



10 Tips to Make Your Course More Accessible and Inclusive to Disabled Students

Mariah Arral

Mariah Arral is a 4th year Ph.D. candidate in the Department of Chemical Engineering at Carnegie Mellon University. Her Ph.D. advisor is Dr. Kathryn Whitehead, and her thesis research focuses on lipid nanoparticle-mediated messenger RNA (mRNA) delivery. Mariah obtained her Bachelor's degree in Chemical Engineering from the University of New Hampshire and did her Honors thesis with Dr. Jeffrey Halpern studying electrochemical biosensors. She has received multiple awards including the National Science Foundation Graduate Research Fellowship (GRFP). Mariah is an openly disabled scientist and has a passion for creating equitable access to education for everyone. During her undergraduate studies, she developed an interest in studying mentorship of disabled individuals and initiated an ongoing research project with Dr. Halpern. In addition to her mentorship research, Mariah enjoys advocating for the disability community.

10 Tips to Make Your Course More Accessible and Inclusive to Disabled Students

Mariah L. Arral, Carnegie Mellon University

Abstract

Ableism is a barrier to accessible engineering education. Although Section 504 of the Rehabilitation Act of 1973 mandates equal access to postsecondary institutions for people with disabilities, there has been continuous pushback. Improvements have been made through laws, research, and activism, but there are still many steps we must take to further the accessibility of education and inclusion of disabled students. Disabled people make up between 13-26% of the US population, but only 6% of undergraduate students, and 7% of doctoral students with an engineering degree (NCSES). This underrepresentation of disabled students in engineering is likely due to a combination of factors. Studies have shown that disabled students face systemic barriers ranging from a general lack of support to negative views from faculty members. Resources about accessible and inclusive education practices related to the disability community are limited, and educators identified this limitation as a barrier to the support process. There is a clear and present need to ensure that support is implemented in our classrooms and that faculty have the resources to adapt their courses to an accessible format. The goal of this paper is to provide a guide to professors and students on accessible education. This guide will summarize resources and findings from both disability and education research into one cohesive space. I will discuss 10 guidelines, as follows: 1) Provide instructor- and course-specific accessibility and accommodations statements, 2) Meet with students privately about their accommodations, 3) Do not ask students to disclose their disabilities, 4) Consider the implications of language used, 5) Apply principles from Universal Design for Learning in the classroom, 6) Proactively provide accessible materials, 7) Upload notes and class slides and/or recordings, 8) Remove attendance requirements, 9) Solicit feedback from students on how accommodations are working in your class, and 10) Include content from those in the disability community in the curriculum. Adopting these guidelines is just the first step in starting to create a more inclusive and accessible educational environment. In conclusion, accessible education for all is within our power, but resources are needed for 1) disabled individuals and 2) educators. This paper provides guidelines and resources backed by disability and education literature to assist in making education accessible.

Key Words: ableism, disability, teaching tips, inclusion, accessibility

Introduction

Almost 50 years have passed since the 1973 Rehabilitation Act granted people with disabilities equal access to postsecondary education under the law.¹ This act was one of the first times in U.S. history that the civil rights of disabled people were protected by federal law. Implementation of the laws took many years, and activists participated in protests, sit-ins, and lobbying to accomplish their goals.^{2,3} In 1990, the Americans with Disabilities Act (ADA) mandated that reasonable accommodations be provided to people with disabilities. While the ADA took many steps forward for those in the disability community, further access to equitable education has been hindered by a ubiquitous ableist mentality in academia.^{1,4} Ableism can be defined as discrimination and social prejudice against disabled people based on the belief that “typical” abilities are superior.⁵ In the past 5 years, a growing body of firsthand accounts of ableism have been shared from members of the academic community.⁶⁻⁹

Disabled people make up between 13-26% of the US population.^{10,11} In the engineering and science community, representation of disabled people is overwhelmingly lacking. Access to research and teaching facilities is disparate for individuals in the disability community compared to their non-disabled counterparts.¹² Disabled students are currently and historically excluded from accessing engineering education. According to the National Center for Science and Engineering Statistics, 6% of undergraduate students who graduate with an engineering degree have a disability (NCSES: Table 2-7).¹¹ For doctoral graduate students, this number is 7% (NCSES: Table 7-3).¹¹ Diving deeper into the NCSES numbers, less than 0.4% of doctoral recipients have a walking disability, and about 1% have a hearing disability.^a These numbers are lower than the overall population that reports these disabilities (~7% walking and ~4% hearing).^{11, b} In addition, individuals from racial and ethnic groups who are also disabled have been shown to be further underrepresented in STEM.¹³ Disabled individuals who are multiply marginalized (minority, LGBTQIA+, socioeconomic background, etc.) face additional barriers to access equitable education, and more research is needed to identify strategies to support these communities.^{13,14}

Disabled students face systemic barriers such as inaccessible classrooms, a general lack of support, and negative views from faculty members.^{1,15} There are limited resources available to educators surrounding accessible postsecondary education, and educators themselves have identified this as a barrier to supporting disabled students' success.^{1,16} This lack of support can lead to students having to be advocates, educators, and students all at once.¹⁶ There is a clear and present need to ensure that support for disabled students is implemented into our classrooms and that faculty have the resources to adapt their classrooms to an accessible format. Furthermore, creating a more accessible and inclusive classroom has the potential to

^a The survey asks “the degree of difficulty—none, slight, moderate, severe, or unable to do—an individual has in seeing (with glasses or contact lenses), hearing (with hearing aid), walking without assistance, lifting 10 pounds or more, or concentrating, remembering, or making decisions. Respondents who answered “moderate,” “severe,” or “unable to do” for any activity are classified as having a disability.”⁷⁶

^b Numbers calculated by adding those who identified with the disability across age groups in NCSES Table 1-3 2021 and dividing by the total number of people surveyed.

create a “Curb-Cut Effect”^c, which means that investing in and improving the well-being of the disability community can cascade out and broaden the well-being of all students.^{17,18} The goal of this paper is to provide a practical guide to professors and students on accessible education. This guide will summarize resources and findings from both disability and education research into one cohesive space.

