

Teaching with Technology in Undergraduate Mathematics

Resource Book Part 2
Tips for Teaching with Technology

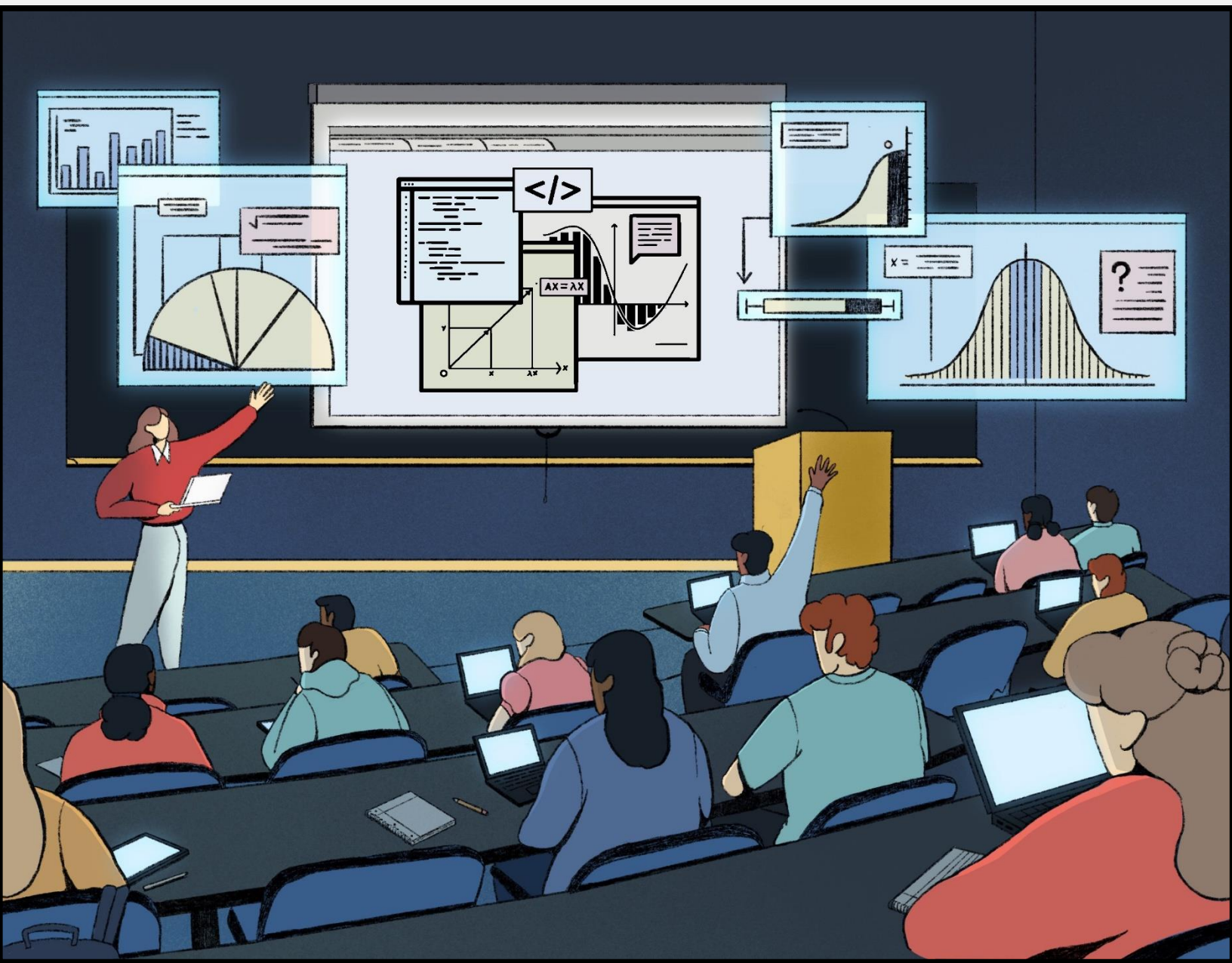




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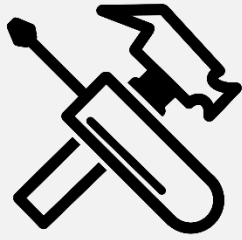
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Addressing Student Questions with Technology: Choosing the right tool

When a question can be addressed using multiple digital resources, what factors should you consider when making a decision?

Let's compare and contrast features of Dynamic Geometry Software, Python, and Interactive Whiteboards.

