

Supplemental Material

CBE—Life Sciences Education

Gin *et al.*

Supplemental Information for

Accessible active learning: To what extent is active learning inclusive for science undergraduates with disabilities?

Logan E. Gin¹, Frank A. Guerrero¹, Katelyn M. Cooper^{2*}, Sara E. Brownell^{1*^}

¹ The Biology Education Research Lab, Research in Inclusive STEM Education Center, School of Life Sciences, Arizona State University

² Department of Biology, University of Central Florida

* These authors contributed equally

^ Corresponding author, Email: Sara.Brownell@asu.edu

This supplement contains the following:

	Item	Page
	Copy of interview questions analyzed	2
	Table S1. Institution characteristics of Disability Resource Centers interviewed	4
	Example survey question for disability status	6
	Copy of final coding rubrics and number of directors who reported each theme	7

Copy of Interview Questions Analyzed

Awareness:

1. Are you familiar with the term active learning? For the purposes of the interview, could you please describe your definition of active learning? (*If they are unfamiliar, define active learning to them as students engaging in the learning process through clicker questions, small group work/discussion, and cold/random call*)
2. To what extent are the large-enrollment science courses at your institution being taught using active learning?
 - a. How do you know these large-enrollment science courses are being taught in an active learning way? (e.g. conversations with faculty/students, data on enrollment sizes, number of accommodations for certain courses, etc.)

Procedures:

1. Can you walk me through the standard process for receiving accommodations at your institution?
 - a. What documentation is required in order for students to receive accommodations?
 - i. What happens if a student cannot provide such documentation?
 - b. Do instructors have say in what accommodations they should get?
 - i. What if an instructor suggests a different accommodation?
2. If a student is enrolled in a large-enrollment science course that is taught in an active learning way, what is the process for them to receive appropriate accommodations for that course?
3. What accommodations are provided for large-enrollment active learning science courses?
 - a. To what extent are these accommodations similar or different to what is typically offered to students in traditional lectures?
4. Are students notified that the course will be taught in an active learning way? (e.g. by the instructors, by your office)
 - a. If no: Is it up to the student to identify if the course they are enrolled in is being taught in an active learning way?
5. How are accommodations for large-enrollment active learning science courses determined?
 - a. To what extent do you work with active learning instructors to identify accommodations?
 - b. To what extent do you work with the students to identify accommodations?
6. Are students required to identify their own accommodations for the active learning courses they are enrolled in?
7. To what extent do you work with students on self-advocacy skills for assisting them in seeking appropriate accommodations?

8. If an instructor teaches in an active learning way, can they notify your office in order to set up appropriate accommodations for students?

Challenges:

1. What, if any, unique challenges have you found when working with students with disabilities enrolled in large-enrollment active learning science classes?
2. Have you noticed students with particular disabilities struggling with small group work?
 - a. Yes: What types of disabilities? How, if at all, have you been able to accommodate these students?
3. Have you noticed students with particular disabilities struggling with clicker questions?
 - a. Yes: What types of disabilities? How, if at all, have you been able to accommodate these students?
4. Have you noticed students with particular disabilities struggling with cold call or random call?
 - a. Yes: What types of disabilities? How, if at all, have you been able to accommodate these students?
5. Have you noticed students with particular disabilities struggling with required attendance/participation?
 - a. Yes: What types of disabilities? How, if at all, have you been able to accommodate these students?
6. Have you noticed students with particular disabilities struggling with active learning technologies (e.g. videos, online learning platforms, etc.)?
 - a. Yes: What types of disabilities? How, if at all, have you been able to accommodate these students?
7. Have you noticed students with particular disabilities struggling with any other types of active learning?
 - a. Yes: What types of disabilities? How, if at all, have you been able to accommodate these students?

Alternatives:

1. What, if any, alternatives are there for students enrolled in an active learning science course if accommodations cannot be implemented?

Recommendations:

1. What recommendations would you have for improving the ways in which you can accommodate students with disabilities in active learning courses?