Positionality

I am an openly disabled student who has faced discrimination at the K-12, undergraduate, and graduate levels of education. I identify as a dyslexic and Autistic individual and alternate between identity-first¹⁹ and person-first language¹⁹ (see definitions in section 4).^d

This paper draws on my own experiences as a disabled student in engineering and literature about ableism in academia, to advocate for other disabled students like me. I have been told that engineering and academia is not a place for someone like me. As someone whose career goals include a tenure-track professorship, these statements made me determined to construct an inclusive and accessible place for myself and others like me. Over the course of my educational journey, I have collected news articles, journals, and books that have helped me to justify my place in the academy and advocate for myself. I have also encountered many people who are well-meaning in their support but lacked the resources or knowledge to assist me in my endeavors. This has led me to want to provide people with resources and engage in informative conversations about the disability community.

Advocacy can be a double-edged sword, as it has led to me finding not only support but also further discrimination. From my conversations with others in the community, I know I am not alone in fearing retaliation from those who discriminate against the disability community. My aim with this paper is to put together a guide that can help both students and faculty navigate the disability space. I was diagnosed with my disabilities over 20 years ago, and in the process of making an inclusive and accessible space for myself and others I have succeeded, failed, learned, and grown. Here, I provide an abbreviated summary of the literature and resources available, so that others can engage in conversations about supporting the disability community in a positive way. This paper is also meant to be a starting point for professors and academic leaders to make courses accessible for all students.

Guidelines for Promoting Disability Inclusion in Engineering Education

^c The curb cut effect occurs when a law or program that is designed to benefit vulnerable groups, like disabled people, ends up benefiting all of society. This term is derived from when curb-cuts (a ramp graded down from the top surface of a sidewalk to the surface of an adjoining street) were required by law to be installed. These curb-cuts were found to benefit people not only with disabilities, but also those pushing strollers or heavy carts.

^d The author of this paper has applied both identity- and person-first language. This is the author’s preferred style of identification. Each disabled person has the right to choose what style they would like to be addressed by.

1) Provide instructor- and course-specific accessibility and accommodation statements

According to a survey of over 200 professors and students, the syllabus was named the component of a course that most often contributes to effective college teaching.²⁰ Universities usually require professors to include a statement about the disability office on campus and accommodation resources available. University websites generally provide a boilerplate statement that can be inserted into any syllabus.²¹⁻²³ These statements usually include 1) a message asking students to contact the instructor if they have an accommodation letter, and 2) who to reach out to if the student suspects they have a disability or need accommodations (e.g. **Box 1**).²¹ These statements often present the legal obligation the university must follow, and can lack supportive language and ownership of making a classroom accessible for all students. Syllabi have the power to set the tone for a course,²⁴ and making sure students are in an inclusive and accessible environment should be a priority for instructors.

There are many online examples of accessibility and accommodation statements for a syllabus (**Box 2**).^{24,25} Portions of the accessibility statement might have to remain due to university policy, but you can add a customized section that pertains to your class. An exercise to consider is viewing your syllabus with disabled students in mind.²⁰

When doing this, question why you have an attendance policy, and how that might impact a chronically ill person. Ask yourself why the exam is restricted to a one-hour class period, and how that might affect those who cannot afford to obtain an official diagnosis of test anxiety, and thus have no accommodations.

Regardless of the policy chosen for a course, the syllabus is the first interaction a student will have with you regarding accessibility, accommodations, and inclusion.^{26,27} The second conversation will most likely be in your office discussing the students' specific accommodations. First impressions are impactful.

2) Meet with students privately about their accommodations.

Students with accommodations generally reach out to their professors during the first or second week of the semester. When a student is unfamiliar with the professor, this can be daunting and worrisome as there are often mixed responses a student can receive after disclosing their

Box 1: Typical Required Syllabus Statement:

Disability Accommodations. If you have a disability and have an accommodations letter from the Disability Resources office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [email].

Box 2: Sample Accessibility and Accommodations Syllabus Statement:

Accessibility and Accommodations. Usability, disability and design: I am committed to creating a course that is inclusive in its design. If you encounter barriers, please let me know immediately so that we can determine if there is a design adjustment that can be made or if an accommodation might be needed to overcome the limitations of the design. I am always happy to consider creative solutions as long as they do not compromise the intent of the assessment or learning activity. You are also welcome to contact the disability service office to begin this conversation or to establish accommodations for this or other courses. I welcome feedback that will assist me in improving the usability and experience for all students.

accommodations or disability.²⁸ When meeting with students, it is important to meet privately.²⁸ It is advised to not meet during office hours as other students might drop in and disrupt the privacy that an accommodations meeting deserves. It is the professor's legal obligation to provide accommodations.²⁹ It is not a faculty member's choice whether or not to provide accommodations. It is also illegal to call a student out publicly in class and ask to speak to them afterward regarding their accommodations. Singling out students can inadvertently out them to their classmates, which can lead to harmful comments.²⁸

It is important to note that the accommodations have been decided by qualified individuals at the university who were provided with detailed medical information from a licensed medical provider that supported the student's need for the accommodations.³⁰ If an instructor believes that an accommodation does not fit the class design, it is important to discuss this with the disability office on campus and to not pressure a student into declining an accommodation they requested. Often the disability office can suggest approaches to adhere to an accommodation and fit the class design.^{1,15,29} The disability office is not just a resource for students, but can also be a resource for professors. If an instructor refuses to allow an accommodation, the student can ask for assistance from the disability office. During this process, the instructor will most likely be asked to provide justification for not providing the accommodation.