Dynamic Geometry Software (DGS)

- Works well with questions prepared in advance as well as on the fly; includes applets, dynamic calculators, and interactive whiteboards;
- Is useful for concepts that require human-machine interactivity where little mathematical notation may be needed,
- Is suitable for instructor-to-student or student-to-instructor interaction, as well as collaboration amongst students;
- DGS focuses on features of the graph or geometric object, as well as on variance and invariance;
- Can be accessed and used on any device in real time, and
- Has no limit to how many students can participate at the same time.

Python

- Works well with code prepared in advance, as student(s) might get impatient watching you type the code. Therefore prepare the code in advance and in class debug it and run the code. Once you have samples of codes used to answer questions, you can reuse them, add new ones, thus enriching your “library” of codes to use with your students.

- Python can do numeric calculations, graphing. It is a versatile support for answering students' questions. Together with annotation tools, you can use Python to discuss almost any question.
- Please note that an important consideration is that Python (working in a notebook, or with a stand-alone Python platform) is not interactive with multiple users.
- Python removes the need to engage with tricky technical details. Importantly, Python focuses on the features of the graph, as well as on the pattern of the functional values (in the table of values). This helps student(s) realize problems they may have in their reasoning and suggests the correct answer. Working with interactive whiteboards in this case, might take longer than Python. Of course, you can use a simpler example to explain errors in students' reasoning

Interactive Whiteboards (IWBs)

- Allow you to communicate with your students in real time, as if you are working together on a (tangible, wall) whiteboard;
- Several students can communicate/collaborate at the same time. However, there is a limit to how many students can participate at the same time.
- Requires students' access to software, and a touch screen or a similar device that enables them to write "on screen."
- Are useful for quickly capturing notation and graphics that do not require human-machine interaction, and are effective for incorporating and combining multimedia, online resources, and applets;
- Together with access to internet (Wolfram, Desmos, for instance), you can use interactive whiteboards to discuss almost any question.
- In Interactive whiteboards, we can start right away to analyze the function and calculate a table of values. However, graphing is challenging on interactive whiteboards, and it takes time to do.

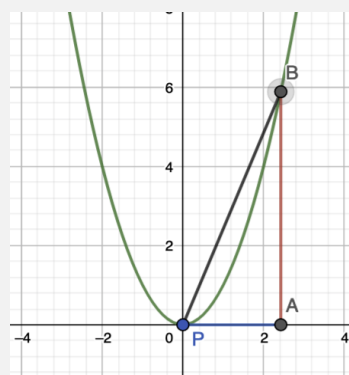
Examples of student questions:

Why can I not say that $\Delta y/\Delta x$ and dy/dx are pretty much the same thing?

In this situation, you might think: Well, because dy/dx is not $\Delta y/\Delta x$ but the limit of $\Delta y/\Delta x$.

Try this:

- Set up a quick sketch on GeoGebra that includes:
 - Fixed point P
 - Arbitrary point B on a parabola
 - A slider for animating point B
 - Segments AB (Δy) and AP (Δx)
- Engage with the DGS and ask the student:
 - What is the derivative dy/dx at $x=0$?
 - What is $\Delta y/\Delta x$ in this picture?
 - Which part of this picture is a secant and where is the tangent line?
 - How are dy/dx and $\Delta y/\Delta x$ different here?



As Q is approaching P, a set of secants lines approximates the tangent line at point P. Could a secant line ever become the tangent?

Try this:

- Search for relevant pre-made Desmos applets, such as this [applet](#), and incorporate it into an interactive whiteboard
- Indicate Δy and Δx using the drawing tool of the interactive whiteboard. As Q is approaching P, a set of secants lines approximates the tangent line at point P. Could a secant line ever become the tangent?



Dear Instructor or TA,

I have to compute the limit of $(x^2+x+1)\sin(2px)$ as x approaches infinity. See, I plugged in large numbers: 10, 100, 1000, 10000, and always get the answer 0, so concluded that the limit is zero. On my test, I got no credit, but I think what I did is right. Should I get part marks?

Thank you,

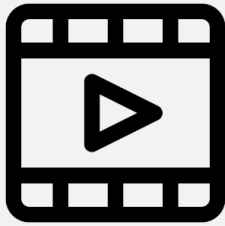
A confused student

In this situation, you might consider responding to the question with Python. Try this:

- Start with the graph of $\sin(2pix)$, build the graph of the function, by adding one term at a time, and asking the student what they expect to see (thus facilitating the understanding of important features of the function).
- Construct a table of values: first by using the numbers that the student provided (and verifying that the values are zero), and then by adding random large numbers (which will show that the values are not always zero).
- Thus, you are able to demonstrate and help your student(s) realize that they have to pick generic values for x to form a table of values. Special values might and will suggest erroneous answer for the limit.

