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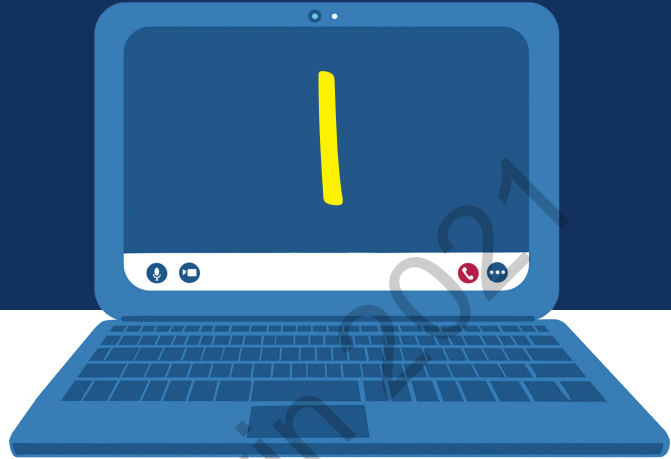
SETTING THE STAGE FOR THE VIRTUAL MATH CLASSROOM

Welcome to the adventure of learning to teach mathematics remotely! Whether you are new to virtual instruction or a veteran, it is important to anticipate how your lessons will unfold differently in the online environment. This chapter will give you an overview of technologies and the tools out there. You will learn both the fundamental tools and how to anticipate student interaction, collaboration, and engagement. There are a plethora of tools available, and while subtle differences might exist, this chapter explores the fundamental purpose of the tool and how to leverage the affordances it offers you in online learning.

Instructional Delivery

As we begin our journey together, it is important that we have a common definition of three terms to describe instructional delivery in an online learning environment that will be used throughout this book: synchronous, asynchronous, and blended.

Synchronous: Online instruction when students learn live, in real time

Synchronous: This instructional format is live and in real time. Students are required to log in to the class session at an assigned time. You should use synchronous teaching when you want to

- Interact with students
- Observe body language
- Ask a question and listen to students' responses
- Facilitate a class discussion or small-group breakout groups
- Observe a student's problem solving as it develops
- Set the stage for independent learning/tasks

Asynchronous: Offline instruction when students work anytime they choose

Asynchronous: This instructional format allows students to complete assignments anytime they choose. This is not to say that you can't have deadlines—even daily deadlines help students to develop organizational skills—but the important thing about the asynchronous format is that there is flexibility in when students do the work. You should use asynchronous teaching when you want to

- Assign prerecorded lessons for students to watch
- Incorporate independent projects
- Teach time management and organization techniques
- Assign an independent assessment or purposeful practice of skills or concepts

Blended: A mix of live online classes with offline independent work

Blended: This format utilizes the advantages of both synchronous and asynchronous instructional delivery. Some of the class sessions are live with interaction, and some of the sessions are independent. You should use blended teaching when you want to

- Record a lesson for students who could not attend class at the assigned time

- Assign a group project with independent components
- Have students complete a follow-up assignment after the synchronous class

Equitable Learning Online

Teaching online contains another element for which students can gain or be restricted from access to learning. Students who have access to up-to-date technology, fast Internet, and immediate tech support will have fewer challenges than students in the opposite situation. As you consider the diversity of your students, make note of inequities that lead to inaccessible curriculum.

It is important to create a plan with your administrator and technology support teacher for how to address these inequities to give all students an equitable entrance to and experience with your online class. Special attention should be paid to the basic technological needs of underresourced populations. When students or school divisions do not have access to basic remote learning needs such as Internet connections and devices, it can significantly hamstring student learning experiences. With all the gadgets out there, it can feel overwhelming and financially impossible to supply each student with basic tools. I recommend three tools: Internet access, a computer with a webcam, and a headset with microphone.

HARDWARE AND GADGETS

I frequently get asked this question from teachers, parents, and administrators: What devices and gadgets should I buy? For some, this list gets ordered and delivered without a second thought. However, for many others, this question is loaded with financial implications. For this reason, I recommend only one or two devices.

- **Chromebook:** This laptop-style computer meets all basic needs. Currently, it is the most affordable device, priced at under $100, and comes equipped with a webcam, microphone, automatic updates, and virus protection. It is web based, so while it cannot download programs and software, it can access websites and applications on the web. I prefer this to tablets, even for our youngest learners. It might take longer for kindergartners to learn the

hand-eye coordination of a mouse, but there are so many more features that are accessible on a laptop than tablets. If touchscreens are necessary, chromebooks with touch screens are still less expensive than most PCs and Macs.

