



New Online Accommodations Are Not Enough: The Mismatch between Student Needs and Supports Given for Students with Disabilities during the COVID-19 Pandemic

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The COVID-19 pandemic resulted in nearly all universities transitioning their in-person courses to online instruction. Recent work from our research team conducted in Spring 2020 established that the immediate transition to online learning presented novel challenges for students with disabilities: students were unable to access previously established accommodations and there was a lack of information from Disability Resource Centers (DRCs) about adapting accommodations to online environments. In this study, we aimed to determine the extent to which these issues still were present 1 year later. In Spring 2021, we conducted a survey of 114 students with disabilities who were registered with the DRC and taking online science courses at a public research-intensive institution. We used our previous interviews with students to develop closed- and open-ended questions to assess the extent to which students with disabilities were being properly accommodated in their courses, document any new accommodations they were using, and elicit any recommendations they had for improving their experiences in online science courses. We used logistic regression to analyze the closed-ended data and inductive coding to analyze the open-ended data. We found that more than half of students with disabilities reported not being properly accommodated, and this was more likely to be reported by students who experienced new challenges related to online learning. When students were asked what accommodations they would have wanted, students often described accommodations that were being offered to some students but were not universally implemented. This study summarizes recommendations for making online science learning environments more inclusive for students with disabilities.

KEYWORDS disability, resources, accommodation, COVID-19, online education, online instruction, accommodations, disability

INTRODUCTION

Colleges and universities are legally mandated to support students with disabilities. Since 1973, students with disabilities have been legally protected from discrimination in institutions of higher education that receive federal funding, and the Americans with Disabilities Act (ADA) of 1990 further codified this into law (1, 2). Although the specifics of these accommodations are not outlined in the laws, the expectation is that students with disabilities will have equal access to higher education and that institutions will modify curricula or provide adequate accommodations so that students with disabilities can engage fully in their educational experiences (3–5).

Importantly, undergraduate science education has changed dramatically since the passing of this legislation (6–8). Chalkboards were replaced with transparencies, which have been replaced with PowerPoint slides. National recommendations for best practices in college education have promoted the transition from teacher-centered to student-centered learning, which changes the role of the student from passive listener to active contributor (9, 10). Technological advances have introduced personal handheld clicker devices for hundreds of students to simultaneously answer questions, microphone balls that can be thrown around the classroom, online platforms for discussions outside of class, and backchannel methods for students to ask questions without disrupting the class (11–13). Thus, the conception of a college science classroom in 1973 and 1990, when these key pieces of legislature were introduced (1, 2), is now in many ways inaccurate.

In the evolution of college science instruction, COVID-19 and the emergency transition to remote learning served as a catalyst for dramatic changes in how instruction is delivered to students and a redefinition of what may constitute a college learning experience (14). In March 2020, the need for

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social distancing sparked the enactment of remote learning almost universally (15, 16). Some courses were transitioned to a synchronous format with students interacting online with each other, while other courses provided students with asynchronous engagement with the materials at whatever time was most convenient for them, often through recorded lectures and online activities. The modality of online education has transformed what constitutes a class session from what happens in a physical classroom into a series of videos, online discussions, and online assignments. An important yet unanswered question is to what extent students with disabilities have been adequately supported after this transition. Has this evolution of learning also been accompanied by a concomitant evolution of accommodations and supports for students with disabilities?

To begin to answer this question, our research group conducted an exploratory interview study with 66 science, technology, engineering, and math (STEM) students with disabilities in June 2020, a few months after these students transitioned online due to COVID-19 (17). The interviews examined students' experiences immediately after the transition. We found that many students with disabilities were generally unable to access the accommodations that they used for their in-person science courses, such as reduced-distraction testing environments, additional test time, and note-taking that were still necessary for their full engagement in online courses. We also identified that the transition to online science instruction created novel challenges for students with disabilities that required additional accommodations, such as closed-captioned video lectures and adapted test proctoring, which were often not provided to students. While these findings were concerning, it is possible that they primarily resulted from the need to transition online so quickly and the lack of notice provided to instructors and support services. Once colleges and universities had sufficient time to plan ahead to modify curricula and design online courses, were appropriate accommodations in place so that students were adequately supported? To address this question, we surveyed students with disabilities registered with the Disability Resource Center (DRC) at a research-intensive institution about their experiences receiving accommodations in their online courses in March 2021, 1 year after these courses were transitioned to an online modality.