For an alternative approach, using IWBs, try this:

- Start with the graph of $\sin(2pix)$, ask student(s) how they would graph $x\sin(2px)$ and $x^2\sin(2pix)$ and then how they would put it all together to obtain the graph of the given function. Observe what they suggest, and comment on their attempts.
- Draw a blank table of values: ask student(s) to suggest x values, and then delegate several calculations to every student (thus, you could generate a table of values, hopefully, in a reasonable amount of time).
- Guide the students to realize that they have to pick generic values for x to form a table of values. Special values might and will suggest erroneous answer for the limit.



Creating and Annotating Video Explanations

Videos are useful as a supplement to face-to-face learning, for providing feedback on students' work, or for relaying lecture material asynchronously.

Whether you create your own videos or annotate existing ones, they have immediate impacts on student learning.

Choosing pre-made videos

Important considerations to think about before selecting videos:

- What are the reasons for selecting a video to teach a particular topic, i.e., why are you not covering it in your usual way?
- What do you expect the video to show (e.g., derivation of a formula, graphic interpretation of a rule, error bound and showing how something is calculated, worked examples)?
- How will your students engage with the video? Are they going to watch it at home (asynchronously), or will you play the video in class, and be available for questions in real time?
- How do you plan to wrap up the topic? Provide additional examples?

Important considerations to think about after selecting videos:

- Do the videos cover all that expected them to cover? Will you ask your students to watch the entire videos, or selected parts only? How do you plan to fill in the gaps, i.e., the content that you need, but that was not appropriately covered (or not covered at all) in the videos?
- Is the language in the videos close to the language that you use in your classroom? Will your students be familiar with the notation, and with the prerequisite knowledge

that the videos require? For instance, if the video uses the summation notation - did you cover it in class?

Creating a video

You might wish to create your own video, if pre-made videos:

- do not cover what you need (for instance, working with the error estimate for Simpson's method), or do not cover it in the way that you would like to see it covered,
- do not cover sufficient number of worked examples,
- require major adjustments in the notation or terminology (i.e, in your lectures you explain content in a different way, and/or use different notation; although it might not look like it to you, this could be a major obstacle for your students, especially because the topic is completely new to them), or
- do not offer the level of interactivity that you would like to see

When creating your videos, keep in mind the following.

- The video should not be too long, definitely not longer than your lecture (it might make sense to break one long video into shorter videos, with one idea or one concept per video).
- It is important to engage students within the video and make the video interactive. For example, you can ask questions and suggest that the students pause a video; create a small quiz half-way, to summarize the content that has been presented so far, etc.
- During the video make multiple connections with the content that you teach in lectures so that the video feels like an integral part of the course, rather than an "outlier"
- Remember that you can combine your video with pre-made videos!

General Suggestions

- Keep in mind that the video you created does not have to be of professional-level quality!
- Making a video could be time-consuming even if you are not aiming at professional quality. On a positive note, it might be worth it as you can re-use the video.
- Determine whether the pre-made videos are free, accessible (closed captioned?), and respect users' privacy (do students have to subscribe, create a login, perhaps leave an email or share personal information?).

- Consider whether pre-made videos would benefit from annotations to make connections to course material or highlight ideas; use software such as VideoAnt or IPEVO Innovator which allows you to annotate your IWB.
- Video-recording can be made by using Zoom, Teams, Webex... Just start a lecture and record it. Just note that although these platforms are convenient, the options to edit your video could be quite limited.
- You can also use recording software, such as Camtasia or Explain Everything.

ScreenCast DGS, Python, and IWB explanations

ScreenCast, also known as video capture and screen recording, has been widely used to capture actions taking place on a computer display, often containing audio narration. Its usefulness is indisputable. ScreenCast takes explanations up a notch. It allows quick sharing of any particular portion of a lesson, applet, piece of code, graph, or animation you want your students to focus on. ScreenCasts can be particularly beneficial for students who don't have access to specific software because a video recording can be accessed from any device. The one downside is that creating a screenCast that contains audio narration might be time-consuming for you, at least at first. Our recommendation is to start with just a few short screenCasts and in the long run you will build your library of screenCast explanations for future uses.