- **Headset with noise-cancelling microphone:** This does not need to be expensive to gain the benefits. A headset can help the student with productivity by focusing their attention on the assignment and not other audio distractions in the home. When shopping for this, search for key terms such as *background noise reduction, unidirectional, boom,* or *noise-cancelling microphone.* There should be a physically extended mic that reaches to your cheek. A noise-cancelling microphone is a game changer when collaborating online. It doesn't pick up the background noise of a TV, adults and siblings, or sounds of the city.

INTERNET SPEED

There are many things that may increase or reduce a student's access to your online class, and Internet speed has the potential to be the biggest factor. But there are some things that you can do to level the playing field.

Video Streaming and Bandwidth

Streaming video uses a lot of bandwidth. That means that if a student is working with a poor Internet connection or slow speed, they will not be able to access the class in the same way as students with high speeds. If you regularly stream video via your webcam, be sure to check in with students on the quality of the video. Poor connections often lead to choppy interactions and confusion about directions or participation.

In general, I don't stream my video over the webcam. My students hear my voice and interact with the online tools rather than watch my face. I only stream myself when I am showcasing the mathematics and even then, only when it is the very action that I want to display, such as stringing beads on a pipe cleaner to show groups of 10 or showing the length on a measuring tape. Consider the reason that you stream and whether the benefits outweigh the inequities in the delivery.

Video streaming is not limited to your webcam. It also includes videos that you share via the teleconferencing tool during synchronous instruction. If you planned to share a video that is linked to YouTube (or TeacherTube if your school division restricts access to YouTube), for example, you can share the link with your students instead of the streaming video. When you give the student the link, they can watch it on their own and pause when the video has finished buffering. This can be liberating to students who have varied signal strength because they get to access the video as intended, rather than a choppy, glitchy version. Once finished with the video, students return to the synchronous class setting and we move on with the lesson.

Power and Internet Outage

There are many things that we want to teach our students about time management and submitting assignments on time, but we need to consider a few elements that are out of their control. One of these is power and Internet outages. We must acknowledge and be prepared for the fact that not all students live in situations where they have consistent and reliable access to Internet and power. Interruptions may be short-term in the case of weather- or natural-disaster-related events, or can be more severe in areas of income insecurity. My neighborhood has above-ground power and cable lines, and I often lose Internet and power during storms. When I teach online, I frequently make a backup plan for days with heavy wind or rain. My plan usually includes connecting to my cell phone as a hotspot (however this uses cell phone data, which may not be readily available for many students learning remotely) or simply moving to an asynchronous lesson for the class that day. To ensure equitable learning, be sure to consider what you know about your students' circumstances, be realistic about what students can and cannot do in the event of interruptions, and offer extensions on deadlines and other ways of communicating with you.

Proactively Helping Students Prepare

As teachers, we have a great responsibility to not only teach students the academic content, but also help them learn how to interact with their world. Consider helping students (and families of

young students, especially) to stay organized and ready for class with these proactive tips:

- ☐ Before the school year begins, check your Internet speed. It is possible that you are using an outdated modem and are not able to get the Internet speed that you are paying for. If you rent a modem, most Internet providers will swap it out at no charge.

- ☐ Charge your devices when not in use. This includes any wireless devices, laptops, tablets, mouse, headset, and so on.

- ☐ Set all tablets and computers to update programs and operating systems regularly.

- ☐ Maintain a virus protection program (not necessary with Chromebook).

Creating a checklist like this will help your students transition into being responsible adults in their digital world.

THINGS WITHIN A STUDENT'S CONTROL

Chapter 2 discusses the importance of norms, rules, and routines to maintain classroom management. From an equity standpoint, it is also important to consider which norms are in a student's control and which are not.

For example, sometimes, when we try to teach students good study skills, we create norms such as be in a quiet place, which works great for some students. The reality is that some students are unable to be in a quiet place. The home may not have a dedicated quiet room, there may be many people living in the house who are home during the day, the student may be baby-sitting younger siblings, and perhaps the student can focus better if a cartoon is on in the background so that younger siblings are not a distraction. The existence of distractions and background noise may be outside of a student's control, but how they respond to these concerns can sometimes be within their control. Your job is to be aware of your students' ability to control their environment and set norms accordingly in order to help them and their classmates stay focused. Let's look at some practices that may help.

