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Getting Started Teaching an Undergraduate Engineering Laboratory

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Abstract

A group of six faculty from laboratory and design courses at a large public university in the Midwest United States recently started a community of practice (CoP) for laboratory and design instructors. The goal of the CoP was to share resources and generate ideas for improving laboratory and design courses after the pandemic. We realized that many of us faced similar challenges during that time as we moved our courses to alternate formats and that we would have benefited from being able to share ideas and collectively brainstorm solutions. Since then, the CoP has grown to almost 40 members representing most of the departments in the college. We have hosted workshops, coffee chats, and other events to facilitate the exchange of ideas between members. Some of the popular topics have been facilitating teamwork; improving inclusivity and belonging; and training laboratory staff. These events have led to us curating resources in these areas. The purpose of this Tips and Tricks paper is to share these resources about teaching laboratory and design courses that we have collected within the CoP with the broader engineering education community, especially for instructors who have recently started teaching a course with a laboratory or large design project.

Introduction

Laboratory experiences are a form of experiential learning and a common component of undergraduate STEM education. They provide valuable experiences for students, who benefit by connecting the theories learned in class to practice in the laboratory. In the laboratory, students also have opportunities for design, problem solving, and exposure to real-world issues that are not usually present in traditional hand-written homework assignments [1]. However, to operate effective laboratories, engineering departments and colleges must address challenges such as budget constraints, space limitations, class size, and limited teaching resources [2], [3], [4], [5]. The COVID-19 pandemic has only exacerbated these issues and added more with the need for online and remote learning experiences that still provide students with the benefits of experiential learning [6], [7], [8]. Additionally, teaching a laboratory course for the first time can be daunting for both new and experienced faculty.

In the spring of 2021, we recognized that the pandemic had forced changes in lab and design courses and that we as faculty had been largely making these changes in isolation. However, we also know that collaboration increases creativity and outcomes in design. It was discovered that we all faced many of the same challenges despite teaching very different courses and labs. Therefore, in the fall of 2021 we formed a community of practice (CoP) for lab and design instructors at the University of Illinois Urbana-Champaign [9]. While building this CoP, we leveraged the Networked Improvement Communities (NICs) framework to facilitate members (instructors) from different contexts (departments, class sizes, student levels) collaborating on developing best practices across all courses toward a shared goal: improving college lab course experiences for instructors and students. The NICs are both learning and design communities grounded in the idea of "learning through doing" [10]. NICs and members are guided by several structuring agents: (1) common targets and ambitious measurable goals, (2) a mapped problem space and shared language, and (3) common inquiry protocols [11]. The team employed the NIC framework to guide and structure our CoP to accelerate progress [12] on improving laboratory courses by sharing information and collaboratively addressing issues that arise. We have found that the CoP has been helpful for both new and experienced faculty to have a network of support.

The current CoP is organized by a group of eight specialized faculty. Our backgrounds are summarized in Table 1. In addition to organizing CoP events, the members of the organizing team also collaborate on research projects across our lab and design courses. We have recruited 32 additional members into the CoP; the available demographics are summarized in Table 2.

During the CoP events, instructors from across the college have shared ideas, collaborated on improvements, and helped each other find solutions to common problems faced in laboratory courses. Our events focus on creating spaces for members to share ideas and learn from one another. The event formats include coffee chats, lightning talks, workshops, and pre-semester work-ins. Lightning talks and workshops are our most formal events. The lightning talks include 4 speakers that present an idea or a problem for 5 minutes each and the presenters spend the rest of the hour discussing each idea further. Workshops are more formal teaching opportunities for members or sometimes all of the new faculty in the college. Coffee chats and the pre-semester work-ins are less formal. Both are scheduled times for members to come together and chat with a very limited agenda. We host a coffee chat and a workshop or lightning talk each month of the semester and a pre-semester work-in before each semester. The most common topics in these events are facilitating teamwork, improving inclusivity and belonging, preparing instructional staff, and sharing lessons learned when the unexpected happens in a lab. In each section below, we summarize the key takeaways and helpful resources we have collected related to each of these four areas to share with other laboratory instructors.