Table S1: Institutional characteristics of Disability Resource Centers interviewed

Interview #	Public or Private?	Carnegie Classification	Region
1	Public	R2	Midwest
2	Public	R1	South
3	Public	R1	Midwest
4	Public	R2	Midwest
5	Private	Master's	West
6	Public	R1	West
7	Public	R1	South
8	Public	R2	South
9	Public	R2	West
10	Public	R2	Midwest
11	Public	R1	West
12	Public	R2	West
13	Public	R1	West
14	Public	R1	Midwest
15	Public	R2	Midwest
16	Public	R1	South
17	Public	R2	Midwest
18	Public	R2	Northeast
19	Public	R1	West
20	Public	Baccalaureate	South
21	Public	Master's	Midwest
22	Public	R1	Northeast
23	Public	R1	South

24	Public	Master's	Northeast
25	Public	R2	Midwest
26	Public	R1	West
27	Public	R2	Midwest
28	Public	R1	South
29	Private	R1	Midwest
30	Public	R2	Midwest
31	Public	Master's	West
32	Public	R1	Northeast
33	Private	R1	Northeast
34	Public	R2	Midwest
35	Public	R1	Midwest
36	Public	Master's	West
37	Public	Master's	Northeast

All institutions were classified as large-enrollment (>10,000 students) based on the Carnegie Classification of Institutions of Higher Education.

R1: Doctoral Universities – Very high research activity: includes only institutions that awarded at least 20 research/scholarship doctoral degrees and had at least \$5 million in total research expenditures, in addition to high indexes for aggregate level of research activity and per-capita research activity.

R2: Doctoral Universities – High research activity: includes only institutions that awarded at least 20 research/scholarship doctoral degrees and had at least \$5 million in total research expenditures.

Master's Colleges and Universities – includes institutions that awarded at least 50 master's degrees and fewer than 20 doctoral degrees.

Baccalaureate Colleges – includes institutions where baccalaureate or higher degrees represent at least 50 percent of all degrees, but fewer than 50 master's degrees or 20 doctoral degrees were awarded.

Example survey question for disability status

Have you currently, or previously, been impacted by one or more of the following conditions?

(Check all that apply):

- Learning disability (e.g. autism, dyslexia)
- Mental health and psychological disability (e.g. anxiety, depression, bipolar disorder)
- Physical disability (e.g. cerebral palsy, spina bifida)
- Chronic health conditions (e.g. cancer, diabetes)
- Vision loss (e.g. blind)
- Hearing loss (e.g. deaf)
- Other (please describe)
- None of these apply

Do you feel as though you may need support or assistance in arranging accommodations for this course with the Disability Resource Center (DRC)?

- Yes (please describe)
- No
- I am not sure

The following question can be given only to students who indicate having a disability, but could also be given to all students in your class:

Given that this course uses active learning (e.g. group work, clicker questions), it may require a different approach than some of your other courses. However, we would like to know how we can make the course more inclusive for all students.

What, if anything, can we do to make you as successful as possible in this course?

Copy of final coding rubrics and number of directors who reported each theme

Theme	Description of theme	n (%) (n = 37)
Active learning processes/procedures		
Familiar with active learning	Director states that they are familiar with the term “active learning.” This could include directors providing a definition of active learning or providing examples of common active learning pedagogy (e.g. cold call, small group work/discussion, etc.).	37 (100%)
Provides standard suite of active learning accommodations	Director states that their department has a suite of accommodations that are implemented specifically for students who are enrolled in an active learning course.	0 (0%)
Has provided proactive accommodations for active learning	Director states any instance where their DRC has provided a single proactive accommodation at any point. Examples of such proactive accommodations include notifying a student that they are in an active learning course, discussions specifically about AL practices/challenges at the beginning of the semester/initial meetings, and if an instructor reaches out to the DRC to discuss their AL pedagogy/practice.	6 (16%)
Systematic process in place for proactive accommodations	Director states evidence that their DRC has been able to proactively accommodate every student enrolled in an active learning science course. Examples of this could include having a list of all identified active learning courses, a suite of accommodations specifically for active learning courses, or mentions that they know of each active learning science course at their institution.	0 (0%)
Provides individualized accommodations for active learning	Director states an example when they specifically accommodated students with a certain type of the disability. Examples of such individualized accommodations include instructors pre-determining groups for students struggling with small group work, ensuring that mobile app/clicker was accessible for users, and creating a flexible attendance and participation agreement form.	37 (100%)
Challenges associated with active learning		
<i>Small group work</i>		
Learning disability-difficulty working with others	Director states examples of students with specific learning disabilities (such as ADHD, students on the autism spectrum, dyslexia, etc.) having difficulty engaging/working with students in small group work.	30 (81%)
Mental health-difficulty working with others	Director states example(s) of students with mental health and psychological disabilities (such as social anxiety or depression) having difficulty when working with other students in small group work.	21 (57%)