In summary, obtaining accommodations can be a highly personal and intimidating task for a student.²⁸ Having the discussion about accommodations in private can assist in making students feel more welcomed. Furthermore, if an accommodation does not appear to work with a course structure, the disability office can often help to adapt the accommodation to the course.

3) Do not ask students to disclose their disabilities.

When a student has obtained accommodations through the university, they have gone through the process of providing their official diagnosis(s) and the appropriate paperwork for experts to determine their accommodations. The information an instructor receives will simply state that the student has a disability, and will outline the associated accommodations, but will not reveal the disability diagnosis. While it might seem like a harmless question, an instructor asking a student to disclose their disability can be a frightening thing.^{1,28} Students are not obligated to share their disability with an instructor. A good analogy for why it is inappropriate to ask a student to disclose their disability would be to consider if you would ask someone their social security or credit card number in an interview. This question is an invasion of someone's personal life, the same can be said for asking someone to disclose their disability. In addition, it is illegal for an employer to ask a person if they are disabled or ask about the nature of the person's disability.³¹

Students may choose to disclose their disability. This disclosure can sometimes be referred to as "coming out" for those who have nonapparent disabilities.^{14,28,32,33} When a student discloses, it is valuable to use affirmative language like "Thank you for being open to sharing this information with me." Students might take the opportunity to provide additional information about their disability that, from their experience, has been valuable to instructors. An example of this would be a student who recognizes they enjoy asking questions, and informs the professor they might not pick up on social cues for when a good time to ask questions is, and that the student is not offended to be told "now is not the best time for questions."

The big take-home is that disclosing a disability is a personal choice that is up to the student.^{14,28}

4) Consider the implications of language used.

Each person within the disability community will have their preferences when discussing themselves and those in the disability community. Language preferences are not universal across the community, and therefore must be adapted on a case-by-case basis. There are some general guidelines that this section will provide, but if a disabled person corrects you on their preferred language, we must adhere to that request.

Identity- and person-first language

There are two commonly used language styles when discussing disabilities: 1) person-first, and 2) identity-first.¹⁹ Person-first language occurs when one puts the person before the disability (e.g. I am a person with disabilities). Identity-first language is where one puts the diagnosis before the person (e.g. I am a disabled person). Many people in the disability community have a preferred language style when discussing themselves or the disability community. Some subcommunities generally prefer identity-first language; these include the Autistic, Blind, and Deaf communities. It is important to ask each student what language style they would prefer.

Ableist language

It is imperative to state that *disability is not a bad word*. Disabled is not a word that should be avoided by saying terms like “differently-abled,” “special needs”, “able-bodied”, or “handicap”.³⁴ These phrases are often considered an insult to those in the disability community, because it strips the person of their disabled identity. In addition, using the word “normal” to refer to those who are not disabled can be insulting. Furthermore, there are many terms that people use every day that have ableist connotations (e.g., lame, crazy, crippled). These terms should be avoided. The National Center on Disability and Journalism has compiled a list of terms surrounding the disability community that can be a helpful reference.³⁵ Some terms, like crippled, have been reclaimed by the community. This was seen by the hashtag campaign #CripTheVote.³⁶ ^e Ableist language is sadly ingrained in our speech, but as individuals and a society we can take steps to make changes.

Helpful Definitions

There is a never-ending list of items that might be helpful for navigating disability literature and communities. Herein are definitions for seven common terms in the neurodiverse community and explanations for how they are intertwined (**Figure 1**). It is recommended to look at The National Center on Disability and Journalism website for a more complete list.³⁵

Disabled – “A difficulty in functioning at the body, person, or societal levels, in one or more life domains, as experienced by an individual with a health condition in interaction with contextual factors.”³⁷ Various laws define disability differently.

Non-disabled – A person who does not have a disability, and a preferred term for referring to those who are not part of the disability community.

^e To make hashtags accessible to screen-readers it is important to capitalize the individual words used, known as Camel Case.⁷⁷ (e.g., #DisabledInSTEM, #ActuallyAutistic)

Neurodivergent – A person whose brain processes, learns, and/or behaves differently from what is considered “typical.” People who identify as neurodivergent might be diagnosed with: Autism, dyslexia, ADHD, depression, anxiety, Tourette syndrome, and/or other disabilities.³

Neurotypical – A person whose brain processes, learns, and/or behaves in what is considered “typical.” These people may be non-disabled or have a non-neurodivergent disability (chronic illness, chronic pain disorder, etc.).³

Autistic – is a group of complex disorders related to brain development, according to the National Institute of Mental Health.³⁵

Allistic – Those who are not Autistic individuals. These people may still be 1) neurodivergent, 2) neurotypical, or 3) disabled.

Neurodiversity - Variation in neurocognitive functioning. This includes both those who are Neurodivergent and Neurotypical. Which by transitive property also includes non-disabled and disabled individuals.³

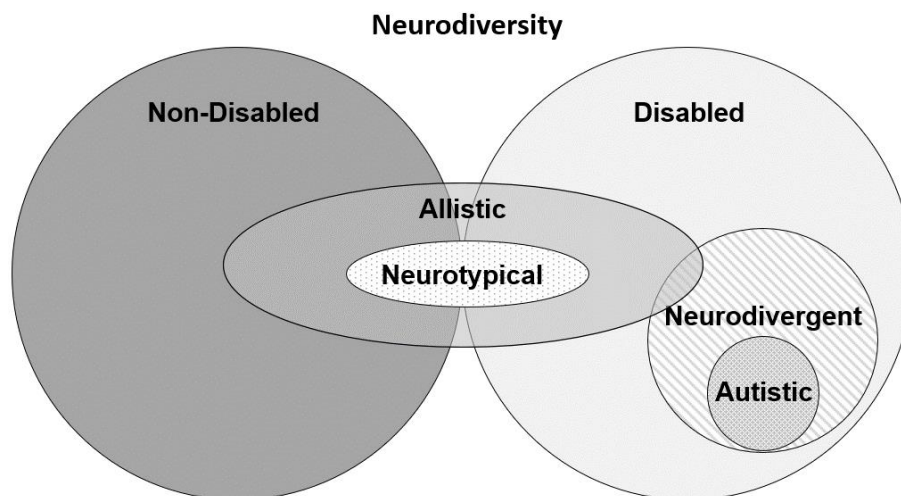


Figure 1: Venn diagram explaining the relationship and intersections between terminology outlined in “Helpful Definitions.”