Table 1 - CoP Organizing Team Demographics and Background

Title, Department	Race	Gender	Years of Teaching Experience	Types of Lab and Design Courses Taught
Teaching Associate Professor, Bioengineering	White	Female	8.5 years as a faculty member and 1.5 years as a Lab TA	Third-year Bioinstrumentation Laboratory; Fourth-year required Dynamic Systems and Controls Laboratory; Third-year Control Systems Laboratory
Teaching Assistant Professor, Bioengineering	White	Woman	5 years as a faculty member	Design courses in bioengineering and robotics
Teaching Assistant Professor, Bioengineering	White	Female	3 years as a faculty member	Third-year Quantitative Physiology Laboratory (required); Upper-level Biofabrication Laboratory (elective)

Title, Department	**Race**	**Gender**	**Years of Teaching Experience**	**Types of Lab and Design Courses Taught**
Teaching Professor, Electrical and Computer Engineering	White	Male	20 years as a faculty member and 7 years as a graduate teaching assistant	Fourth-year Digital Communications Lab (with design), Fourth-Year Senior Design Lab, Fourth-Year Integrated Circuit Fabrications Lab, First-Year Exploring Digital Information Technology (with design lab for non-engineers), First-Year Introduction to Electronics (with design lab)
Teaching Associate Professor, Electrical and Computer Engineering	Asian	Male	12 years as a faculty member, 4 years as a graduate teaching assistant (for Lab), two semesters as a visiting lecturer	Fourth year
Teaching Assistant Professor, iSchool	White	Male	10 years of adjunct social science teaching, 1 year design teaching	Undergraduate large-enrollment database 1
Senior Lecturer, Materials Science and Engineering	White	Female	8 years as a faculty member, 3 summers of lab instruction as research staff, plus one semester as lab TA	Two third-year laboratory classes (required); graduate-level transmission electron microscopy lab
Teaching Assistant Professor, Physics	White	Female	4 years as a faculty member and 6 years as a Lab TA; 3 years K-12 physical science teaching	Large-enrollment introductory courses: College Physics 1 and 2; University Physics 1 and 2

Table 2 – Available Demographics of Recruited CoP Members

University Role	• 19 Specialized Faculty (includes all ranks of teaching and clinical professor tracks and lecturer track) • 11 Tenure-Stream Faculty (all ranks) • 2 Academic Professionals
Rank	• 18 Assistant (all professor tracks) • 5 Associate (all professor tracks) • 3 Full (all professor tracks) • 1 Lecturer • 3 Senior Lecturer
Teaching Experience	0 – 25 years
Departments	10
Courses Taught	~60

Facilitating Teamwork

Having students work in groups in laboratory and design courses can be useful for both logistical and pedagogical purposes. While tasks that students might complete in these courses meet the criteria for being well-suited to group work [13], the flexibility and nonlinearity of design tasks can mean that instructors need to support teamwork development to prevent or mediate problems [14]. It is therefore not surprising that facilitating fair teamwork has been a popular topic in CoP workshops and meetings; a subgroup of our CoP formed a one-semester working group to focus on this challenge in a variety of laboratory and design course settings. Conversations about the different courses represented in the working group revealed how the logistics of teamwork in classrooms are highly context dependent. There is no single “right way” to set up and run student groups. In this section, we highlight some considerations that may be useful.

Know your students

When considering how to group students and how to support the success of student teams, what is “best” will depend on several factors of your course population. Are your students new to campus or more experienced? How established are their social networks? Does your course serve students in one major or a diverse group of majors? Do your students feel like they belong in this subject? What is the demographic balance of your course? What working styles, skill levels, and preferences are represented across your classroom? General advice includes setting up groups so that minoritized students are not isolated and trying to represent multiple skills in each group. It is unclear whether it is advantageous to represent multiple skill levels in each group, as any grouping by ability will benefit some students over others [15].