Using the Microphone in Small Groups

In order to engage students in participation and discussion, I used to require all microphones to be on, both in whole class and in small groups when working with me or in breakout rooms. I used this norm in all my classes. I had good intent in that I wanted students to discuss ideas together, and the best way to discuss ideas is by having their microphones on all the time. Over time I learned that this is not always feasible for everyone. Sometimes there are conversations in the background that are disruptive or even embarrassing, construction that is noisy, and pets that are beyond a student's control. It can also lead to just more background noise and chatter than students are comfortable processing, as well as challenging echoes. So, I changed this norm to be, microphones "active" in small-group discussions. The difference between "on" and "active" is that rather than passively leaving them on, but maybe not contributing to the discussion, the expectation is that students speak often, but they have to turn their microphones on only when speaking . . . hence they are more *active*.

Using the Camera

As a teacher, I love to see my students' faces and observe their body language and facial expressions. Both in the face-to-face classroom and online, these observations can inform my instruction. However, these observations in the online space are different from in a classroom, because they not only show the student, but also the home environment. Sometimes the home environment can be distracting both to other students in the class and to a student who may be embarrassed to show the home setting. As students move into adolescence, they are often more concerned about visual appearance, which may take away from the mathematics lesson. You might ask yourself, do I really need to see all my students at this moment, or only when they are showing me how they regrouped their manipulative in order to add? I recommend considering the purpose of video, and using it only when purposeful.

THINGS OUTSIDE A STUDENT'S CONTROL

Just as with background noise, there will be many other things outside of a student's control when engaged in distance learning that we need to be attentive to, supportive of, and flexible about. These may be things they have less ability to manage or mitigate.

Speech Differences

Speech is a major component to online learning. Because audio is such an important factor, it can magnify accents, dialects, and speech disorders/difficulties. This can result in some students participating less often than in a face-to-face class. There are many accessibility tools available both within the teleconferencing program (such as captioning) as well as programs or extensions (such as voice to text). In addition, if your students use voice to text applications, they might have an unfair advantage over students whose speech is not well recognized or even recognized at all by the program.

Outdated Devices

School districts often survey families about technology available to students for distance learning. They don't always update the survey as often as needed to ensure that every student has a working and updated device. You should be prepared to confront outdated devices and have a plan for how to respond. Be sure that students know what to do if their device malfunctions during homework, in the middle of class, during a presentation, or while watching a video. Be sure students have easy access to your school or district's technology help number, so that they can get the dedicated IT support that they need and you can continue teaching.

Additional Responsibilities

As teachers, we may think that our students are home and able to be fully attentive. However, just because a student is home doesn't mean that they are able to be 100 percent focused. If the parent(s) is working, your student might be a caretaker for other children in the household. In some cases, younger siblings are watching a video while the older child is interacting in your class. They can be distracted because the younger siblings are fighting or a toddler didn't go down for a nap during the synchronous class time. A proactive way of becoming aware of student responsibilities is to create a space for anonymous feedback (such as Google Forms). Be aware that your students might have other responsibilities and they don't have full control over their attendance or attentiveness during class.

CLOSING THE GAP ON MATERIALS AND RESOURCES

There is a bright side to equitable mathematics in online learning, and this comes in equal access to resources and materials. Due to the plethora of free online manipulatives, free interactive graphing calculators, and free geometry software, students who may not have previously had financial access to these tools can gain access in the online world. Similarly, if supplies such as paper, books, and other materials were not easily available, there is an almost infinite amount of space online. If we consider these affordances and leverage them in our online class, we have the potential to level the playing field in terms of virtual manipulatives and models used to show thinking.

Technology Tools

When teaching online, there are some common tools that you will use regardless of what platforms your school has adopted, or if you plan to teach in a synchronous, blended, or asynchronous model. These tools are necessary for organization, consistency, and efficiency.

LEARNING MANAGEMENT SYSTEMS

The Learning Management System (LMS) is the platform for the class home page where students enter their online class. The LMS varies by school district but is usually a secure website that connects student logins with their registration at their school. Learning Management Systems are used in all instructional delivery formats: synchronous, asynchronous, and blended. There are usually choices within the LMS platform to support instruction, such as assignments, readings, recordings, videoconferencing tools, and grades. Currently, examples include Blackboard, Canvas, and Google Classroom.