Inspiration Porn

The term “inspiration porn” was popularized by the late activist and comedian Stella Young.^{38,39} One definition for inspiration porn is “the representation of disability as a desirable but undesired characteristic, usually by showing impairment as a visually or symbolically distinct biophysical deficit in one person, a deficit that can and must be overcome through the display of physical prowess.”³⁹ More simply put, inspiration porn is the objectification of a disabled person for the benefit of non-disabled individuals. Young gave an example of inspiration porn in her 2012 Ted Talk:

“Inspiration porn is an image of a person with a disability, often a kid, doing something completely ordinary - like playing, or talking, or running, or drawing a picture, or hitting a tennis ball - carrying a caption like “your excuse is invalid” or “before you quit, try” .”

When discussing the disability community, it is important to make sure we are not objectifying people. Language has the power to be both incredibly supportive and utterly destructive. The intentions of our words do not always lead to the impact we anticipate. When navigating conversations about the disability community, mistakes can and will be made. When mistakes are made, it is important to recognize them and make corrections.

5) Apply principles from Universal Design for Learning in the classroom.

Accessing accommodations at the postsecondary level requires that students provide current documentation that they have a disability. This documentation is often stipulated to be “no older than 5 years.” The cost of obtaining this documentation is on the student, which can be a burden for low-income students.³⁰ These assessments can cost somewhere between \$500-\$2,500, or even higher for certain tests.⁴⁰ Some schools offer emergency loans to pursue obtaining documentation, but this can be a huge financial burden for accessing equitable education.³⁰ When we place the burden of accommodations, accessibility, and inclusive language on the shoulders of those who are most impacted, we are making a mistake as an education community.

To relieve this financial burden from students, there are steps educators can take to make their classroom more accessible, such as applying Universal Design for Learning (UDL) principles. UDL is a framework that, when implemented, can improve and optimize teaching and learning for all people. The main concept for UDL is to provide multiple ways for students to engage with the course material.^{41,42} This means bringing flexibility and options into the learning environment. For example, if you require course participation in discussion, allow students to engage 1) in the class, and 2) via an online forum. Providing both avenues better encourages student engagement because different options for communication can meet distinct strengths. In addition, it is important to provide students with clear instructions on how they are going to be evaluated. A well written rubric offers a transparent, quantitative, and comprehensive tool for students.^{43,44} There is a website dedicated to UDL guidelines that has resources and literature to support these claims (<https://udlguidelines.cast.org>).⁴⁵ Additionally, biologist Dr. Cait S. Kirby, has created short guides that explain the concepts of UDL, backwards design, rubrics, and more (www.caitkirby.com/resources.html).⁴⁶ UDL is a proven strategy for making an accessible classroom and offers a wide variety of strategies.^{5,12,47}

UDL also provides the opportunity to uplift all students (Curb-Cut Effect). Accessibility and inclusion cannot be an afterthought. Finding ways to implement UDL practices can take a lot of time, and potentially result in restructuring of a course. Creating an accessible course will not occur instantaneously, instead it takes making conscious decisions over time.

6) Proactively provide accessible materials.

The way we communicate information has transitioned away from the typical lecture and textbook format of yesteryear. Our educational strategies and materials are more interactive and diversified than ever (**Table 1**). Communicating educational material using different mediums can be helpful to students who have different learning styles.⁴⁸ When designing these course materials, it is important to make sure they are accessible to all. Critically evaluating the source material (videos, images, textbooks, etc.) for

Table 1: Examples of course materials that need to be accessible.

Lectures
PowerPoints
Videos
Podcasts
Images/Graphs
Journal Articles
Websites
Handouts
Textbooks
Zoom/Online Meeting

accessibility can alleviate having to find alternatives in the future. Proactively making materials accessible can save you time down the line.

Written and Visual

Students with learning disabilities or those who are blind or low-vision might need to use screen-readers or audiobooks to access written or visual material, including textbooks, graphs, photographs, diagrams, PowerPoints, and more. Screen-readers can read more than just the text written on the page. They can also read images and figures if they are given appropriate alternative-text (alt-text). Alt-text is a detailed description of an image that can be inserted into documents. The alt-text should sufficiently convey the meaning of the image to someone who cannot see the image. Software like Word⁴⁹, PowerPoint⁴⁹, and Twitter⁵⁰ have online guides on how to add alt-text to documents.⁵¹

When choosing online content like websites, news articles, or journals, check if they are accessible via screen-reader. While online content should be accessible to all by law, that does not mean it is a reality.⁵² There are many online tools for checking a website's accessibility. One way is to download a screen-reading app and check the website, Chrome has an extension you can add on easily. There are also other online websites that might be helpful in checking for accessibility.⁵³

Auditory

Lectures still dominate our teaching methods and primarily consist of auditory communication. Auditory materials can go beyond lectures and also includes videos, podcasts, online meetings, and more. When selecting and designing auditory materials, it is important to ensure that there are closed captions^f and transcripts available. Closed captioning and transcripts are important for Deaf people, those with auditory processing disorders, or those who are communicating in their non-native language (Curb-Cut Effect).⁵⁴

Additionally, if you are giving a lecture and working with an interpreter, there are some general guidelines⁵⁵ that can facilitate effective communication:

- 1) Meet with the interpreter ahead of time to discuss vocabulary, acronyms, and jargon.
- 2) Do not block the view of the interpreter. Discuss placement before the lecture.
- 3) Provide lecture notes in advance so the interpreter can prepare.
- 4) Talk directly to the Deaf or hard-of-hearing person and not the interpreter.
- 5) Do not ask the interpreter to censor content.