Physical disability- classroom layout is not conducive to group work	Director states example(s) of students with physical disabilities (such as students utilizing a wheelchair or crutches) having difficulty participating based on classroom layout (e.g. stairs or limited space between rows of desks).	4 (11%)
Physical disability- difficulty writing quickly on assignments	Director states example(s) of students with physical disabilities having difficulty with fine motor dexterity impacting their ability to write notes and finish class assignments.	1 (3%)
Hearing loss- difficulties hearing discussion	Directors states example(s) of students with a partial or significant hearing loss having difficulty engaging with a small group because it was difficult to hear the discussion.	5 (14%)
Hearing loss- off-site transcriptionists have difficulty listening and transcribing group's conversation	Director states example(s) of students with partial or significant hearing loss having difficulty with off-site transcriptionists not able to listen and transcribe small group discussions accurately.	2 (5%)
<i>Clicker questions</i>		
Learning disability- students are not provided enough time to process	Director states example(s) of students with specific learning disabilities (such as ADHD, students on the autism spectrum, dyslexia, etc.) having difficulty with not being provided enough time to process clicker questions.	12 (32%)
Physical disability- fine motor difficulties clicking buttons	Director states example(s) of students with physical disabilities having trouble clicking buttons on the clicker due to their problem with fine motor dexterity.	12 (32%)
Vision loss- Students cannot see questions posted	Director states example(s) of students with partial or significant vision loss having difficulty visualizing the clicker questions posted during class.	19 (51%)
Vision loss- students cannot see correct buttons on clicker	Director states example(s) of students with partial or significant vision loss having difficulty visualizing the buttons on the clicker and accurately answering the question.	17 (46%)
<i>Cold/random call</i>		
Learning disability- students are not provided enough time to process	Director states example(s) of students with specific learning disabilities (such as ADHD, students on the autism spectrum, dyslexia, etc.) having difficulty being randomly requested to answer questions with a short amount of time to process and answer the question.	12 (32%)

Learning disability- students have difficulty speaking in front of the class	Director states example(s) of students with specific learning disabilities (such as ADHD, students on the autism spectrum, dyslexia, etc). having difficulty with speaking in front of the class.	12 (32%)
Mental health- students do not feel comfortable sharing ideas with the class	Director states example(s) of students with mental health and phycological disabilities (such as social anxiety or depression) having difficulty with comfort sharing ideas and answering questions during lecture.	19 (51%)
<i>Required participation</i>		
Physical disability- students may miss multiple class periods	Director states example(s) of students with a physical disability (such as muscular dystrophy, cerebral palsy, etc.) that prevented them from attending the course regularly.	6 (16%)
Chronic illness- students may miss multiple class periods	Director states example(s) of students with a chronic illness (such as diabetes, Chron’s Disease, chronic migraines, asthma, etc.) that prevented them from attending the course regularly.	25 (68%)
Mental health- students may miss multiple class periods	Director states example(s) of students with a mental health and psychological disability (such as episodic depression or anxiety) that prevented them from attending the course regularly.	23 (62%)
<i>Online activities (online homework, videos)</i>		
Vision loss- online learning platforms not accessible	Director states example(s) of students with partial or significant vision loss having difficulty accessing online learning platforms with their assistive technologies.	16 (43%)
Hearing loss- difficulty hearing videos and activities	Director states example(s) of students with partial or significant hearing loss having difficulty hearing videos and online activities within the course.	2 (5%)
Hearing loss- instructor videos are not always captioned	Director states example(s) of students with a partial or significant hearing loss having difficulty engaging with the videos and online activities since they are not closed-captioned.	4 (11%)
Accommodations for active learning challenges		
<i>Small group work</i>		
Students choose their groups	Director states example(s) of providing accommodations for students struggling with small group work with allowing students to pre-determine their groups.	3 (8%)
Instructor pre-determines	Director states example(s) of providing accommodations for students struggling with small group work with the	4 (11%)