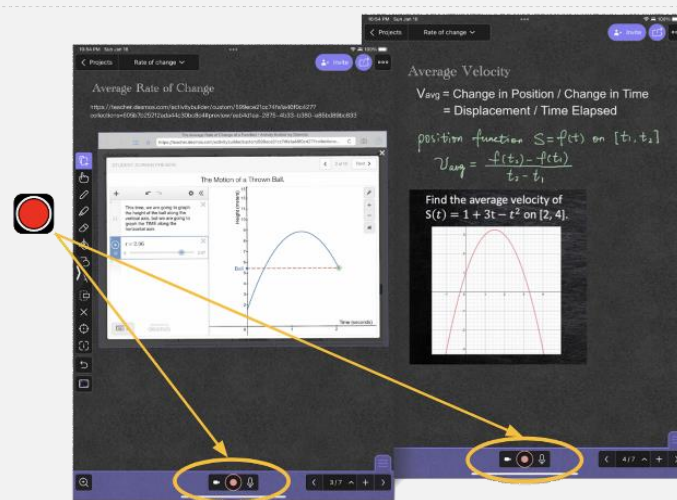
Explain Everything

Explain Everything is an interactive whiteboard that allows you to record interactive video lectures. Using the whiteboard, you can illustrate the mathematical concepts as you build the ideas through your lecture.

You may incorporate:

- Texts
- Pictures
- Drawings
- Websites
- Applets

and record what you have to say



VideoAnt

Videoant was developed by researchers at the University of Minnesota. It is a web-based tool that allows for collaborative annotation of videos. The tool is like a google doc for videos. You can use VideoAnt and add your own annotations or you can have students annotate videos as a group as a part of your classroom learning experience.



Example of using DGS and Screencast to address student question:

I have no idea how to graph the function $f(x)=2x\exp(-0.4x)+3\exp(0.2x)$.

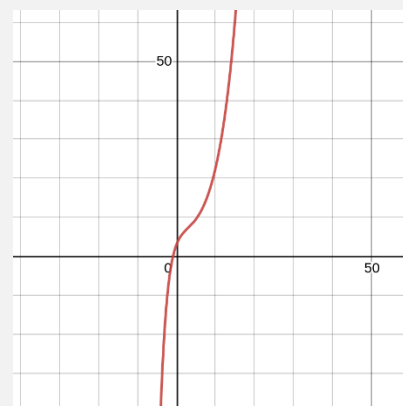
This is a fairly complicated function, why don't we try Desmos?

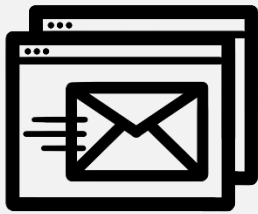
Check out this link: <https://www.desmos.com/calculator/p2yoobd29u>

You can now lead the student through an investigation of the function using this computer-generated graph.

You might ask:

- Where is the graph concave up?
- Where is the graph concave down?
- Plot a point where you think the graph changes concavity.
- Can you show me the places on the graph where it is increasing?





Addressing Student Questions with Technology: Optimizing Email Time

Responding to emails could largely affect your productivity during a workday when daily email volume is high or when dealing with a backlog of unanswered emails.

Set priorities and expectations, make decisions, use email templates, and address the most asked question on your LMS.

Set Clear Expectations

- Inform your students the expected timeline for receiving responses, i.e., within 24-48 hours, and whether you answer email over weekends.
- Emphasize that the course outline and other relevant information usually provide an answer to their questions.
- Emphasize that email is not for private tutoring, going over three pages of someone's solutions, for writing long and complicated calculations, or chat-like discussions. Instead, remind students about office hours and encourage your students to take advantage of office hours (in person or online) to have their questions answered.

Use Email Templates

Email requests and questions from students are often repetitive. Therefore, create a file into which you can save all email responses that you anticipate you will use again in your future communication with students. Use appropriate headings so you can easily access the emails later. Soon, you'll be able to copy/paste your message as a reply to other students. Believe us this saves time! Also, some of the responses you have created could also be used as posts and announcements in your LMS.

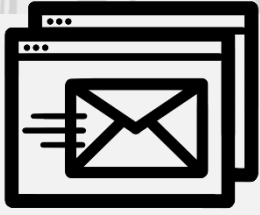
Question of the Week

If one student asks a question, chances are a number of students have the same question (and some didn't even know they had that question). We recommend posting a "Question of the Week" in your LMS.