Lastly, in the age of COVID-19, many professors began recording their lectures to help students who might be absent, for example due to illness or new caregiving roles.⁵⁶ Recorded lectures are an accommodation that students can request. Providing this material without being asked can be helpful not only for students who need the accommodation, but also for those who want to revisit a topic when studying. These recordings can be a way to implementing UDL and furthermore result in a Curb-Cut Effect.⁵⁶

^f Closed captions contain information about sound and music in a video. Subtitles only contain information on words spoken.

7) Upload notes and class slides and/or recordings.

Note-taking is a skill that takes time to master and can be difficult for people with certain disabilities.^{57,58} A common accommodation is to request copies of notes and/or recordings from lectures. These can come in the form of written notes, slides, and/or recording from 1) the professor and/or 2) a notetaker that is another student present in the class.³¹ The second option can and does lead to students being forced to disclose their disabilities to both the professor and their peers to obtain accommodations.³¹ As was previously mentioned, disclosing disability status should be a personal decision, and not one predicated on obtaining an accessible classroom experience. Additionally, providing notes, slides and/or recordings can assist more than just the disabled students (Curb-Cut Effect).⁵⁶ Uploading notes is a small but impactful way to support students with disabilities.

8) Remove attendance requirements.

Attendance requirements are ableist because they present unfair challenges for those in the disability community.^{59,60} Some might attempt to circumvent the ableist mentality of attendance policies by allowing a number (N) of dropped classes per semester. While this might seem like a fair policy, it is an inherent example of equality versus equity. Equality, in this case, would allow all students to miss the same number of classes. Equity would recognize that some students might have more than the average number of doctors' appointments, sick loved ones, childcare needs, or an illness that prevents them from attending a class. These obligations are all valid reasons for missing a course and should not penalize a student. Having inequitable attendance policies can also lead to the ostracization of a disabled or chronically ill student.⁶¹

During the COVID-19 pandemic, we have seen a shifting conversation about accommodating attendance or remote work as many recognized the strain people were facing.⁶² While we are transitioning back to in-person classes, it is important that we do not leave behind the accessibility that we established during the pandemic.

9) Solicit feedback from students on how accommodations are working in your class.

It has been shown that receiving mid-semester feedback can be helpful for course instructors in evaluating goals and clarifying expectations.⁶³ This type of feedback could be beneficial for understanding how students perceive the universal design principles and accommodations being applied in your classroom. At the same time, reaching out to your disabled students to see if there is any feedback on the accommodations you have implemented for the class could be beneficial. Discussions of accommodations should always be done in private, so scheduling an email to send to students with accommodations mid-way through the semester is a quick way to solicit feedback. Disclosing accommodations can be daunting and having someone willing to have continued open communication can be helpful.

Accommodation needs might change within a semester, due to a new diagnosis, a change in treatment plans, or something else—like a global pandemic. If the student needs new accommodations, they should reach out again to discuss them. Communication and feedback are essential to making the classroom accessible and inclusive.

10) Include content from those in the disability community in the curriculum.

Representation matters. It is widely accepted that having a diverse workforce results in more innovation.⁶⁴ Including the representation of disabled people in the engineering curriculum is important.⁶⁴ For example, if you are teaching an introductory course that uses Kirchhoff's law, you could mention that he had chronic illnesses that resulted in him using mobility aids.⁶⁵ In an Introduction to Chemistry course, you could mention Joseph Priestley, who discovered oxygen, and had a speech disability.⁶⁴ There are many disabled individuals, past and present, who have contributed to STEM, and taking a moment to talk about them as people so the students might see themselves in them can be powerful. Considering intersectionality is also important, disabled women, disabled people of color, disabled LGBTQIA+, all exist and have contributed heavily to STEM and deserve acknowledgment. Only 1.5-4% of all faculty have a disability.⁶⁶ This means most students who are disabled will not learn from someone like them during their course of study. Taking the time to represent the disability community in the classroom might be the only time disabled students are connected with a disabled scientist.

A note on the impact of COVID-19 on accessible education.

The COVID-19 pandemic has irrevocably changed our world. In a matter of weeks, major institutions moved to remote and online classes. In the best cases, classes were recorded, deadlines were extended, and flexibility was implemented into the classroom. Disabled students have spent years asking for many of these same accommodations.⁶⁷⁻⁷⁴ As we are transitioning to in-person classes, it is important that we remember and continue to implement the accessibility lessons that we learned during the pandemic.

During the pandemic, many people who had not previously disclosed their disabilities found themselves asking for reasonable accommodation or disclosing their status to their colleagues for the first time. Accommodation needs ranged from requests for remote work, flexible hours, deadline extensions, or transcripts of virtual meetings.⁶⁷ And while many people are trying to "move on with life" and "live with COVID", this can be much more difficult for many people with disabilities. To implement a classroom that is "living with COVID" effectively disregards essential protections for people with disabilities and chronic illnesses. Several articles have been published recently, regarding the effect that the pandemic has had on disabled students.⁶⁷⁻⁷⁴ One report showed that disabled graduate and professional experienced higher rates of housing insecurity, loss of wages from employment, loss of insurance coverage, and loss of financial aid (e.g., scholarship, grant, or loans) than their non-disabled counterparts.⁷⁵ Additional studies are needed to truly understand the lasting impacts of the pandemic on disabled students and accessible education.