groups	instructor pre-determining the students' groups.	
Reducing the size of groups	Director states example(s) of providing accommodations for students struggling with a small group by reducing the size of the groups (e.g. working in pairs).	5 (14%)
Students can interact virtually	Director states example(s) of providing accommodations for students struggling with small group work by allowing them to interact virtually via Zoom or Skype.	3 (8%)
Real-time captioner or scribe placed within groups	Director states example(s) of providing accommodations for students struggling with small group work by providing real-time captioners or scribes for students with hearing loss or vision loss.	2 (5%)
Changing the physical setting where groups work	Director states example(s) of providing accommodations for students struggling with small group work by changing the physical setting where groups can work. An example of this is that the small groups can work in the hallway or outside instead of working in the classroom.	1 (3%)
Providing accessible tables, chairs, and furniture conducive to group work	Director states example(s) of providing accommodations for students struggling with small group work by providing accessible furniture for students in their classrooms. An example of this is when a student in a wheelchair needs a table that can be adjusted in height.	2 (5%)
Completing an alternative assignment for credit	Director states example(s) of providing accommodations for students struggling with small group work by instructors providing an alternate assignment that does not require a small group to complete it.	13 (35%)
<i>Clicker questions</i>		
Access to clicker questions before class	Director states example(s) of providing accommodations for students struggling with the processing and answering of clicker questions by providing access to the questions before the start of class.	8 (22%)
Student motions to the instructor when they have read the question	Director states example(s) of providing accommodations for students who may struggling with the processing and answering of clicker questions by the students creating a hand signal notifying the instructor that they have had time to process the questions.	1 (3%)
Instructors reads the questions aloud before starting time	Director states example(s) of providing accommodations for students struggling with the processing and answering of clicker questions by having instructors to read the question aloud before starting the timer. This gives students optimal time for processing the questions.	4 (11%)
Clicker question can be completed before/after class	Director states example(s) of providing accommodations for students struggling with the processing and answering of clicker questions by allowing students to answer the questions before/after class before being graded. This gives students optimal time for processing the questions.	2 (5%)

Increased amount of time given to answer clicker questions	Director states example(s) of providing accommodations for students struggling with the processing and answering of clicker questions by the giving students an increased amount of time to answer a clicker question. This gives students optimal time for processing the questions.	5 (14%)
A volunteer can physically aid the student in clicking in their answer	Director states example(s) of providing accommodations for students struggling with the usage of clickers by having a volunteer help the student click in their desired answers.	4 (11%)
Ensure that the mobile app/clicker is accessible to users	Director states example(s) of providing accommodations for students struggling with the usage of clickers by ensuring the mobile app/clicker is accessible. An example of this is when a student's vision loss requires a clicker that has braille on the buttons.	6 (16%)
<i>Cold/random call</i>		
Instructor signals/ notifies the student they will be called on soon (advanced notice)	Director states example(s) of providing accommodations for students struggling with the processing and answering of questions from the professor by the professor signaling to that student that they will be called on soon to answer a question.	9 (24%)
Students are only called on when the student's hand is raised (opt-out of random call)	Director states example(s) of providing accommodations for students struggling with the processing and answering of questions from the professor by the student being able to answer the question voluntarily.	3 (8%)
Instructor does not call on the student to speak, or they can pass	Director states example(s) of providing accommodations for students struggling with the processing and answering of questions from the professor by the student being able to pass on the question asked by the professor.	7 (19%)
Student submits answer through a written form	Director states example(s) of providing accommodations for students struggling with the processing and answering of questions from the professor by the student being able to answer the question through submission of the answer being written or typed.	2 (5%)
<i>Required participation</i>		
Flexible attendance and participation agreement form	Director states example(s) of providing accommodations for students struggling with the required participation/attendance by creating a flexible attendance and participation agreement form that is approved by the DRC, instructor, and student.	33 (89%)
Students can attend class virtually (e.g. Skype, Zoom)	Director states example(s) of providing accommodations for students struggling with the required participation/attendance by allowing students to virtually attend class via Zoom or Skype.	2 (5%)

<i>Online activities (e.g. online homework, videos)</i>		
Ensure all videos are captioned (or replaced with one that is)	Director states example(s) of providing accommodations for students struggling with online activities by ensuring all videos that are utilized within the course are captioned.	6 (16%)
Allow students to work with an assistant to read/input answers	Director states example(s) of providing accommodations for students struggling with online activities by allowing students to work with an assistant to read/input answers for the student's classwork.	3 (8%)
Notify 3rd party software companies of inaccessible products	Director states example(s) of providing accommodations for students struggling with online activities by allowing DRCs and instructors to notify 3rd party software companies that their product is inaccessible to students with certain types of disabilities.	6 (16%)
Add tactile graphics, braille, or 3D models to online instruction	Director states example(s) of providing accommodations for students struggling with online activities by adding tactile graphics, braille, or 3D models to online instruction.	2 (5%)
Use screen readers to make online platforms accessible	Director states example(s) of providing accommodations for students struggling with online activities by making online platforms accessible for screen readers.	5 (14%)