We wanted to explore the following research questions:

1. To what extent did science students with disabilities who reported new challenges in online learning report being properly accommodated?
 - a. What challenges were not accommodated for?
2. To what extent did receiving new accommodations affect science students' perceptions of whether they were properly accommodated?
 - a. What new accommodations did students receive?
3. What ideas do students have about how online science learning environments can be improved for students with disabilities?
 - a. What specific accommodations do students recognize as important for improving their learning experience?

METHODS

The study was completed with an approved Institutional Review Board (IRB) protocol #13434 from Arizona State University.

Recruitment

In Spring 2021, all instructors teaching undergraduate life science courses ($n = 127$) at a single research-intensive institution in the southwest United States that had transitioned their courses online due to COVID-19 were contacted and asked if they would be willing to send a survey to their students. Thirty-eight instructors (29.9% response rate) agreed to send out the survey to their students and 2,175 students completed the survey.

Survey

The survey generally asked students about their experiences taking online science courses (defined as life sciences, chemistry, physics, or geosciences) during the Spring 2021 semester. Students who identified as having a disability and reported that they registered with the Disability Resource Center were asked a specific set of questions. These questions explored the extent to which students with disabilities experienced challenges with being accommodated, the extent to which students with disabilities were properly accommodated, the extent to which students were given new accommodations, and the types of accommodations students reported they would have liked to receive in their online science courses during the Spring 2021 semester. For a copy of the survey questions analyzed, see the supplemental materials.

Data analysis

To what extent did students who reported new challenges in online learning report being properly accommodated? What challenges were not being accommodated for?

Students with disabilities were given closed-ended questions asking, "Has the online format of Spring 2021 online science courses led to any new challenges for your disability?" and "Given your disability, to what extent do you feel like you are currently being properly accommodated in your online college science courses?" We used descriptive statistics to determine the percentage of students who experienced new challenges and the percentage of students who reported being properly accommodated. To assess whether students who experienced new challenges were less likely to be properly accommodated compared with those who did not experience new challenges, we conducted a chi-square test. We confirmed that these data met the assumptions of chi-square and non-parametric tests (18).

To assess what new challenges were not being accommodated, students who reported both experiencing new challenges online and not being properly accommodated were given a closed-ended question asking them to select any challenges they experienced in their online college science courses. This list was created from an in-depth interview study of 66 students with disabilities conducted during Spring 2020, which identified disability-related challenges students experienced when learning science online during the COVID-19 pandemic. Students also had the opportunity to write in any additional challenges they experienced that were not listed. Descriptive statistics were used to determine the most commonly reported challenges. Few students wrote in any additional challenges and any responses that were written could be categorized in an existing broader category.

To what extent did receiving new accommodations affect students' perceptions of whether they were properly accommodated? What new accommodations did students receive?

All students were asked "Have you actually received any new or adapted accommodations from the Disability Resource Center (DRC) for your Spring 2021 online science courses?" which they answered with a binary yes/no response. Descriptive statistics were used to identify the percent of students who received new or adapted accommodations and a chi square test was used to determine whether receiving new accommodations was more commonly reported by students who experienced new challenges compared to those who did not. We also confirmed that these data met the assumptions of chi-square and non-parametric tests (18).

Additionally, we used logistic regression to determine whether students' perceptions of being properly accommodated was predicted by experiencing new challenges in online learning and receiving new accommodations. We regressed whether students reported being properly accommodated on whether they experienced new challenges in online learning and whether they received new accommodations. We included an interaction term that included whether students experienced new challenges and received new accommodations because we predicted that for students with new challenges, being properly accommodated may be particularly dependent on whether or not they received new accommodations. Prior to conducting the regression, we calculated the variance inflation factor (VIF) using the car package in R for each predictor variable in the model (model: properly accommodated ~ new challenges + receiving new accommodations) to determine that our predictor variables were not too closely related to one another to be included in the same model (19, 20). The VIF results confirmed that multicollinearity was not an issue. We also confirmed that there were no extreme outliers using the influence plot function in the car package in R (21).

Students who reported that they were given new accommodations were given a question asking them to describe any new accommodations they received in their online science courses. One researcher (S.E.B.) reviewed all

student responses to this question and developed an initial rubric of themes that was given to two other researchers (L.E.G. and D.C.P.) (see supplemental material). Owing to the small number of written responses, the two researchers coded each response independently then met to discuss each code, discussed any discrepancies, and coded to consensus (22, 23).

What ideas do students have about how online science learning environments can be improved for students with disabilities?