Here are two examples of how course populations may be taken into consideration:

- A large-enrollment STEM course taken by non-engineering students who are typically juniors or seniors, and who are about 60% female. Lab instructors allow students to self-assemble into groups so they can use their existing social networks to feel more comfortable in the classroom.
- An engineering lab course taken by first and second-year students. Approximately half of the students are majors in the course's department, and the other half come from one other department. Approximately 70% are male. Lab instructors prefer to pre-assign groups to make sure that women are not isolated and to represent the skill sets of both majors in each group.

Know your capacity

The choices instructors make are limited by their personal capacity and the capacity of any course staff. It is more manageable for instructors of smaller classes to organize group formation, monitor team functioning, and respond to group member concerns. Instructors of larger courses, or courses with multiple course staff members, may find it useful to utilize tools to ease the group assignment and/or feedback process. CATME [16] is a useful, if long, survey tool that can sort students into groups. There also exist other reflective surveys and writing exercises that serve a dual-purpose of communicating valuable information to instructors while supporting student reflection on their team dynamics (see examples in [17]). Our experience is that utilizing such reflective tools in classroom activities may also equip instructors to become aware of and respond to the team dynamics that are actively occurring in the classroom.

Know your goals

How groupwork is implemented should be tied closely to the instructor's purpose for having students work in teams. If the goal is to manage course staff workload and to facilitate a large number of students in a limited number of workstations, it may be appropriate to make choices that limit disruptive conflict and prioritize progress over equitable student experiences. We encourage instructors to consider "learning to work in a team" as an important outcome of their courses. There are various resources and scripts available to help students express expectations, set useful norms, and value each other's perspectives (for example, Sections 3, 4 and 6 of the Departmental Action Team Digital Toolkit [18]). Because the most effective teams can navigate conflict without it being disruptive [19], members of our working group have committed to adding course activities that would (1) equip students to be reflective teammates with an orientation towards repair and (2) position instructors as partners in group repair and success. Team contracts can be useful tools to start the conversation, provided they include a component that prepares students for conflict (a good example can be found in [20]). We have also found that it is important to revisit the conversation with reflection and remediation after student teams have worked together long enough for patterns to begin to emerge. Details about the implementation of these activities and the activity documents are presented in [21].

Improving Inclusion and Belonging

When preparing to teach a laboratory course, implementing practices that enhance inclusion and belonging for students can impact retention, confidence, and achievement [22], [23]. In this section, we offer suggestions for promoting these practices in laboratory courses. These suggestions were derived from lessons shared in CoP meetings and workshops over three years.

Syllabus

Improving inclusivity and belonging in lab classes starts even before students come to the classroom. How instructors organize classroom materials can signal to students the environment that the lab will create. Faculty can set the stage for an inclusive classroom by including syllabus statement(s) and an instructor learning philosophy. These sections of the syllabus connect students with resources and make clear the instructor's commitment to creating an inclusive environment. When students come to class on the first day, spending time reviewing these items demonstrates their importance to the class. If you have a syllabus quiz, including questions on these items can also reinforce their importance to students.

Syllabus statements can include a land grant acknowledgement, a policy on academic integrity, family education rights and privacy act (FERPA), mental health resources, disability resources and services, policies on religious observances, and sexual misconduct reporting obligations. Each institution may have their own recommended syllabus statements and instructors can inquire about recommended or required statements. An example instructor philosophy is included below.