Summary

Achieving accessible postsecondary education for all is within our power, but more resources for 1) disabled individuals and 2) educators are needed.^{1,28,61} Accessibility and inclusion cannot be afterthoughts. Thorough planning, trial and error, and feedback are essential for successful implementation. Furthermore, we have the opportunity to uplift all students when we enact accessible and inclusive policies for disabled students (Curb-Cut Effect). We as an academic community need to make a commitment to put accessibility at the forefront of our course design. Herein was a list of 10 tips for making classrooms more inclusive and accessible to disabled students. These guidelines are just a first step in creating a more inclusive and accessible educational environment. Academia has a long way to go to remove the ableist barriers that

exist within it. Tearing down these barriers is a daunting objective, but one we must all strive to achieve.

Acknowledgments

M.L.A would like to thank Dr. Angela Andersen who is the Co-Founder and Co-Director of the Life Science Editors Foundation, which provides awards to provide editorial services to those from historically underrepresented groups (<https://lifescienceeditors.org>).

M.L.A. would like to also thank Dr. Cait S. Kirby for reading a draft copy of this paper and providing feedback.

M.L.A. was supported by an NSF Graduate Research Fellowship Program award (# DGE1745016).

References

1. Weatherton, Y. P., Mayes, R. D. & Villanueva-Perez, C. Barriers to Persistence of Engineering Students with Disabilities: A Review of Literature. *Proc. 124th Annu. Am. Soc. Eng. Educ. Conf.* 12 (2017).
2. Disability Studies for Human Services. *Disabil. Stud. Hum. Serv.* (2020). doi:10.1891/9780826162847
3. Kapp, S. K. Autistic Community and the Neurodiversity Movement. *Autistic Community Neurodiversity Mov.* 330 (2020). doi:10.1007/978-981-13-8437-0
4. Limas, J. C., Corcoran, L. C., Baker, A. N., Cartaya, A. E. & Ayres, Z. J. The Impact of Research Culture on Mental Health & Diversity in STEM. *Chem. – A Eur. J.* **28**, e202102957 (2022).
5. Abegglen, S., Aparicio-Ting, F. E., Arcellana-Panlilio, M., Behjat, L., Brown, B., Clancy, T. L., DesJardine, P., Din, C., Dyjur, P., Ferreira, C., Hughson, E. A., Kassan, A., Klinke, C., Kurz, E., Neuhaus, F., Pletnyova, G., Paul, R. M. & Peschl, H., Peschl, R., & Squance, R. T. Chapter 11: Accommodation is Not Inclusion: Application of UDL Principles to Support Disability Diversity in a Post-Secondary Classroom. in *Incorporating Universal Design for Learning in Disciplinary Contexts in Higher Education* (ed. M. Arcellana-Panlilio and P. Dyjur, E.) (Taylor Institute for Teaching and Learning Guide Series., 2021).
6. Brown, N. & Leigh, J. Accounts of academic ableism. *Nat. Chem.* 2021 136 **13**, 511–511 (2021).
7. Byrne, D. Science diversified: Tackling an ‘ableist’ culture in research. *Nature* (2021). doi:10.1038/D41586-021-00317-3
8. Powell, K. Academia’s ableist mindset needs to change. *Nature* **598**, 693–695 (2021).
9. Schaal, A. Science must rise up to support people like me. *Nature* **556**, 275 (2018).
10. Okoro, C. A., Hollis, N. D., Cyrus, A. C. & Griffin-Blake, S. Prevalence of Disabilities and Health Care Access by Disability Status and Type Among Adults — United States, 2016. *MMWR. Morb. Mortal. Wkly. Rep.* **67**, 882–887 (2019).
11. Foundation, N. S. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019. (2021). Available at: <https://nces.nsf.gov/pubs/nsf21321/data-tables>. (Accessed: 16th February 2022)
12. Grout, I. Towards a Universally Accessible Laboratory for the Teaching and Learning of Electronic and Computer Engineering. *Lect. Notes Networks Syst.* **298**, 502–513 (2021).
13. Da, E. *et al.* Experiences of Minority College Students with Disabilities in STEM. *J. Postsecond. Educ. Disabil.* **29**, 375
14. Toft, A. Identity Management and Community Belonging: The Coming Out Careers of Young Disabled LGBT+ Persons. *Sex. Cult.* 2020 246 **24**, 1893–1912 (2020).
15. Bain, S., Santos, D. L., Kupczynski, L. & Mundy, M.-A. Determining Academic Success in Students with Disabilities in Higher Education. *Int. J. High. Educ.* **8**, 16–38 (2019).
16. Haas, A. M. & Eble, M. F. Key theoretical frameworks : teaching technical communication in the twenty-first century. 320
17. Morson, E. The Curb Cut Effect: How Making Public Spaces Accessible to People With Disabilities Helps Everyone | by Disability Science Review | Medium. (2016). Available at: <https://mosaicofminds.medium.com/the-curb-cut-effect-how-making-public-spaces-accessible-to-people-with-disabilities-helps-everyone-d69f24c58785>. (Accessed: 2nd May 2022)
18. Blackwell, A. G. The Curb-Cut Effect. (2017). Available at: https://ssir.org/articles/entry/the_curb_cut_effect. (Accessed: 2nd May 2022)
19. Dunn, D. S. & Andrews, E. E. Person-first and identity-first language: Developing psychologists’ cultural competence using disability language. *Am. Psychol.* **70**, 255–264 (2015).