Students were asked to "Please tell us about any ideas you have for accommodations in the online science learning environment that you are not receiving that could be helpful to you." Once again, one researcher (S.E.B.) reviewed the student responses to this question and developed an initial rubric of themes that was given to two other researchers (L.E.G. and D.C.P.) (see supplemental material). The two researchers used the rubric to code each response independently then met to discuss each code, discussed any discrepancies, and coded to consensus (22, 23). In addition to identifying accommodations that students would have found helpful, the researchers coded challenges that students described if alleviated could improve their experiences in online science learning environments. In the reporting of the results, pseudonyms were given to students to maintain their anonymity.

RESULTS

One-hundred and 14 students with disabilities reported being registered with the Disability Resource Center. This represents 5.2% of the students who completed the initial survey in their courses (see Table 1).

Finding 1: More than half of students with disabilities reported not being properly accommodated during the Spring 2021 semester, which was more likely to be reported by students who experienced new challenges related to online learning.

Of the 114 students registered with the DRC who answered the question asking whether they felt they were currently properly accommodated in their online science courses given their disability, 47.4% ($n=54$) reported that they were properly accommodated and 51.8% ($n=59$) reported that they were not (one student declined to state). Students were also asked whether they experienced new challenges related to their disability in the novel context of online learning; 60.5% ($n=69$) reported experiencing new challenges, while 29.8% ($n=34$) did not (11 students declined to state their answer to this question). Sixty-six percent of students who experienced new challenges online perceived that they were not properly accommodated, while 23.5% of students who did not experience new challenges online perceived that they were not properly accommodated; students who experienced new challenges were significantly more likely to report not being properly accommodated ($\chi^2 = 14.9$, $P < 0.001$, Fig. 1).

Students who experienced new challenges and did not feel properly accommodated ($n=45$) were asked to select challenges

TABLE 1
Demographics of students who completed survey, including disability types

(n = 114)	n (%)
Disability type ^a	
Mental health	98 (86.0)
Learning	39 (34.2)
Chronic health condition	29 (25.4)
Vision	3 (2.6)
Physical	7 (6.1)
Hearing	5 (4.4)
Other	28 (24.6)
Gender	
Man	12 (10.5)
Woman	88 (77.2)
Non-binary	12 (10.5)
Decline to state	2 (1.8)
Race/ethnicity	
Asian/Pacific Islander	11 (9.6)
Black/African American	3 (2.6)
Latinx	15 (13.2)
Native American	1 (0.9)
White	74 (64.9)
Other	6 (5.3)
Decline to state	4 (3.5)
College generation status	
First generation	44 (38.6)
Continuing generation	67 (58.8)
Decline to state	3 (2.6)
Academic yr in school	
First yr	23 (20.2)
Second yr	31 (27.2)
Third yr	26 (22.8)
Fourth yr	22 (19.3)
Fifth yr or more	11 (9.6)
Decline to state	1 (0.9)

^aStudents could select multiple disabilities on the survey. Therefore, percentages add up to greater than 100%.

that they experienced from a list developed from our previous interview study of students with disabilities engaged in online courses. One year after transitioning to online instruction, the most common challenges that students identified in the online learning environment were video proctoring software challenges (62.2%), accessing distraction-free testing (55.6%), the requirement for individuals to spend additional time on their computers (53.3%), instructors not recognizing their accommodation (48.9%), and instructors forgetting a student's accommodation (42.4%). See Fig. 2 for additional challenges and the percentage of students who reported each.

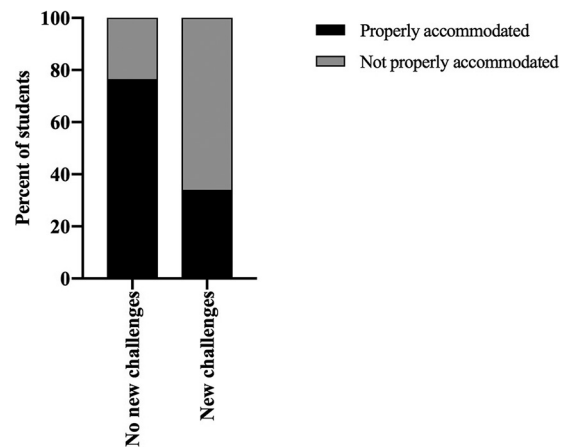


FIG 1. Percentage of students who reported being properly accommodated in their online college science course based on whether they have experienced a new disability-related challenge in online learning. Students who experienced new challenges ($n = 69$) and students who did not experience new challenges ($n = 34$) are separated along the x axis. Students who experienced new challenges were significantly more likely to report not being properly accommodated ($\chi^2 = 14.9$, $P < 0.001$).