> *Your success and development throughout this course is my priority. Below you will find several beliefs that are paramount to achieving this goal:*
>
> - *All students are valuable and important; this course is designed to be accessible and inclusive.*
> - *Student-centered active learning is key to mastery and internalization of professional skills.*
> - *Everyone has the right and ability to be successful in this course.*
> - *Transparency and authenticity are essential to effective communication and collaboration.*
> - *An atmosphere of trust and safety is necessary in order to benefit from the varied social and cultural perspectives addressed in this course.*
> - *Your involvement in course design is critical. In preparation for this course, learning theories were used as the basis for course design.*

Student feedback

After presenting these syllabus statements to students, instructors can solicit input, therefore signaling their stake in cultivating an inclusive learning environment. Before the second week of class, request anonymous feedback from students. Let students know the anonymous form will remain open for the remainder of the semester and that they can raise concerns to your attention either directly or through the anonymous form at any point. Instructors can also solicit feedback on student preferences before the first day of class. Questions may include:

- What name or nickname do you use? What pronouns do you use? Can you provide a phonetic spelling or a recording of your name?
- How inclusive have the previous lab and design courses you've taken felt? (e.g., using a Likert scale) What do you think the instructors could have done to create a more inclusive learning environment?
- Is there anything I can do to create a more inclusive learning environment?
- Do you have any concerns about your collaboration experience in this course?

Identity in the lab

Once in the lab, there are practices instructors can implement to help students see themselves as engineers and scientists. Using students' names increases confidence and feelings of belonging, while also helping to make a large class feel smaller and more personal. Students can use magnetic name signs to label their lab benches or workspaces so instructors and TAs can easily recall names. Using photo rosters is another tool for instructors to learn student names.

In pre-lab assignments and readings, including examples from authors and engineers with diverse backgrounds can help students to identify with the course content. When examples are not available, explicitly addressing the absence of representation and reasoning can be a way of recognizing the lack of diversity in science and engineering. When the work of diverse scholars from the past is not available, using student "favorites" can be a way to bring students voices and identities into the future of course content. A CoP member uses information gathered from the students at the beginning of the semester to create scenarios in the lab by polling students about their "favorite things."

Normalize mistakes and imperfect outcomes

Including students in lab and design processes by demonstrating a task from start to finish helps to illustrate real-life usage of material and experimentation in a way that well-structured examples from textbooks do not. It is important for instructors and TAs to model that not everything goes correctly the first time by showing their mistakes and how to work through them. This practice teaches students how to adapt to circumstances and learn from common errors. During class, instructors can write code, build a circuit on a breadboard, analyze data, design in CAD software, or solve dilution calculations in real time on the whiteboard or a tablet so that students can observe imperfection and correction and still feel a sense of belonging despite failure or setbacks.

One way that this practice can be directly applicable is through writing. Many lab assignments ask students to complete a lab report; however, this may not be a skill that comes as easily to an undergraduate engineering student as it does to the course instructor or TA. Writing is developed through many instances of practice and revision. It is helpful for students to see instructors model this process and provide realistic examples of this nonlinear process. A student who has never engaged in research may only see the end result of a published paper, but not realize that the manuscript likely went through multiple drafts and rounds of revision before publishing. Demonstrating the imperfection of the writing process can also help students to adopt a growth mindset, while providing "low stakes" opportunities for student correction (through revision and resubmission of a lab report, or second chance on a lab practical, for example).

Assignments and deadlines

Flexible deadlines boast advantages for students as well as instructors. This can be implemented in a variety of ways. Rolling deadlines can reward students who turn in work early or deduct a certain percentage of points when submitted late. By preparing and assigning homework or a lab report earlier, the instructor provides students with more time to work (or work around the constraints of other courses' deadlines and exams) without detrimental impact on the grade. Finally, permitting students to drop a certain number of assignments (for example, the two lowest graded quiz scores) creates a cushion for disruptions or personal situations and illness that arise during the semester. By allowing students to submit assignments with flexible due dates, instructors benefit from less grading all at once and fewer logistical decisions with deadline extension requests. Alternative grading strategies (specifications grading, standards grading, ungrading, etc.) can also provide benefit by placing the emphasis on learning instead of solely on the final score [24].

