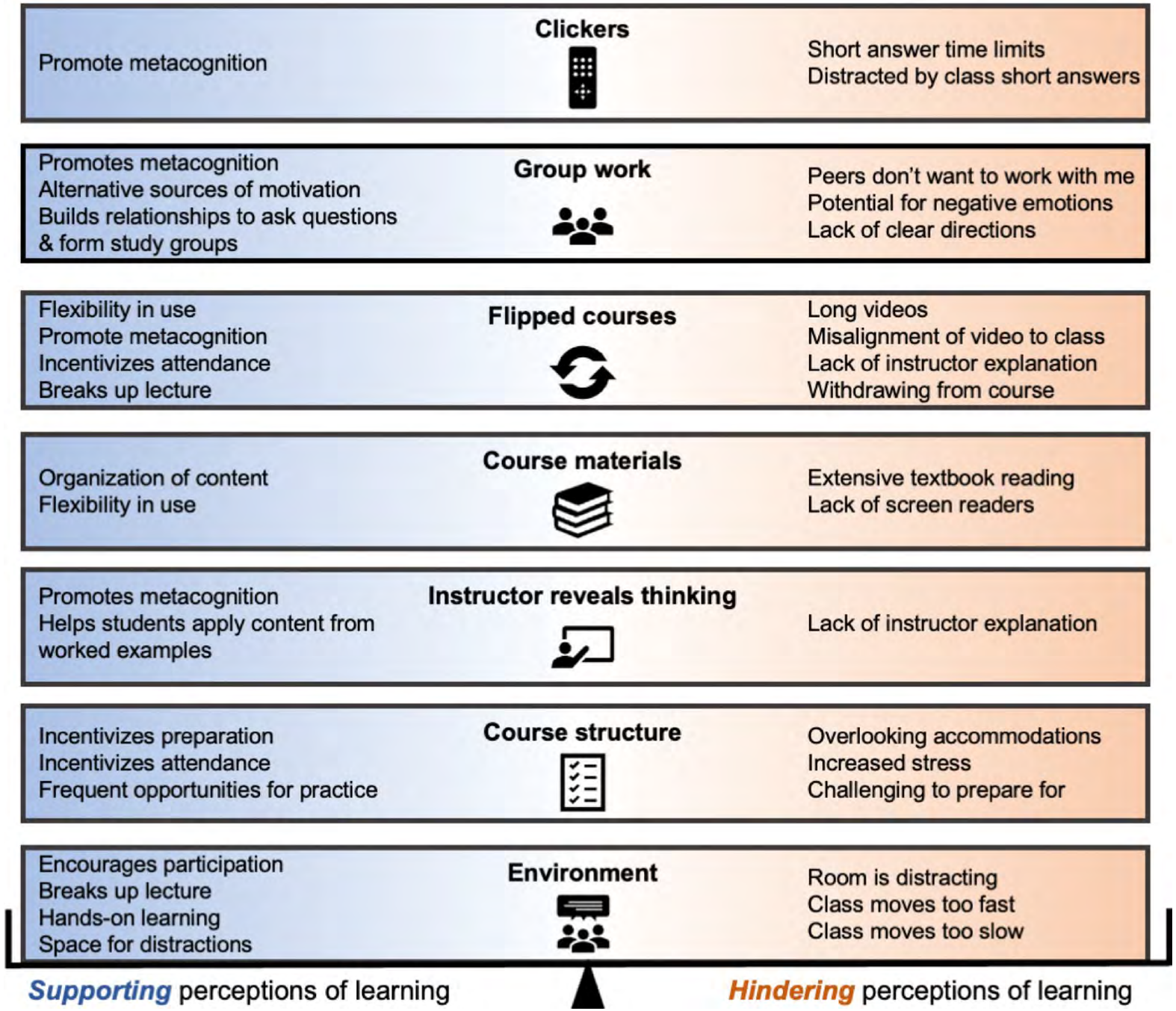
Pfeifer et al., 2023

Pause & Reflect

- **Are you surprised by any of these findings?**
- **What patterns do you see?**