Finding 2: Receiving new accommodations did not affect students' perceptions of whether they were properly accommodated in the online learning environment.

Nearly 38% of students ($n = 43$) reported receiving new accommodations in response to the transition to online courses; students who reported new challenges were more likely than students who did not to report receiving such accommodations ($\chi^2 = 10.1$, $P = 0.001$). We hypothesized that receiving accommodations would predict whether a student felt properly accommodated, especially among students who experienced novel challenges while learning science online. However, when we regressed whether students perceived they were properly accommodated on whether they experienced novel challenges and whether they received new accommodations, accounting for an interaction effect, we found that whether students received new accommodations did not predict whether a student felt they were properly accommodated (Table 2). The only significant predictor was whether a student experienced new challenges learning science online. This indicates that these novel accommodations were not necessarily properly addressing the new challenges emerging for students with disabilities in online science courses.

Students who reported receiving new accommodations ($n = 43$) were asked an open-ended question about what new accommodations they were receiving. The most common accommodations that students were receiving 1 year after the transition to online instruction were additional extended testing time (46.5%), flexible assignment deadlines (27.9%), recorded lectures and class meetings (9.3%), flexible class attendance (7.0%), and online note-taking services (7.0%). See Fig. 3 for the new accommodations that students reported and the percentage of students who reported each accommodation.

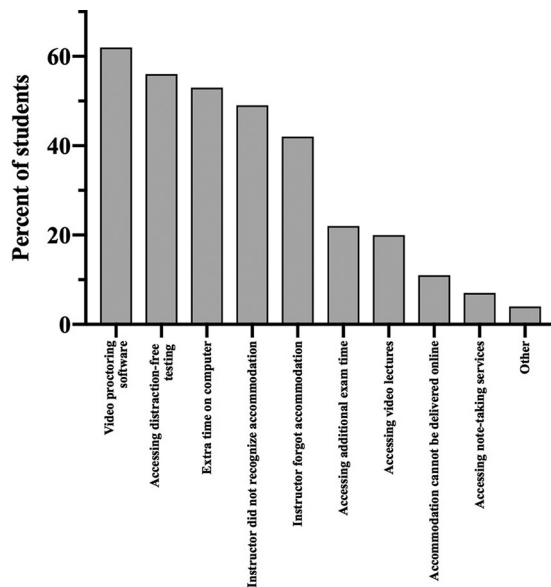


FIG 2. The percent of students who indicated they experienced each challenge during their online college science courses ($n = 45$).

Finding 3: When discussing how to improve online science education for students with disabilities, some students identified that additional accommodations were needed, while others honed in on challenges related to delivering accommodations that needed to be mitigated.

We asked all students who reported not being properly accommodated about their ideas for accommodations in online science learning environments that they are not receiving and would find helpful. Interestingly, students mentioned an array of accommodations that other students were already receiving but that had not been offered to all students (even students with the same disability type). For example, students mentioned that they wanted attendance flexibility, having flexible due dates for assignments, or extended deadlines—all accommodations that other students reported receiving at the same institution. The accommodations and percentage of students who reported whether an accommodation could have been helpful can be found in Fig. 4.

Interestingly, many students chose not to write about a specific accommodation in response to the question asking them what would have been helpful given their experience learning science online and instead some expressed challenges

that they encounter, which if alleviated, would have improved their experience. For example, some students indicated that it was up to the instructor's discretion about whether to provide an accommodation or accept a particular student's request for an accommodation.

"I do respect professors' wishes and by no means mean this in a disrespectful way, but the DRC only saying students can receive certain accommodations if the instructor says yes, and having the DRC advisors questioning your accommodation requests is really emotionally draining in itself." - Morgan (new challenges, no new accommodations)

"I want professors to recognize that I am supposed to get extensions on assignments. It's part of my accommodations and still some [professors] don't provide it." - Gaby (new challenges, new accommodations)

Instructors deciding whether particular accommodations are appropriate for students is concerning given that instructors do not receive any training about student disabilities or what could be an appropriate accommodation (24, 25). Even instructors who had significant teaching experience were likely inexperienced teaching online.

It appeared that some instructors had unrealistic expectations with respect to how far in advance a student with a disability could ask for an extension, which highlights a mismatch in expectations and knowledge about certain disabilities.