20. Womack, A.-M. Teaching Is Accommodation : Universally Designing Composition Classrooms and Syllabi. *Coll. Compos. Commun.* **68**, 494–525 (2017).
21. Innovation, E. C. T. E. & E. Accommodations. Available at: <https://www.cmu.edu/teaching/designteach/syllabus/checklist/accommodations.html>. (Accessed: 2nd December 2022)
22. 4. Include a syllabus statement | Poorvu Center for Teaching and Learning. Available at: <https://poorvucenter.yale.edu/AccessibilityStatements>. (Accessed: 16th February 2022)
23. Sample Syllabus Accessibility Statement | Accessible Education and Student Support | Bates College. Available at: <https://www.bates.edu/accessible-education/faculty/sample-syllabus-statement/>. (Accessed: 16th February 2022)
24. Tara Wood and Shannon Madden. Suggested Practices for Syllabus Accessibility Statement. *Kairos Rhetor. Technol. Pedagog.* (2014).
25. Refocus: Syllabus Statement. Available at: <https://exploreaccess.org/projectshift-refocus/syllabus.htm>. (Accessed: 16th February 2022)
26. Fuentes, M. A., Zelaya, D. G. & Madsen, J. W. Rethinking the Course Syllabus: Considerations for Promoting Equity, Diversity, and Inclusion: <https://doi.org/10.1177/0098628320959979> **48**, 69–79 (2020).
27. Harrington, C. & Thomas, M. *Designing a motivational syllabus : creating a learning path for student engagement*. (Stylus Publishing, LLC, 2018).
28. Smith, S. A., Woodhead, E. & Chin-Newman, C. Disclosing accommodation needs: exploring experiences of higher education students with disabilities. <https://doi.org/10.1080/13603116.2019.1610087> **25**, 1358–1374 (2019).
29. Cook, L., Rumrill, P. D. & Tankersley, M. Priorities and Understanding of Faculty Members Regarding College Students with Disabilities. *Int. J. Teach. Learn. High. Educ.* **21**, 84–96 (2009).
30. Meeks, L. M., Jain, N. R. & Laird, E. P. Equal Access for Students With Disabilities. *Equal Access Students With Disabil.* (2020). doi:10.1891/9780826182234
31. Roslin, T. Vitriolic Verification: Accommodations, Overbroad Medical Record Requests, and Procedural Ableism in Higher Education. *Am. J. Law Med.* **47**, 109–130 (2021).
32. Mullins, L. & Preyde, M. The lived experience of students with an invisible disability at a Canadian university. <http://dx.doi.org/10.1080/09687599.2012.752127> **28**, 147–160 (2013).
33. Solis, S. I'm "Coming Out" as Disabled, but I'm "Staying in" to Rest: Reflecting on Elected and Imposed Segregation. <http://dx.doi.org/10.1080/10665680500534007> **39**, 146–153 (2007).
34. Bottema-Beutel, K., Kapp, S. K., Lester, J. N., Sasson, N. J. & Hand, B. N. Avoiding Ableist Language: Suggestions for Autism Researchers. <https://home.liebertpub.com/aut> **3**, 18–29 (2021).
35. Disability Language Style Guide | National Center on Disability and Journalism. Available at: <https://ncdj.org/style-guide/>. (Accessed: 17th February 2022)
36. 'Nothing About Us Without Us': 16 Moments in the Fight for Disability Rights - The New York Times.
37. Leonardi, M., Bickenbach, J., Ustun, T. B., Kostanjsek, N. & Chatterji, S. The definition of disability: what is in a name? *Lancet* **368**, 1219–1221 (2006).
38. Stella Young: I'm not your inspiration, thank you very much | TED Talk. Available at: https://www.ted.com/talks/stella_young_i_m_not_your_inspiration_thank_you_very_much?language=en. (Accessed: 16th February 2022)
39. Grue, J. The problem with inspiration porn: a tentative definition and a provisional critique. <http://dx.doi.org/10.1080/09687599.2016.1205473> **31**, 838–849 (2016).
40. Adult Learning Disability Assessment Process – Learning Disabilities Association of America. Available at: <https://ldaamerica.org/info/adult-learning-disability-assessment->