Pfeifer et al., 2023

Influential aspects of active learning named by participants

Supporting perceptions of learning

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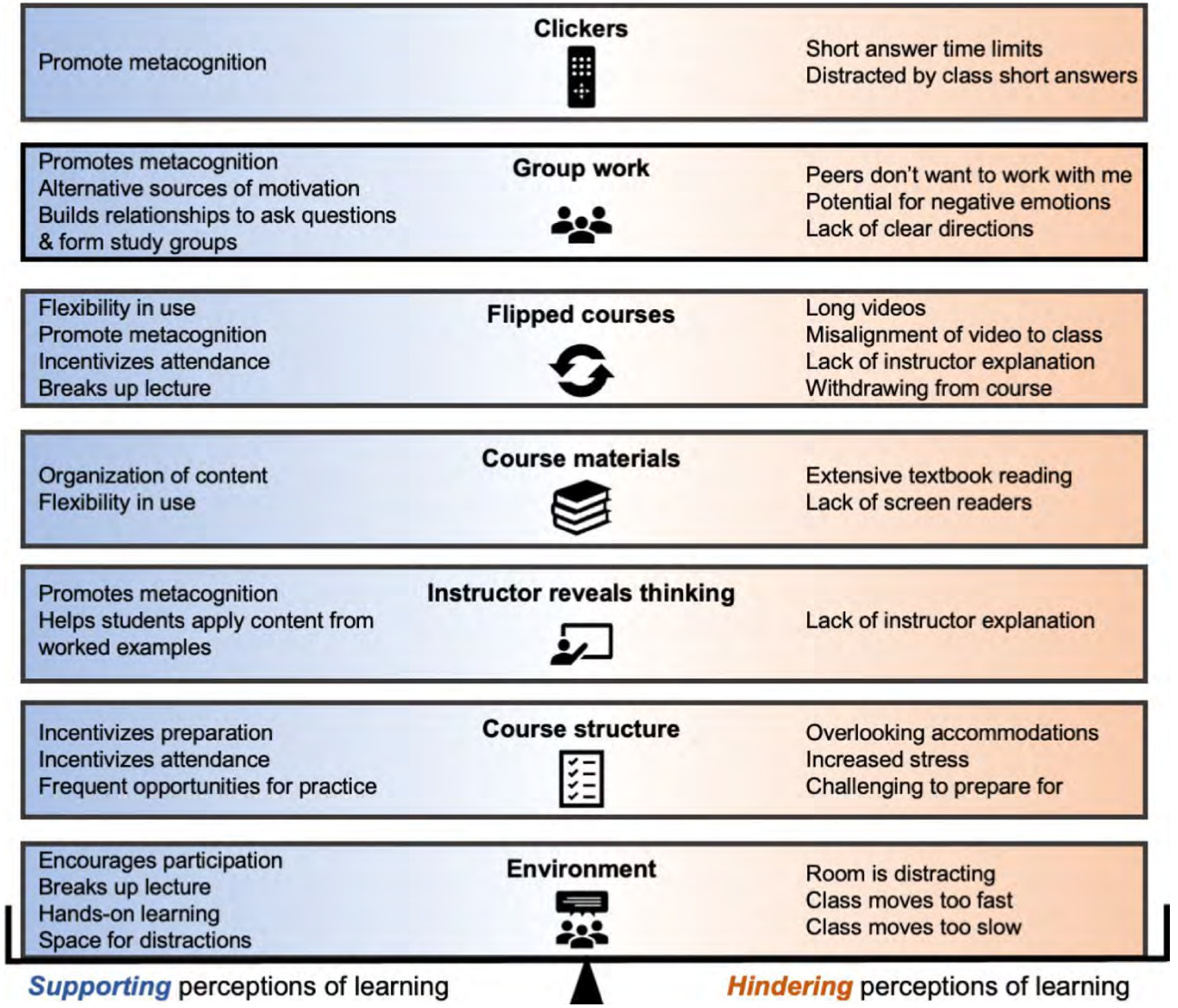
- **Many supports already known**



Hindering perceptions of learning

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Pfeifer et al., 2023

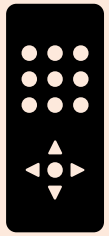
When active learning was hindering…

- **Not so much about WHAT practice the instructor used…**
- **More about HOW the practice was implemented**

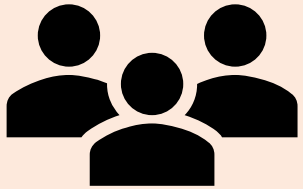
Examples of active learning hindering

- I'll start with some specific active-learning exercises

Clicker questions

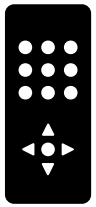


Group work



How is the practice implemented by the instructor?