"I have been asked to provide warnings in advance when my disability will cause me to need an extension, but my disability doesn't always give me an itinerary and I am not able to predict when I will need help. As a result, I have had repeatedly missed assignments and I have been told [by instructors] I should have planned ahead. Professors need to understand that many of us cannot plan when our disability will affect us." - Kyle (new challenges, new accommodations)

Further, there seemed to be disconnects in what instructors were told to do by the DRC and what they knew how to do.

"There needs to be updates in professor knowledge about extending test times when courses are online. I've had many professors struggle with this or do it incorrectly." - Lauren (no new challenges, no new accommodations)

TABLE 2
Regression output for challenges and accommodations

Variable	B	SE B	z	P
(Intercept)	1.34	0.46	2.93	0.003
New challenges	-2.26	0.59	-3.82	<0.001
New accommodations	-0.94	1.02	-0.92	0.36
New challenges + New accommodations	1.42	1.14	1.24	0.21

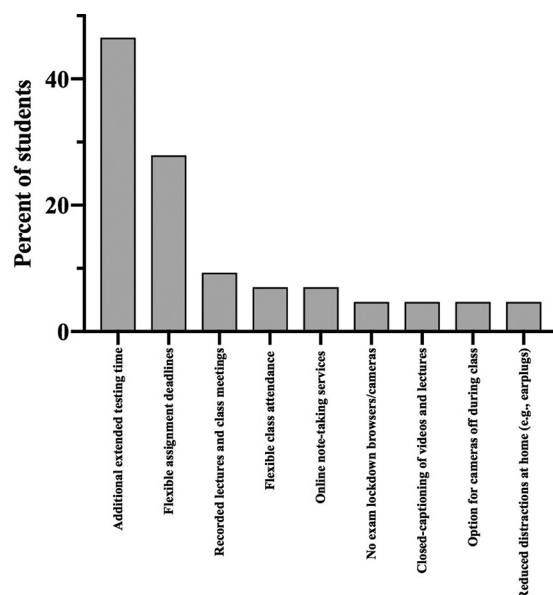


FIG 3. New accommodations received by students ($n=43$). Additional themes reported by $<5\%$ of students include: instructors share slides prior to class, work in smaller (breakout) groups, and the use of clear masks by instructor.

In sum, while additional accommodations may improve the extent to which students with disabilities feel properly accommodated, the substantial challenges some encountered when trying to access existing accommodations shed light on the nuance of accommodation delivery.

DISCUSSION

This study explored how students with disabilities registered with the DRC were accommodated in their online instruction 1 year after the transition to online learning due to COVID-19. Although institutions and instructors had almost a year to identify challenges and accommodations for students with disabilities online, we found that many students with disabilities were still not being properly accommodated in their online courses. Our finding that students with new challenges received new accommodations, but that they did not perceive that they were properly accommodated, reveals that these new accommodations may not be sufficient.

It was perplexing that students with the same type of disability were not offered similar accommodations. Although the same disabilities can present differently and result in unique challenges (26, 27), this highlights the lack of standardization of accommodations, particularly in response to novel teaching environments (28). One of the major issues that we identified was the lack of accountability on the part of instructors. Institutions are legally mandated to provide accommodations to students with disabilities and the DRCs contact instructors about what the proper accommodations would be for each student (4, 28). However, there is often very little follow-up to see if an instructor has implemented the accommodation.

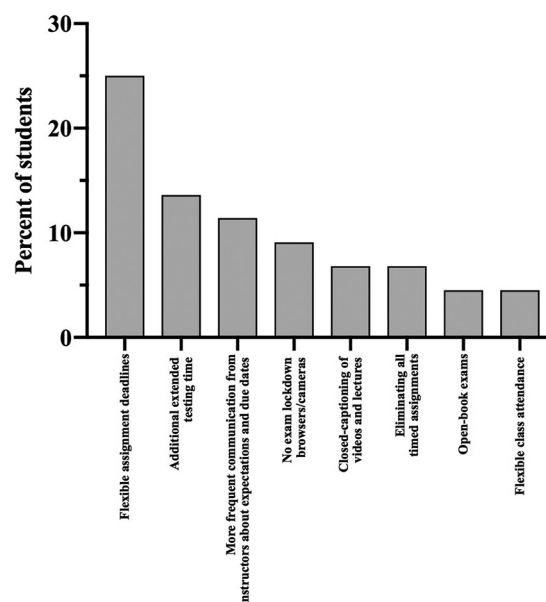


FIG 4. Accommodations that students with disabilities reported would have been helpful to them when learning science online ($n=44$). Additional themes reported by $<5\%$ of students include: online note-taking services, recorded lectures and class meeting, work in smaller breakout groups, option for cameras off during class, reduced distraction home environment (e.g., earplugs), instructors share slides prior to class, socially distant testing centers on campus, and requests for printed materials.