Provide supplemental material related to background topics

Especially in entry-level, general education, or first-year courses, students may begin the course with very different backgrounds. Even when arriving from the same prerequisite course, diverse experiences and opportunities mean that certain assumptions cannot be made, and some students will need additional material to be provided. Making available supplemental resources related to background topics allows students to access more information on their own schedule as needed, without disrupting the course or lab schedule. These materials can include textbook chapters, journal articles, protocol videos, lab equipment specification sheets, representative images or data, links to online resources, or examples of graded assignments from previous instructors or versions of the course.

Preparing Instructional Staff

The makeup of staff involved in a laboratory course is going to vary widely between institutions and even departments. However, students are likely to interact with more than one person throughout the course. Laboratory courses can be supported by faculty, professional staff, student staff, and/or peer mentors, who will all likely have different roles and responsibilities within the course. To quickly introduce your staff to course objectives, staff duties, and staff expectations, we strongly encourage the adoption of a course "field guide." In such a guide, you may want to begin with a brief welcome and overview of the course goals. A course motto (for example, "Always challenged. Never frustrated.") can set the tone. Information regarding the operational hierarchy of the course staff can then be provided. This is especially important for a staff that may include multiple instructors and teaching assistants at both the graduate and undergraduate levels. Everyone should know and feel comfortable with the process of getting help with technical instruction, pedagogical advice, and logistical (hardware/software) assistance. It is important that everyone is informed of lab safety protocols. Finally, ensure that all staff have an avenue for providing feedback on the course, perhaps anonymously, as a mechanism for making the course better. To improve the quality of this feedback, support your staff in learning best practices in pedagogy through explanation of the underlying theory of the methods applied in the course, and inviting them to join in the discussions of your broader CoP.

Experiential learning is important not only for students, but also for instructors. Most teachers are familiar with the adage, “When you teach, you learn twice.” There will be a human nature, however, to skip important activities just to save time. It is strongly recommended that you schedule hands-on exercises in staff meetings, ensuring that everyone is familiar with what exactly the students will experience and that the TAs are prepared [25], [26]. It is especially important when working with large TA teams to have a common time to perform the lab experiment together, such as during a weekly check-in meeting. This time also serves as an opportunity for staff to ask questions of the professor, recommend changes (for clarity, perhaps), and ensure that the entire staff is prepared for student questions in the upcoming lab sessions. You can also provide “advanced” projects that can be demonstrated to students or merely made available for “play” during lab sessions to help pique student interest in not only what they are doing now (as procedural labs can often feel boring), but also to excite them for what their training makes possible.

With a large team, consistent grading can also present a challenge. It is recommended that you provide example student submissions (“good, bad, and ugly”) that are scored by a “master grader” to demonstrate strong, formative feedback. These can be an excellent tool for students and TAs alike to learn how a grading rubric is to be applied to an assignment. To improve the feedback mechanism, tools provided by Canvas or Gradescope, for example, allow for TAs to generate and reuse feedback while grading assessments. Anyone who has been responsible for grading recognizes that there are always “common misconceptions” among the student body. These misconceptions may persist even as instructors modify their approach to content delivery and exercises to alleviate them. Strong feedback can include a concise response to the issue at hand and include additional resources where the student can look to more deeply appreciate the explanation. In a multi-section, multi-TA course, it can be beneficial to generate these “canned-but-complete" formative feedback responses to be used for every instance of that mistake.

What To Do When the Unexpected Happens

Even the most experienced instructor can be caught by surprise when the unexpected happens. Conversations within the CoP have shown that certain situations or scenarios are frequently cited as areas of concern for instructors of all ranks. In this section, we share some of our most frequent “Oh No!” moments, to provide both reassurance for new faculty as well as suggestions on how to handle these moments.

Oh no! The data didn’t turn out as we expected!