Clicker questions hindering



- **Showing a flood of free responses to clicker questions**

ENERGY!!!! CO USES GDP & POST USES ATP

SRP *not needed* in post-trans, BiP *not needed* in co-trans

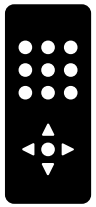
the signal sequence for cotrasnlational is more *hydrophobic* whereas *signal sequence for post is not as hydrophobic*

Ribosome Pushing PolyPeppTide vs BIP

CO and POST = *translocon*

Co-translational translocation imports proteins as they are synthesized. post-translational translocation imports already synthesized proteins.

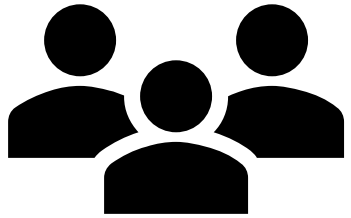
Clicker questions hindering



- **Showing a flood of free responses to clicker questions**

> With free-response clicker questions the technology is weird… Some people do the answers in all capital letters, some people do them in all lowercase letters. Some people do them in both kind of letters. Some people put in commas, some people don't. That's so stressful for me. It's not organized in any way. —*Kacey*

Group work hindering

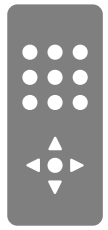


- When participants work with peers to complete in-class activities
- **Being assigned reader or writer role during group work**

> I wish they would understand why I never like reading in groups like out loud reading or why I don't like writing by hand in front of them...If they knew why I didn't want to read out loud or why I didn't want to write then they probably wouldn't make me... If they knew why I was struggling, it'd be better than them just thinking I was not capable. –*Jack*

Pfeifer et al., 2023

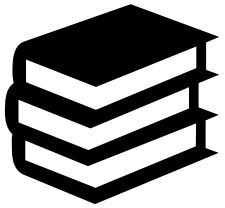
Influential aspects of active learning named by participants



Clickers

Instructor reveals thinking: sharing feedback

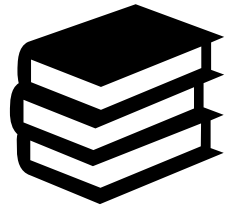
Group work



Course materials

Environment: physical space & classroom climate

Course Materials



- Refers to the media & other resources provided by instructors

<u>Discussing course materials (some overlap with course structure):</u>

It's hard for me to read something without being exposed to it before. So if I just read about a topic, then I really don't grasp it at all. I prefer to read after the class. So, in classes that they don't want you to do that, it's really hard for me.—*Vivian*

Instructor Reveals Thinking

- Refers to instructors demonstrating & explaining course content

<u>Missing instructor explanations for clicker questions</u>

I don’t understand how you could call this a class, when they’re just throwing this stuff at you, but they’re not helping you understand it, and they’re not going back and saying, “This is wrong because of this, and this is how you do it the right way, because X, Y and Z.” I got none of that from [my instructor], and so I learned all my stuff from [a third-party tutoring service]. —*Kacey*

Environment

- Physical space and classroom climate of a course
- **SCALE-UP (TEAL) rooms can be distracting**

Photo from Talbert Blog

Environment

- How instructors utilize the space perceived as hindering

It’s irritating because he’ll be on one end of the room starting a problem, run over to the other end of the room, finish the problem … Half of the class has to move to see what he’s writing … He’s just running back and forth. For me, with ADHD and stuff, it’s better to just have it all in one spot. So I’m not missing half of what you’re saying.—*Stella*

Many teaching suggestions emerged...