Further, if an instructor is unwilling to provide an accommodation, then it puts the student in a tenuous position where they are forced to self-advocate in ways that may jeopardize their relationship with the instructor and simultaneously any subjective grading in the course (29–31).

We consider this to be a systemic problem due to the interconnectedness of how students with disabilities are supported (5, 28). Students with disabilities have to bring their diagnosis to the DRC and that DRC contacts the instructor about the appropriate accommodations (32, 33). There is not typically an opportunity for an instructor to share with the DRC what changes they have made to their courses, or what accommodations might be most appropriate given their instructional strategies (28). If a student experiences something challenging in their course they can address it with the DRC, but they may not receive the accommodation until weeks or months into the term. The confidentiality of student disability means that instructors know that a student has a disability, but do not know what that disability is, making it difficult for instructors and students to work together to solve a problem without the involvement of the DRC (25, 34). If students self-advocate with the instructor, they may risk disclosing their identity and suffer unconscious bias or discrimination for their disability (35–37). Thus, the compounded challenges of DRCs not being experts in novel pedagogies, instructors not being experts in disabilities and disability supports, and students needing confidentiality for their disability means that often students with disabilities are not adequately supported in

TABLE 3
Proposed recommendations for fully accommodating students with disabilities in online science learning environments

Recommendation 1: Increase DRC staff and trainings to support pedagogical innovations
Recommendation 2: Require training for instructors to better understand and support students with disabilities
Recommendation 3: Monitor instructor compliance with disability accommodations and sanction non-compliance
Recommendation 4: Create communication pathways between instructors and DRCs to discuss teaching strategies
Recommendation 5: Encourage institutions to share resources for better supporting students with disabilities
Recommendation 6: Research and development of high-quality and evidence-based online accommodations

innovative learning spaces (29, 38, 39). Further, DRCs are understaffed, instructors developing online courses for the first time are often overworked and under a time crunch, and students are dealing with additional financial and mental health challenges of the pandemic, highlighting the systemic nature of this problem (40, 41).

So, what are the solutions? First, institutions must better support their DRCs through increased staff and training about pedagogical innovations. This requires a financial investment, but this is critical for institutions to meet their legal obligations for students with disabilities. Second, institutions need to require instructors to better understand the needs and supports for students with disabilities. Similar to trainings required for fire safety or data management, instructors could be required to complete an online training to help equip them to better understand students with disabilities and their responsibilities as instructors (e.g., Access Zone). Third, institutions need to monitor instructor compliance with disability accommodations and sanction instructors who did not comply. Fourth, institutions can help create communication pathways between instructors and DRCs so DRCs have a better idea of what types of teaching strategies are being used in an instructor's class (28). This could be particularly helpful for large-enrollment courses to avoid the need for multiple students with disabilities individually self-advocating. Fifth, instead of each institution acting in isolation, shared networks of institutions and individuals interested in better supporting students with disabilities could help provide resources for students, instructors, and DRCs. Sixth, it is critical that funding and time is spent in the research and development of high-quality and evidence-based online accommodations that can become standardized, similar to the common suite of accommodations for in-person courses (which likely needs to be updated as per the first recommendation). These recommendations have been summarized and provided as a table that can easily be distributed to DRCs, instructors, and other support staff involved in accommodating students with disabilities in novel learning environments (Table 3). Notably, these recommendations have been created based on only the perspectives of students; instructors and disability resource center staff may have unique perspectives related to these recommendations, including potential insights into university constraints and affordances that could influence these recommendations.

Limitations

This work was conducted at a single research-intensive institution and would benefit from being replicated at other institution types (42). Notably, all participants who participated in this study were registered with the DRC. However, being registered requires a diagnosis and we know that health care is disproportionately unavailable to low-income individuals and communities of color (43). As such, the number of students with disabilities who reported not being properly accommodated when learning science online is likely an underestimate of the total number of students with disabilities who feel this way. We also note that these data come from only the perspectives of students; we encourage future research to consider the experiences of other stakeholders, such as instructors and DRC staff, who are involved in educating and accommodating students with disabilities in online courses (28).

SUPPLEMENTAL MATERIAL

Supplemental material is available online only.

SUPPLEMENTAL FILE 1, PDF file, 0.4 MB.