- On the course web page, or your LMS, pose a "Question of the Week" with your answer and comments. Inspiration for the questions can come from students' emails. You can quote the question a student recently asked (our suggestion: use the email format in your post, so that students see that it's a real email. This might encourage other students to email you their questions as well). Be careful not to reveal anything that could identify the student who asked the question.
- "Question of the Week" is also a great place to post answers to questions that are relevant to everyone and support learning, such as "How do I prepare for a test?" "How do I do better on a test next time?" or "How should I study math" or "Why do I need math"?
- Alternatively, you can create a web page (easy to do with WordPress, Wix, GitHub, etc.) with frequently asked questions, and then refer your students to that page.

Other Strategies

- Publish your "email etiquette" (e.g., how to write an email to a TA?) on the course LMS or web page.
- Insist that in emails students should identify the course they are in and sign the email message with their full name.
- Suggest to students that they should consider writing short, get-to-the-point messages and avoid phrases such as, "I hope this email finds you well."
- Inform students that you will NOT respond to emails 2 hours before a test, unless there is something absolutely urgent.
- Let emails accumulate and answer them in bulk so that you can make better use of your template to respond to frequently received emails.
- Do not leave the impression that you are available to your students immediately as their emails arrive to your inbox.



Reading Between the Lines of Student Emails

Student emails are often written in informal language with unconventional acronyms, awkwardly formulated, and sometimes unclear—they are anything but straightforward.

Understanding what exactly students are asking is the first step towards effectively assisting them.

General Tips

- First, try to figure out what the student is actually trying to say. If needed, ask the student to clarify or rephrase their email.
- A student who is under pressure or emotional stress might amplify or misinterpret their concerns (“I do not know anything” “I am failing the course”). Consider a Zoom meeting as an alternative to a chain of emails.
- If a student refers to their mental health, take it seriously, even if you do not believe it (see dealing with student anxiety).
- Keep your email reply short, and to the point. Students will likely skip half the email if faced with a several paragraphs and with links to yet more information.
- There is no need to retype paragraphs from your course outline, policies for missed assignments, and so on. Just remind students where to find them.

Examples of Student Emails & Tips for Responding:



**Dear Instructor or TA,
I missed the last three lectures and am reaching out to ask
if you can tell me what you lectured about.
Thank you,
A confused student**

- There is no need to inquire about the reasons for this student's absence. Keep in mind that you cannot get personal with your students, but instead need to keep a distance. You can be friendly, but professional.
- Write a short reply, remind the student that the videos of your lectures are available. As well, there is a Discord for the course.
- Between the lines: The student might be asking for a summary of the missed lectures, or to figure out how important or relevant the content is. It is not your duty to do this



**Dear Instructor or TA,
Can I make a short appointment with you?
Thank you,
A confused student**

- First, try to figure out what the issue is over email.
- Keep in mind that a short appointment is rarely ever short. "Do you have a second to answer a quick question" could easily turn into 30 minutes of answering many questions
- Between the lines: This could easily be about a test. A student would like to discuss their test, or plea, in person, for extra credit. If it is about a test, ask them to go over the test, and have questions ready to discuss when they meet with you. This way, you can check how serious they are about actually learning from their mistakes (as opposed to begging for extra points). Some students, unhappy with your reaction/response, will try to come back and plead their case. In which case, you have already made a decision—so there would be no need to meet with the student again.



**Dear Instructor or TA,
I missed my test because last night I ate something bad and was sick all night. What can I do to make up for it?
Thank you,
A confused student**

- There is too much information here— it is best to ignore the extra information and address the missed test only.
- Remind the student of the missed test policy, which clearly states what happens if a student misses a test or an assignment
- Do not make private deals with any student because you're feeling sorry for them. This is not fair towards other students in your class and threatens the integrity of your assessments and your course.
- If a student insists, send the student to their faculty adviser.



**Dear Instructor or TA,
I have no idea about integration, and we have a test next week. What do you suggest I do?
Thank you,
A confused student**

- Writing “I have no idea” is often an overstatement. If a student comes to your classes regularly, they are likely to pick up at least on some ideas
- Between the lines: It could be that the student realized that they will not have enough time. Stressed, they looked at their notes/textbook and felt overwhelmed by the amount of material they need to study.
- Suggest that the student make an appointment with you during office hours.
- As a strategy, suggest that the student focuses on one part of the material, to help their anxiety. Suggest that the student try not to cram all of it at once. Advise the student to work on the problems and not to study “ready-made solutions.”
- Suggest an extra resource, such as a math help centre or a tutorial centre.