Big List of Suggestions

Link to paper

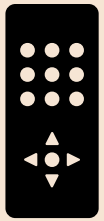
TABLE 4. Suggestions for STEM instructors[a]

Aspect of active learning	Suggestion
General	**Consider student differences in your teaching.** Across our studies, participants shared that they wanted their STEM instructors to be more aware of how ADHD and SLD can affect their experiences in STEM courses (Pfeifer *et al.*, 2020, 2021). See *Discussion* for more information.
	Know that how instruction is implemented directly affects participant success in a course. Several participants describe that active learning can be a significant support for their learning, if implemented appropriately. We encourage instructors to consult existing resources when incorporating active-learning strategies into their courses, for example, the *CBE-LSE Evidence-Based Teaching Guides*.
	Add a road map for accommodations in the syllabus. See *Discussion* for more description.
	Conduct access check-ins regularly with your class to determine what students need in order to do their best work (Sins Invalid, 2019; Reinholz and Ridgway, 2021). Reinholz and Ridgway (2021) provide directions and several examples of how these types of check-ins can be incorporated into undergraduate STEM courses.
	Review the checkpoints from the universal design for learning framework and incorporate them into the design of the course. As a starting point, we encourage instructors to review the guidelines and checkpoints within the principle called "providing multiple means of representation" (CAST, 2018).
	Find ways to include "hands-on" learning opportunities for students when possible. For example, students can benefit from manipulating 3D printed models of complex structures. Participants in our study appeared to especially value these types of in-class engagement activities over more abstract, paper-based activities.
Group work	Provide clear expectations for group work and clear learning objectives for group assignments.
	Offer options for students to opt out of a specific group role. For example, students who do not feel comfortable reading or writing in front of their peers could select a different role in their group if given the choice.
	Communicate the expectation that all group members should be included and establish a mechanism to ensure that all students are included in group work. This could look like frequent instructor check-ins to make sure students are included in their groups. Wilson *et al.* (2018) suggest that using reward structures (e.g., shared grades or certificates of recognition for reaching a specific goal) can incentivize students to work together.
Clickers	Avoid displaying short-answer responses from the entire class. Avoid assigning short-answer clicker questions that are graded for accuracy, especially with strict time limits, or as suggested by Gin *et al.* (2020), offer students the option to submit their responses before or after class.
	Select clicker software programs that aggregate student responses. The volume of free-response text answers can be distracting to students, because it can be challenging to focus on the content of the answers as opposed to the way the answers are formatted.
	Explain your expert thinking to the entire class. Student learning is enhanced when students are provided the opportunity to discuss clicker responses with peers combined with instructor explanation of answers (Smith *et al.*, 2011).
Flipped courses	**Videos are preferred over extensive reading from the textbook.** Use established evidence-based practices to create short, engaging videos that are closed captioned (Brame, 2016).
	Provide interactive note-taking guides. Participants described that "fill-in-the-blank" notes from the instructor supported their learning. This helped them take notes during the lecture portions of some STEM courses and could also support textbook reading and video watching for flipped courses.
	Organize video links and provide students with suggestions for how to use the videos to prepare for class. Be explicit about the length of the videos and invite students to take notes while watching.
Course materials	Select textbooks with built-in voice-to-text features that students can readily access.
	Provide detailed reading assignment schedules to students, ideally by the first day of the course. This helps students, because they can share these schedules with the DRC to create accessible forms of readings in a timely manner. If you use primary literature or other reading sources not found in a textbook, then have PDF versions of these readings readily available. If you are contacted by the accessible media team at your DRC, you can provide the PDFs in a timely manner, which supports student access.
Course structure	Apply extended-time accommodations to reading quizzes, pop quizzes, and graded clicker questions.
	Offer students options to take pop quizzes before class starts or after class so they can use extended-time accommodations without missing class instruction.
Environment	Invite students who feel highly distracted in a SCALE-UP–type classroom to meet with you to find the least distractable seat in the room. You could share this invitation verbally at the start of the class or by posting it in your course syllabus or on the course website.

How can we implement active learning in ways that are perceived as supportive?