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REFERENCES

1. ADA. Americans with Disabilities Act of 1990. 328, 101–336. 1990.
2. Section 504. Section 504 of the Rehabilitation Act. 34 1973.

3. Eckes SE, Ochoa TA. 2005. Students with disabilities: transitioning from high school to higher education. *Am Second Educ* 6–20.
4. Madaus JW. 2011. The history of disability services in higher education. *New Dir High Educ* 2011:5–15. <https://doi.org/10.1002/he.429>.
5. Meeks LM, Jain NR. 2015. The guide to assisting students with disabilities: equal access in health science and professional education. Springer Publishing Company, New York, NY.
6. Ali W. 2019. The efficacy of evolving technology in conceptualizing pedagogy and practice in higher education. *HES* 9:81–95. <https://doi.org/10.5539/hes.v9n2p81>.
7. Brubacher JS, Rudy W. 2017. Higher education in transition: a history of American colleges and universities. Routledge, New York, NY.
8. Englund C, Olofsson AD, Price L. 2017. Teaching with technology in higher education: understanding conceptual change and development in practice. *High Educ Res Dev* 36:73–87. <https://doi.org/10.1080/07294360.2016.1171300>.
9. American Association for the Advancement of Science. 2011. Vision and change in undergraduate biology education: a call to action. AAAS, Washington, DC.
10. Freeman S, Eddy SL, McDonough M, Smith MK, Okoroafor N, Jordt H, Wenderoth MP. 2014. Active learning increases student performance in science, engineering, and mathematics. *Proc Natl Acad Sci U S A* 111:8410–8415. <https://doi.org/10.1073/pnas.1319030111>.
11. Burns M. 2017. # FormativeTech: meaningful, sustainable, and scalable formative assessment with technology. Corwin Press, London, UK.
12. Misseyni A, Papadopoulou P, Marouli C, Lytras MD. 2018. Active learning strategies in higher education. Emerald Publishing Limited.
13. Smith MK, Jones FHM, Gilbert SL, Wieman CE. 2013. The Classroom Observation Protocol for Undergraduate STEM (COPUS): a new instrument to characterize university STEM classroom practices. *CBE Life Sci Educ* 12:618–627. <https://doi.org/10.1187/cbe.13-08-0154>.
14. Aguilera-Hermida AP. 2020. College students' use and acceptance of emergency online learning due to COVID-19. *Int J Educ Res Open* 1:100011. <https://doi.org/10.1016/j.ijedro.2020.100011>.
15. Baker M, Hartocollis A, Weise K. 6 March 2020. First US colleges close classrooms as virus spreads. More could follow. *New York Times*, New York, NY.
16. Hartocollis A. 11 March 2020. An 'eviction notice': chaos after colleges tell students to stay away. *New York Times*, New York, NY.
17. Gin LE, Guerrero FA, Brownell SE, Cooper KM. 2021. COVID-19 and undergraduates with disabilities: challenges resulting from the rapid transition to online course delivery for students with disabilities in undergraduate STEM at large-enrollment institutions. *CBE Life Sci Educ* 20:ar36. <https://doi.org/10.1187/cbe.21-02-0028>.
18. McHugh ML. 2013. The chi-square test of independence. *Biochem Med (Zagreb)* 23:143–149. <https://doi.org/10.11613/bm.2013.018>.
19. Craney TA, Surles JG. 2002. Model-dependent variance inflation factor cutoff values. *Qual Eng* 14:391–403. <https://doi.org/10.1081/QEN-120001878>.
20. Fox J, Weisberg S. 2018. An R companion to applied regression. Sage Publications, Los Angeles, CA.
21. Fox J, Friendly GG, Graves S, Heiberger R, Monette G, Nilsson H, et al. 2007. The car package. *R Found Stat Comput*.
22. Bradley EH, Curry LA, Devers KJ. 2007. Qualitative data analysis for health services research: developing taxonomy, themes, and theory. *Health Serv Res* 42:1758–1772. <https://doi.org/10.1111/j.1475-6773.2006.00684.x>.
23. Richards KAR, Hemphill MA. 2018. A practical guide to collaborative qualitative data analysis. *J Teach Phys Educ* 37:225–231. <https://doi.org/10.1123/jtpe.2017-0084>.
24. Gokool-Baurhoo N, Asghar A. 2019. "I can't tell you what the learning difficulty is": barriers experienced by college science instructors in teaching and supporting students with learning disabilities. *Teach Educ* 79:17–27. <https://doi.org/10.1016/j.tate.2018.11.016>.
25. Love TS, Kreiser N, Camargo E, Grubbs ME, Kim EJ, Burge PL, et al. 2014. STEM faculty experiences with students with disabilities at a land grant institution. *J Educ Train Stud* 3:27–38.
26. Brown S. 2002. What is disability culture? *Disabil Stud Q* 22.
27. Shakespeare T. 2006. The social model of disability. *Disabil Stud Read* 2:197–204.
28. Gin LE, Guerrero FA, Cooper KM, Brownell SE. 2020. Is active learning accessible? Exploring the process of providing accommodations to students with disabilities. *CBE Life Sci Educ* 19:es12. <https://doi.org/10.1187/cbe.20-03-0049>.
29. Marshak L, Van Wieren T, Ferrell DR, Swiss L, Dugan C. 2010. Exploring barriers to college student use of disability services and accommodations. *J Postsecond Educ Disabil* 22:151–165.
30. Pfeifer MA, Reiter EM, Hendrickson M, Stanton JD. 2020. Speaking up: a model of self-advocacy for STEM undergraduates with ADHD and/or specific learning disabilities. *Int J STEM Educ* 7:1–21.
31. Pfeifer MA, Reiter EM, Cordero JJ, Stanton JD. 2021. Inside and out: factors that support and hinder the self-advocacy of undergraduates with ADHD and/or specific learning disabilities in STEM. *CBE Life Sci Educ* 20:ar17. <https://doi.org/10.1187/cbe.20-06-0107>.
32. Ben-Simon A, Beyth-Marom R, Inbar-Weiss N, Cohen Y. 2008. Regulating the diagnosis of learning disability and the provision of test accommodations in institutions of higher education. In 34th Conference of the Association for Educational Assessment, Cambridge, UK [Google Scholar].
33. Lovett BJ, Nelson JM, Lindstrom W. 2015. Documenting hidden disabilities in higher education: Analysis of recent guidance from the Association on Higher Education and Disability (AHEAD). *J Disabil Policy Stud* 26:44–53. <https://doi.org/10.1177/1044207314533383>.
34. Dunn C, Rabren KS, Taylor SL, Dotson CK. 2012. Assisting students with high-incidence disabilities to pursue careers in science, technology, engineering, and mathematics. *Interv Sch Clin* 48:47–54. <https://doi.org/10.1177/1053451212443151>.
35. Fine M, Asch A. 1988. Disability beyond stigma: social interaction, discrimination, and activism. *J Soc Issues* 44:3–21. <https://doi.org/10.1111/j.1540-4560.1988.tb02045.x>.