**Dear Instructor or TA,
Today I was feeling depressed in the morning and could not get out of bed. I do not know what to do, can you help me please? Thank you,
A confused student**

- Regardless of whether you believe this email is serious, we always need to assume that it is serious
- Invite the student for a brief chat. During this conversation be supportive, and gather some more information so that, if necessary, you can refer the student to the appropriate facility or resource on campus.
- Remember that you are not a trained psychologist, so refrain from giving advice.
- Listen. Sometimes that's what students need.
- Encouragement works only if it's genuine.



**Dear Instructor or TA,
My friends told me that you moved the due date for our assignment to Friday, but now I see that it was due yesterday. Can you still accept my assignment as it is not my fault?
Thank you,
A confused student**

- First, correct the student by telling them that it is actually their fault - there are multiple sources of information (the LMS, course syllabus) with the correct date. The student should be relying on course materials not hearsay from friends.
- Suggest that the student reads missed/late assignments policy in your course outline. Do not copy/paste that policy, as it is better that the student finds it on their own (by doing so, they might discover other important pieces of information about the course).



Teaching Online: Zoom Etiquette

Zoom etiquette is some baseline parameters that help everyone fully utilize the potential of teaching and learning in an online platform.

When everyone is on the same page, it allows everyone to have a positive experience, be productive and build community.

Here are expanded descriptions of 6 strategies that will help to make your teaching in an online platform more positive:

The Mute Button

We've all experienced this one, and some of these have definitely gone viral. The most disruptive (and sometimes embarrassing) aspect of online learning platforms is when someone is unmuted when it is not their turn to share. So... think about your mute button!

Prepare in Advance

One of the best parts of teaching online is that we get to practice in the room before day one. We don't always get to do this in face-to-face rooms on campus. So, before the first class get to know all the controls and try out different setups. Do you want to ensure that everyone is muted upon entry, or do you want to give people the choice? Do you want to have a waiting room? Should the classroom have a password to enter? How do you use the polling tool? How do you share a screen? Should everyone have the power to share a screen or just the hosts and co-hosts?



Make Eye Contact

Keeping eye contact will help to build community. If you can, keep your video on as instructor and place your camera at eye level.

Monitoring the Chat

A lot of participation happens in the Chat Box- even when cameras are off, and you can't see students. Make sure you pause teaching often to check the chat. Acknowledge comments and questions even if you can't address them all- it encourages more participation. Chat is also an excellent way to check in with students. Throw in a quick question into the chat- you can ask for a quick report on how the students are feeling about the content. Use a waterfall (for more discussion see the section on waterfalls) or another one of the tools you learned in the course.

Appropriate Background

Think about your background in view of your students. Keep the area that is in view of the camera neat and tidy or choose an appropriate background that blurs the mess.

Frequent Pauses

Incorporating frequent pauses into online teaching is important for two reasons. First, there is always at least one person in class experiencing technical difficulties. Incorporating frequent pauses allows those who are experiencing difficulties to catch up. Oh, and you most definitely should address any internet interruptions while in class. It puts those experiencing interruptions more at ease. Addressing internet interruptions can be just suggesting that students dial-in, or turn off their cameras. You can also record the class so students can access it later, or direct students to the LMS or an alternate place for the resources shared in class. Second, learning in an online environment has a lot more distractions than in face-to-face environments. (You know- the cat sitting on your favourite pen, the telemarketer incessantly calling, and even wondering if you turned off that stovetop). These pauses allow time for those who have become distracted to reorient themselves.



Responding to Internet Disruptions and Lag

Technology offers a lot of affordances. It also can cause troubles when there are internet disruptions or lag in communication. These moments are unavoidable and can happen to anyone.

We present strategies help your class to transition (more) smoothly during these moments.

Strategies for Faster Internet

Even though not everyone has access to high-speed internet, there are some strategies that can help your internet to go faster. First check the speed of your internet here at [speedtest](#). Sometimes resetting a router can help or connecting your laptop directly to your modem or moving close to your router can give you greater speed.

Be Prepared and Create Systems in Your Classroom

During the first day or during orientation for the class, establish clear guidelines for when the students will inevitably experience lag or connectivity issues. First alleviate student's anxiety. Many students inevitably panic when they get cut off from class. Students become especially anxious when they cannot connect to the class from the beginning. Let students know that it is ok. They should:

- Contact the instructor to let the instructor know what is going on.
- Find a person in the class who can share what was covered in class.
- Use their phone to connect with someone in the class and ask them to place their phone near the screen so they can still participate.
- Ask students to check the LMS for class resources (video recordings, work, powerpoint etc.) so they will know what they missed.
- Ask students to catch up on the missed work.