THIRD-PARTY WEBSITES AND TOOLS

Third-party websites and tools are the other websites, links, videos, and programs that you will use in your class, regardless of the instructional delivery format. They are used to connect students to

outside resources that enhance your curriculum. Current examples include YouTube, Khan Academy, educational websites, virtual manipulatives, Desmos, Microsoft Word, and CAD programs. In addition, your curriculum text or school division resources may have virtual tools for teachers and students to access.

INTERACTIVE SLIDES

Interactive slides are used in all instructional delivery methods and are characterized by a slide deck that both students and teachers interact with and can edit simultaneously. This is more than simply sharing a slideshow presentation in that all users interact with and modify the presentation. When using interactive slides, students can upload images of their drawings, insert screenshots of their virtual manipulatives, create models using shapes and arrows, and comment using text boxes. Current examples include Google Slides, Microsoft PowerPoint, Desmos, Jamboard, Peardeck, and Seesaw.

VIDEOCONFERENCING TOOLS

Videoconferencing tools are specific to synchronous instruction formats because they connect students and teachers through live audio and/or video streaming. Current examples include Zoom, Blackboard Collaborate, Microsoft Teams, Google Meets, and Seesaw (K–3 only). There are several components to any videoconferencing tool:

- **Audio:** The ability to speak and listen to live audio
- **Chat box:** The ability to read and type in a live space
- **Video streaming:** The ability to watch or display people in front of their computers
- **Share applications:** The ability to view or watch programs from another person's computer

Technology Implementation

Successful technology implementation requires more planning than you may be used to. However, there are many great advantages because of the abundance of technology tools, apps, and collaborative shareability. From virtual manipulatives to

interactive whiteboards and video directions, the choices can seem endless. In addition to these technological tools, it is important not to discount traditional paper-and-pencil drawings, concrete manipulatives using everyday objects students have access to at home, and abstract notation, as students can upload pictures or videos of these into your virtual classroom space. As you sift through all of these resources, you must identify which technological tools are most appropriate to your lesson goals and how students will interact with those tools. When planning, consider the following questions:

- What technology tools will my students have access to?

- Will I provide the technology tools or have students search for them?

- Does the technology tool allow for different mathematical models (e.g., linear model, area model, set model)?

- Does the technology tool support students' thinking of the mathematical situation?

- How long will it take my students to learn the technology tool versus use the technology tool to show a mathematical strategy or representation?

- What mathematical ideas might the technology tool overlook?

- Will the technology tool be more or less efficient than using paper/pencil or handheld manipulatives?

- How do I practice using the technology tool myself?

- What low-tech tools (such as paper/pencil) are relevant, and how will my students share these in collaborative spaces?

Let's explore each of these questions in more detail.

What technology tools will my students have access to?

A simple web search for "virtual math manipulatives" will provide hundreds of results for interactive tools. Each of these tools has advantages and disadvantages, and you must consider the role of the tech tool as it relates to the mathematics task. This is similar to a face-to-face classroom as a teacher considers all the manipulatives available in the classroom and the advantages and disadvantages to using each manipulative for the math task. When

anticipating student thinking, you should explore the potential tech tools and anticipate student usage and potential misconceptions. In addition, you should plan for unstructured exploration time as students become familiar with the tech tool before actually building its use into your lessons.

Will I provide the technology tools or have students search for them?

In order for students to work efficiently, you may want to sift through the plethora of virtual manipulatives ahead of time and identify a few that are best used to meet the mathematical goal. This is especially true for young students. Importantly, as students get older and are more experienced in an online setting, you do not always have to be the provider of the tech tool. It is indeed a 21st century skill to learn to search and sort the tech tools themselves. This should only be practiced, however, after you have modeled several lessons with a variety of tech tools.

Does the technology tool allow for different mathematical models (e.g., linear model, area model, set model)?