36. Lyons BJ, Volpone SD, Wessel JL, Alonso NM. 2017. Disclosing a disability: do strategy type and onset controllability make a difference? *J Appl Psychol* 102:1375–1383. <https://doi.org/10.1037/apl0000230>.
37. Santuzzi AM, Waltz PR, Finkelstein LM, Rupp DE. 2014. Invisible disabilities: unique challenges for employees and organizations. *Ind Organ Psychol* 7:204–219. <https://doi.org/10.1111/iops.12134>.
38. Dowrick PW, Anderson J, Heyer K, Acosta J. 2005. Postsecondary education across the USA: Experiences of adults with disabilities. *J Vocat Rehabil* 22:41–47.
39. Kyvik S. 2015. Changes in funding university research: Consequences for problem choice and research output of academic staff p 387–412. In Enders J, Ben Jongbloed B (ed), *Public-private dynamics in higher education*. Verlag, Bielefeld, Germany.
40. Adedoyin OB, Soykan E. 2020. Covid-19 pandemic and online learning: the challenges and opportunities. *Interact Learn Environ*. <https://doi.org/10.1080/10494820.2020.1813180>.
41. Huckins JF, daSilva AWW, Wang W, Hedlund E, Rogers C, Nepal SK, Wu J, Obuchi M, Murphy EI, Meyer ML, Wagner DD, Holtzheimer PE, Campbell AT. 2020. Mental health and behavior of college students during the early phases of the COVID-19 pandemic: Longitudinal smartphone and ecological momentary assessment study. *J Med Internet Res* 22:e20185. <https://doi.org/10.2196/20185>.
42. Schinske JN, Balke VL, Bangera MG, Bonney KM, Brownell SE, Carter RS, et al. 2017. Broadening participation in biology education research: engaging community college students and faculty. *Am Soc Cell Biol*.
43. Artiga S, Garfield R, Orgera K. 2020. Communities of color at higher risk for health and economic challenges due to COVID-19. The Henry J. Kaiser Family Foundation, San Francisco, CA.