This may be one of the most common situations that arise in the laboratory, given the myriad of potential ways things can go wrong. Students find it very uncomfortable when their data does not show the expected (or sometimes any) trend, but it should be emphasized in class that this is still a learning experience. One positive outcome is the opportunity to practice identifying potential sources of error. (For example, you may discuss: What did you expect to see and why? What went wrong? Was it something related to the equipment? Was a step of the protocol missed? Were our tools and techniques not sufficiently accurate? Were conditions different than in the cited literature study?) Some errors can be quite subtle, while others are very well-known. The students can also be asked for suggestions on how to improve the experiment or minimize the identified errors.

Another way to combat “bad” data is to have backup or example data sets available for students to use for reports. These data can be acquired while TAs are preparing for the lab, or they can be generated from previous semesters if available. While it does not have to be perfect, the example data set will hopefully be more representative of the planned experiment’s expected outcomes. In addition, the instructor can use this opportunity to emphasize the importance of citing results that the students did not personally collect.

For example, in a junior-level Materials Science and Engineering lab, students are asked to collect optical microscope images of a polymer alloy as it solidifies to compare to expectations from the phase diagram. Samples are cooled slowly to better simulate equilibrium conditions. Because some samples take over an hour to fully cool, there is not enough time to redo the sample within the lab session if it is discovered that something is wrong with a microscope setting or if a group fails to notice when or where their sample first starts to solidify. As another example, students in a Bioengineering-based physiology lab could fail to acquire usable data if optimal biomedical conditions were not met during recording, a transducer or electrode was not placed correctly on the subject’s skin, or if any number of sources of human error were present during data acquisition and processing. In these instances, the instructor has a collection of previously acquired images or a sample data set taken by TAs that they can provide to the students for analysis in their report.

Oh no! I’ve given the students incorrect information on how to use a piece of equipment, or a setting was wrong when the experiment was run!

The first step is to acknowledge the mistake. Contact the students, let them know that something was wrong, and offer the correct information. If there is time, have the students retake the data. If there is no time for repetition, having the aforementioned backup data can be a good solution. It is also important to ensure that whoever is grading the report or analysis knows students were given incorrect information so that the grader can consider this and not overly penalize the students for something not their fault.

Oh no! The technology is not working, or the internet/network is down!

This is the worst nightmare of many instructors. The best approach depends somewhat on the particular scenario. If a computer fails during a lecture, having a printed copy of the necessary materials can prevent lost time. The instructor can share the class material using a whiteboard, document projector, or other means. It is critical to take the time to become acquainted with the technology in the classroom (as well as online conferencing platforms such as Teams or Zoom) before the semester begins. Another option is to have a recorded version of the lecture that can be shared. (Introductory videos for the labs can also be useful not only for students but also to help bring TAs up to speed on a particular topic during training or allow students who were absent due to illness to stay on track.)

If the internet or network is down and students are unable to access programs necessary for class, alternative arrangements may have to be made. Although students may be able to access websites through a mobile hot spot, that method will likely be slow due to the sheer number of people doing likewise. Sometimes, the best option may be to end the lab session so you can arrange for a different session, a secondary lab location (depending on department or building space), or an alternative assignment. These tactics can also be applied if lab equipment breaks or needs extensive troubleshooting.

Oh no! I'm ill or cannot attend the lab today!

This situation can be challenging, depending on your level of teaching support. If you have TAs, you may be able to call on one to take your place if they have been well trained or have experience in the topic. Or, if they have everything well in hand, check-in with them remotely during the session (via email, Slack, Teams, or messaging platform) and make yourself virtually available as you are able. However, if you are the sole instructor for the class, you are faced with a tougher dilemma. One possible solution is to ask a colleague to take over your class for the day; this is easier if your absence is planned (such as conference travel or a meeting), as that will give them time to prepare. In the worst-case scenario, cancel class and either schedule a makeup lab or give the students an alternate assignment.