It can be tempting to select the same tech tool over and over because both you and the students become comfortable with it. NCTM's (2014b) *Principles to Action* calls on teachers to present students with multiple representations so that students can make connections between those models. Much like choosing only one problem-solving strategy or one visual representation, this can result in students being unable to connect to various models. For example, consider fractional representations. There are linear models, area models, and set models, and all are equally important to gain a full understanding of fractions in various situations. If you only select technology tools that use a linear model, student thought will become fixed within this model and students will not see connections to other representations.
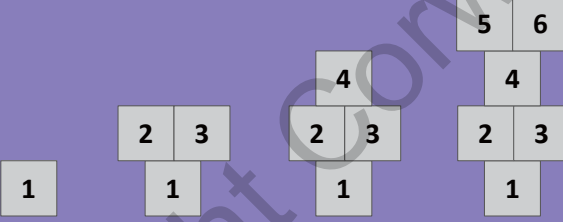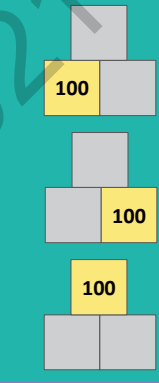
Does the technology tool support students' thinking of the mathematical situation?

Not all technology tools are best for all problems. As you'll read about in Chapter 8, it is important to select tools based on how you anticipate students will approach and solve a problem. A crucial part of your preparation is to do this anticipation by solving a problem yourself in multiple ways, and *then* deciding which

technology tool is the best match to assist students in that thinking process. Having a mismatch can lead to unnecessary misconceptions. For example, in the following hopscotch problem, the teacher selected a geoboard tool without fully anticipating how her students would approach the problem. The tool could not create a visual model that matched with the problem scenario described. This led to confusing representations that did not connect to the problem, which had never happened when students used paper and pencil.

The problem:
Your school wants to unveil a hopscotch course on the 100th day of school. If this pattern continued to 100 boxes, what is the placement of the 100th box? Does it make sense to end at 100?

Optional: The follow-up business:
Infinity Hopscotch creating a pricing template for their hopscotch business. For every foot of blacktop, they can paint one row of the hopscotch course. How much should each row cost? What is your reasoning?
Your local park asked for a quote to paint a hopscotch course on their blacktop. Estimate the length and determine the cost.
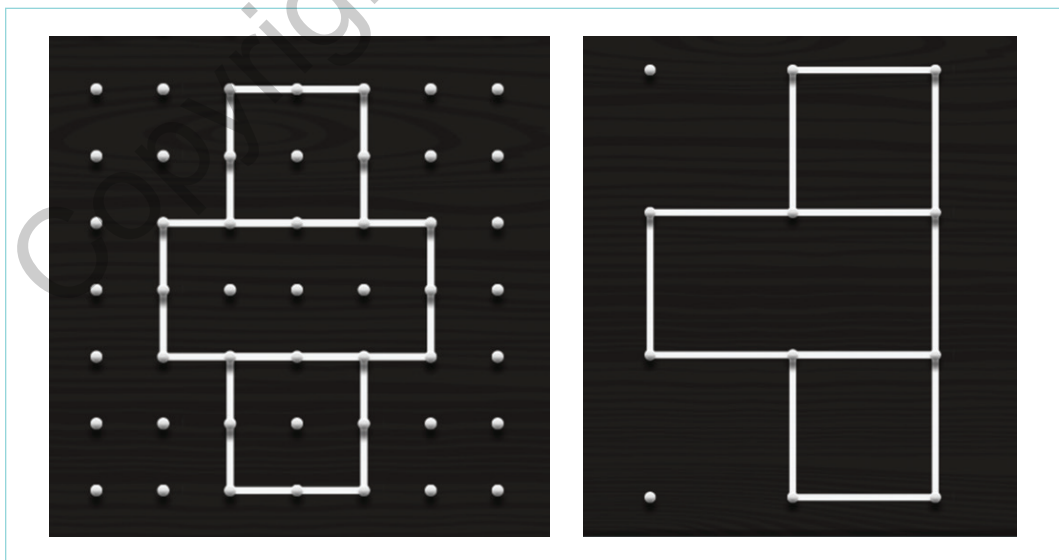
How long will it take my students to learn the technology tool versus use the technology tool to show a mathematical strategy or representation?

Learning a technology tool has many advantages, and yet a clear disadvantage: it is time consuming. While it might take students time to learn the tech tool, you should consider this learning as it connects to digital literacy and digital citizenship.

Digital literacy and digital citizenship are not only school division goals, but also important life skills that our students need to practice in a structured environment before graduation. Digital literacy refers to the ability to navigate technology. Students need to learn how to save files, organize folders, use tools such as copy/paste, navigate the web, and identify reputable people and posts. Digital citizenship refers to a student's contributions to the digital world. Students should learn appropriate ways to chat, blog, and post to social media. They should learn how to identify harmful people and programs and safe practices online. They should be able to identify fact versus opinion and understand the foreverness of comments that they post online.