- process/. (Accessed: 16th February 2022)
41. Sheryl Burgstahler. *Universal Design in Higher Education: Promising Practices*. (2008).
 42. DO-IT | Disabilities, Opportunities, Internetworking, and Technology. Available at: <https://www.washington.edu/doi/>. (Accessed: 16th May 2022)
 43. Chowdhury, F. Application of Rubrics in the Classroom: A Vital Tool for Improvement in Assessment, Feedback and Learning. *Int. Educ. Stud.* **12**, (2019).
 44. Wolf, K. & Stevens, E. The Role of Rubrics in Advancing and Assessing Student Learning. *J. Eff. Teach.* **7**, 3–14 (2007).
 45. UDL: The UDL Guidelines. Available at: <https://udlguidelines.cast.org/>. (Accessed: 16th February 2022)
 46. Cait Kirby - Resources. Available at: <https://caitkirby.com/resources.html#Teacher>. (Accessed: 17th February 2022)
 47. Baumann, T. & Melle, I. Evaluation of a digital UDL-based learning environment in inclusive chemistry education. *Chem. Teach. Int.* **1**, (2019).
 48. UDL: Use multiple media for communication. Available at: <https://udlguidelines.cast.org/action-expression/expression-communication/use-multimedia>. (Accessed: 16th May 2022)
 49. Add alternative text to a shape, picture, chart, SmartArt graphic, or other object. Available at: <https://support.microsoft.com/en-us/office/add-alternative-text-to-a-shape-picture-chart-smartart-graphic-or-other-object-44989b2a-903c-4d9a-b742-6a75b451c669>. (Accessed: 17th February 2022)
 50. How to make images accessible for people. Available at: <https://help.twitter.com/en/using-twitter/picture-descriptions>. (Accessed: 17th February 2022)
 51. Alternative Text | Accessible U. Available at: <https://accessibility.umn.edu/what-you-can-do/start-7-core-skills/alternative-text>. (Accessed: 17th February 2022)
 52. Palmer, Z. B. & Palmer, R. H. Legal and Ethical Implications of Website Accessibility: <https://doi.org/10.1177/2329490618802418> **81**, 399–420 (2018).
 53. Mifsud, J. 8 Free Web-Based Website Accessibility Evaluation Tools - Usability Geek. Available at: <https://usabilitygeek.com/10-free-web-based-web-site-accessibility-evaluation-tools/>. (Accessed: 11th May 2022)
 54. Gernsbacher, M. A. Video Captions Benefit Everyone. *Policy insights from Behav. brain Sci.* **2**, 195–202 (2015).
 55. 10 Tips for Using a Sign Language Interpreter | Office of Equity, Diversity and Inclusion. Available at: <https://www.edi.nih.gov/blog/communities/10-tips-using-sign-language-interpreter>. (Accessed: 17th February 2022)
 56. Epaminonda, E., Efthymiou, L. & Ktoridou, D. COVID-19 contingency plans: The impact on students' future choices. *IEEE Glob. Eng. Educ. Conf. EDUCON 2021-April*, 1737–1742 (2021).
 57. Luo, L., Kiewra, K. A., Flanigan, A. E. & Peteranetz, M. S. Laptop versus longhand note taking: effects on lecture notes and achievement. *Instr. Sci.* **46**, 947–971 (2018).
 58. Englert, C. S. *et al.* The Learning-to-Learn Strategies of Adolescent Students With Disabilities: Highlighting, Note Taking, Planning, and Writing Expository Texts. <http://dx.doi.org/10.1177/1534508408318804> **34**, 147–161 (2008).
 59. Nicolas, M. Ma(r)king a Difference: Challenging Ableist Assumptions in Writing Program Policies.
 60. Kruse, A. K. & Oswal, S. K. Barriers to higher education for students with bipolar disorder: A critical social model perspective. *Soc. Incl.* **6**, 194–206 (2018).
 61. Bê, A. Ableism and disablism in higher education: The case of two students living with chronic illnesses. *Alter* **13**, 179–191 (2019).
 62. Ocean, M. Telework during COVID-19: exposing ableism in U.S. higher education.

- <https://doi.org/10.1080/09687599.2021.1919505> **36**, 1543–1548 (2021).
63. Robert Marx. Soliciting and Utilizing Mid-Semester Feedback | Center for Teaching | Vanderbilt University. *Vanderbilt University Center for Teaching* (2019). Available at: <https://cft.vanderbilt.edu/soliciting-and-utilizing-mid-semester-feedback/>. (Accessed: 17th February 2022)
 64. Pence, H. E. & Pence, L. E. Introducing Diversity into a General Chemistry Course. *J. Chem. Educ.* **99**, 359–362 (2022).
 65. Inan, A. S. What did Gustav Robert Kirchhoff stumble upon 150 years ago? *ISCAS 2010 - 2010 IEEE Int. Symp. Circuits Syst. Nano-Bio Circuit Fabr. Syst.* 73–76 (2010). doi:10.1109/ISCAS.2010.5537049
 66. The Neglected Demographic: Faculty Members With Disabilities. Available at: <https://www.chronicle.com/article/the-neglected-demographic-faculty-members-with-disabilities/>. (Accessed: 16th February 2022)
 67. Madaus¹, J. W., Gelbar¹, N., Faggella-Luby², M. & Dukes, L. L. Experiences of Students with Disabilities During the COVID-19 Interruption of In-Person Instruction. *J. Postsecond. Educ. Disabil.* **34**, 5–18
 68. Jandrić, P. *et al.* Teaching in the Age of Covid-19. *Postdigital Sci. Educ.* 2020 **23** **2**, 1069–1230 (2020).
 69. Benson, K. In Favour of Universal Design: The Argument for Continued Hybrid Online/In-Person Courses in the Wake of the COVID-19 Pandemic with a Focus on Students with Disabilities. *SSRN Electron. J.* (2021). doi:10.2139/SSRN.3875075
 70. Rotarou, E. S., Sakellariou, D., Kakoullis, E. J. & Warren, N. Disabled people in the time of COVID-19: identifying needs, promoting inclusivity. *J. Glob. Health* **11**, 1–4 (2021).
 71. Aquino, K. C. & Scott, S. The Disability Resource Office and COVID-19: Disability and Accessibility Support during the Pandemic within the Two-Year Postsecondary Environment. <https://doi.org/10.1080/10668926.2021.2006825> (2021). doi:10.1080/10668926.2021.2006825
 72. Goggin, G. & Ellis, K. Disability, communication, and life itself in the COVID-19 pandemic. <https://doi.org/10.1080/14461242.2020.1784020> **29**, 168–176 (2020).
 73. Armitage, R. & Nellums, L. B. The COVID-19 response must be disability inclusive. *Lancet Public Heal.* **5**, e257 (2020).
 74. Goel, R. R. *et al.* Distinct antibody and memory B cell responses in SARS-CoV-2 naïve and recovered individuals following mRNA vaccination. **6**, (2021).
 75. Soria, K. M., Kirby, C. S. & Xiong, S. NCCSD Research Brief Graduate and Professional Students with Disabilities: Financial Hardships During the COVID-19 Pandemic Graduate and Professional Students with Disabilities: Financial Hardships During the COVID-19 Pandemic. (2021).
 76. Technical Notes - nsf.gov - Women, Minorities, and Persons with Disabilities in Science and Engineering - NCSES - US National Science Foundation (NSF). Available at: <https://www.nsf.gov/statistics/2017/nsf17310/technical-notes.cfm>. (Accessed: 18th February 2022)
 77. Christensen, S. & Pionke, J. J. Social Media Best Practices: Implementing Guidelines for Disability and Copyright. *Soc. Media Acad. Libr. Perspect.* 45–55 (2019). doi:10.1016/B978-0-08-102409-6.00004-3