- Some starting points from our data…

Limit short answer displays of clicker questions



Offer outs from assigned reading or writing roles during group work

Provide intentional materials to support access

There is more to the story…

Teaching Tips & Resources

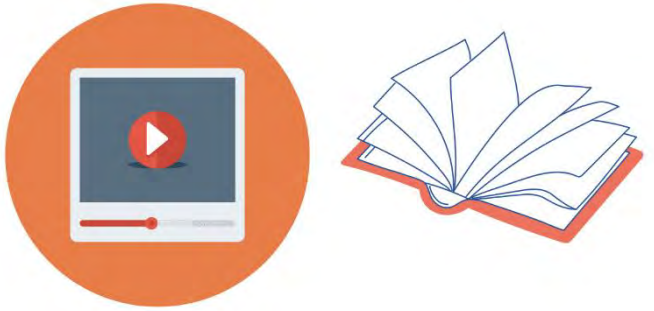
- Design courses with Universal Design for Learning (UDL)
- Proactively plan for student accommodations
- Ask students about their access needs
- Consult resources for implementation of active learning

Designing Courses with UDL

- **What is universal design for learning (UDL)?**
  - Multiple means of engagement, representation, and action & expression

- **How to get started with UDL?**
  1. Prioritize materials
     - Accessible textbooks & captioned videos
  2. Make organization & directions clear to support executive functions
  3. Start to build in options for students

- **Where to learn more about UDL?**
  - CAST website
  - Jackie Chini Dimensions of Ability Tool
  - Jay Dolmage Getting Started with UDL



Proactively Plan for Accommodations

- **Ideally**: design course so students don't need accommodations

- **Have plans in place for frequently-used accommodations**:
  - Extended time: in-class quizzes, graded clicker questions, etc.,
  - Note-taking: students like fill-in-the-blank notes
  - Flexible attendance: how to access learning opportunities

- **Share accommodation plans with students**
  - Participants in our study asked for this directly

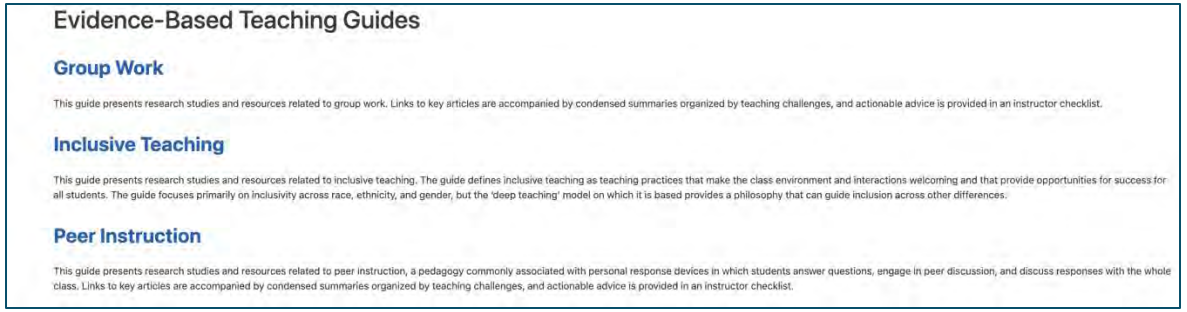
- *See Gin et al., 2020 for more information*

Ask students about their access needs

- **What is access?**
  - When a space (classroom) provides everything that all people need to fully participate in the space of activity
- **Everyone person has access needs & these needs can fluctuate**
  - Examples: I need internet, a computer, ergonomic mouse & keyboard to present
- **We can ask students about their access needs**
  - *What do you need in order to do your best work in this class?*
  - Sending out surveys, checking in with students as we teach, etc.,
- **See Reinholz & Ridgway, 2021 for more information**

Resources for active-learning facilitation

- **Many instructors want to use effective active learning**
  - *Hard to learn how to do something when many of us did not experience as students*
- **Resources exist!**
  - Realise Videos
  - Teaching Guides from DBER journals
  - Teaching & Learning Lab
  - *Many DBER articles share teaching implications*
- *Lots of forthcoming research about neurodivergent STEM students*



Putting it all together

- *In the chat….*

- **What suggestions or resources would you like to explore further to support neurodivergent students in your teaching?**

Thank you! Questions?

Thank you to participants, DRC partners, co-authors & funders

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Teaching Resources

Compiled by Dr. Stephen Podowitz-Thomas & me