Oh no! We have to cancel class or move to remote teaching!

Building in an "off week" can be a useful cushion for a lab course in which technology is bound to fail, course staff and instructors will be out due to illness, or (depending on geography) weather prevents students from traveling to class at least once during the semester. This helps to ease the difficulty of having to cancel or move to a remote or hybrid lab. For example, if your course is ten weeks long, having ten experiments planned makes it challenging to flip or cancel a class; instead, planning for nine labs gives you the freedom to adapt the schedule as needed when the unexpected undoubtedly occurs.

Some institutions and departments have strict policies on when students can access labs, while some allow access outside of scheduled lab times. With the latter, it may be possible to schedule a make-up session outside of normal lab hours, assuming students and instructors are both willing and available. Even with limited access to a lab space, it can be helpful to have back-to-back office hours with TAs to create a block of time for "make-up" lab session later in a week.

Oh no! We're out of [x]!

Having a backup supply of important consumables or reagents is important for unexpected events (e.g., mistakes, higher enrollment, supply chain interruptions). However, estimating the rate of consumption per student and ordering ahead is even better. Ask lab staff to watch for low levels of common supplies like gloves, compressed air/gases, 3D printing filament, cell culture plates, and necessary reagents, but also know where to go or who to call when supplies do get low. If there are items that can be substituted, it helps for the teaching staff to have that information as well; as an example, the Differential Scanning Calorimeters (DSC) in a Materials Science lab can run with either nitrogen or argon as their purge gas. If more than one lab class uses the same material (for example, the Bioengineering physiology lab and bioinstrumentation lab both rely heavily on protocols that require disposable electrodes), having a "sharing" plan with other lab instructors or the building's lab manager can help in the case of a last-minute emergency or when items are on backorder. Creating a list of "consumable" supplies the first time through a lab can help you anticipate what might be needed each semester so that you can create a regular supply ordering plan with your department. Finally, many campuses have chemical, electrical, or material storerooms where items can be purchased immediately without ordering.

Oh no! How do I adapt to many different student needs?

It's important that all students have access to opportunities for learning. Accommodations related to documented disabilities can range from the relatively minor (for example, extra time to work on assignments) to major (for example, overhaul of lab space to allow access for students with disabilities). When in doubt, department advisors, disability specialists, or other experts may need to be consulted to advise or assist with policy changes, specialized equipment, or physical space modification. Although these can appear daunting, the good news is that you usually have more time to address these properly, unlike some of the other "oh no" moments mentioned earlier.

On the other hand, labs also have challenging constraints that make them harder to adapt than traditional lectures. In such instances, it is important for the instructor to ask themselves what "has to happen" in lab versus what can be flexible. Separate from documented disabilities or special situations (such as religious observances and athletics), interruptions to normal routine can occur at any time. Many such student requests come from one-off situations that occur for multiple reasons, including unexpected travel, illness, family emergencies, etc. These can present different challenges such as when students are working in groups and must miss class, or when labs build on skills learned in previous experiments, making the order in which the labs are completed important. Is it reasonable to ask the student to make up for the missed class (and does time permit this), does data instead need to be provided, or is there an alternative method for students to learn and complete the necessary material? With group work, is the group negatively impacted by the missing student, or is it still able to complete the assignment as expected? Things can happen unexpectedly, so instructors must ask themselves how and when they can be flexible, and when is it important to set and hold boundaries? Finding the right balance can be challenging; ultimately, we as instructors want to do what is right for our students, but also only have so much capacity.

Conclusion

Over the first three years of our CoP we have gathered insights, addressed problems, identified improvements, and supported each other. We have summarized the key takeaways from our discussions on facilitating teamwork, improving inclusion and belonging, preparing instructional staff, and responding to unexpected events to share with other faculty who may be facing similar circumstances. We also encourage others to consider developing their own CoP or network of instructors of laboratory and design courses to leverage some of the benefits we have seen so far.

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