Educational curricula frequently embed STEM, and there is value in the way students explore these tools. Thinking like computer engineers also builds students' minds. Plus, once students learn the tool, they will use the tool with more efficiency in the future. Making the time investment at the beginning can pay off considerably with future lessons. In other words, it is worth it for students to take the time to learn a tool they will use consistently and that builds their skills beyond the task at hand. But it may not pay off to have students spend time learning a tool that they won't use in the future or that doesn't provide additional learning benefits.

What mathematical ideas might the technology tool overlook?

Good mathematical tasks are used to help students uncover key mathematical ideas. Sometimes, the tech tool is too advanced to use with all developmental levels of students and can be a case where the tool is a distraction that gets in the way of good learning. For example, if you are teaching a lesson about graphing and correctly choosing the best graphical representation for a data set, some spreadsheets automatically label the x- and y-axis, identify the dependent and independent variable, and plot the

data. This may give too much away for students just learning about graphs and takes away a learning opportunity. You should consider if the technology tool replaces or enhances the exploration of the mathematics.

Will the technology tool be more or less efficient than paper/pencil or handheld manipulatives?

Efficiency is an important consideration when implementing a math task in the synchronous online environment. If you expect to use student-elicited responses for the math discussion after 20 minutes of exploration time, you must provide experiences that can be explored, with appropriate tools, in that allotted time. This means there is still a place for paper-and-pencil representations in a virtual classroom, when more concrete tools will be more efficient. Students can use paper/pencil or mini whiteboards to collaborate with group members by using the video streaming feature on the teleconferencing tool or by taking a picture of their handwritten or drawn work and uploading it to the slides. They might also use physical manipulatives such as paper clips, cereal, pasta, beans, and more. Students can upload images of these traditional face-to-face representations to the interactive slides for the class to view.

How do I practice using the technology tool myself?

Before you implement any technology tools, be sure to anticipate student responses and technological issues, and plan how you will respond. First, try the tool with a friend or colleague. Be sure to make a copy of your interactive slide so that you can have a clean version while you and your planning partner test out the copy. Consider asking friends who have access to different devices so that you see how the tool(s) play out with different operating systems and browsers. PCs, Macs, and Chromebooks all use a physical keyboard and mouse, which have benefits and drawbacks compared to tablet devices. Tablets and phones often use an app to interact with the slides. Be sure to download the app and open the presentation using it. Test out how the technology is different in each situation. Ensure that you know how to turn on features such as the hotspot, the camera, the videoconferencing tool, and the Learning Management System. Once you have a willing friend, ask them to make a mistake so that you are prepared for student mistakes. Consider your language and tone, and role-play the situation to give you practice using those words.

What low-tech tools (such as paper/pencil) are relevant, and how will my students share these in collaborative spaces?

With all the digital gadgets and apps available, it is easy to jump to a Google search of virtual tools to draw and write numbers, expressions, and multistep equations, but paper and pencil and other low-tech modalities still have their place. Teachers need to balance the cognitive demand of learning new technology with learning new mathematics content. This is seen in the classroom as teachers read aloud word problems to balance the literacy demands so that students can focus on the mathematics of the problem. Similarly, paper and pencil; homemade manipulatives (such as Lego's, beans, and egg cartons); colorful sketches; Play-Doh shapes; and glued craft sticks all have a place in the remote classroom. There are a variety of ways that students can upload their low-tech tools using video and images, both during the creation process and for the final product. Many of these upload tools are embedded in the Learning Management System, teleconferencing tools, interactive slides, and third-party apps.

●●● REFLECT AND REIMAGINE

Whether this is your first remote class or you have experience teaching online, if you are transitioning from a face-to-face classroom, you will need to reimagine your course delivery. This chapter gave you considerations for technology and equity. As you consider the topics in this chapter, reflect on the tools:

- What LMS and teleconferencing tools will my students access? Will they have access to multiple tools?

- How might I use these tools to support collaboration and interaction between my students?

- What third-party tools, apps, and manipulatives can my students access?

- Are my students already familiar with the physical version of the tool? How can I build on that?

- What can I do in my classroom to create a more equitable environment for my students?