

BME/BIOE Guide to Going Online

Many schools have moved online due to the COVID-19 pandemic. A group of individuals in the BME community have created a document to help collect and disseminate guidance for the BME community to move lectures, labs, and design projects online. Within each course type, we separated into focus areas of Content (resources for topics covered in BME curricula), Content Delivery Mode (modes to deliver remote content and student engagement strategies), Assessment Modes (modes for capturing direct assessment from students remotely), and Tools (platforms to collect assessment data). This is a living document and we welcome others from the community to add to and use the advice provided in this document.

Link to share: <https://go.bioengineering.illinois.edu/GuidetoGoingOnline>

Read an article about the process to make this guide published in Annals of Biomedical Engineering (open access): <https://link.springer.com/article/10.1007/s10439-020-02501-4>

Hi everyone, we are hoping to get a sense of who all is reading this. Even if you aren't adding anything, please put your name down to let us know you stopped by and to facilitate collaboration!

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We have provided some categories below and each one is split into content, content delivery/student engagement strategies, assessment, case studies, and tools.

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I. Ideas for Design Classes

This is a survey to understand what design capabilities that students have at their homes. Put in by Ann Saterbak (Duke)

https://docs.google.com/document/d/1N4omCvahhf4bYkegPerZnu1L_Dllu1g1GOzV1vDLdgM/e/dit?usp=sharing

Managing Capstone during COVID-19 - Ongoing Community Board (not BME specific)

For continued conversation and idea sharing about how to manage capstone during COVID-19, join the ongoing "Capstone Contingency Planning" board set up on Trello. Review the ideas that have already been posted and add your comments and/or post new ideas. (Note: if you don't already have a Trello account, you'll need to create one - it's free.)

trello.com/invite/b/dY5dZs0e/256c39413b8c1b9183fa5bf8b076f60a/capstone-contingency-planning

Content

Med Device Innovation

<http://ebiodesign.org/>

QMS/Risk/Standards

<https://www.greenlight.guru/blog>

NIBIB Bionic man

<http://www.nibib.nih.gov/science-education/bionic-man>

Medical design excellence award winners

<https://www.mdeawards.com/en/2019-mdea-winners.html>

2019 NIBIB Design by Biomedical Undergraduate Teams (DEBUT) Challenge Winners

<https://www.nibib.nih.gov/2019-DEBUT-Winners>

Medical devices for women's health

<https://medicalfuturist.com/10-outstanding-companies-for-womens-health/>

Standards

<https://www.standardslearn.org/>

<https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/standards-and-conformity-assessment-program>

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfStandards/search.cfm>

<https://www.asme.org/codes-standards/training-and-events/engineering-student-resources>

https://www.ansi.org/education_trainings/university_outreach?menuid=9

Engineering Design Process

https://www.youtube.com/playlist?list=PLFiViU_gwuxmAMSJjLRAELSFiy6R9_UBY

Focus on business models/3d Modeling

Med Device Lifecycle Topics beyond what might normally be covered in Capstone (Healthcare Economics, Distribution, Packaging and Logistics, Product end of Life, Manufacturing, Process Improvement, Postmarket Surveillance/CAPA, FTO)

Content Delivery/Student Engagement Strategies

Create sign-up in google sheets to establish a standing weekly zoom meeting with each team (Instructor logs in to 1 zoom link, 1 team joins for 20 minutes, then leaves, next team joins for 20 minutes, etc.)

Use zoom to manage entire live class periods. Break class into teams using Zoom breakout functionality. Instructors permeably move from room to room offering feedback. (Matthew Wettergreen at OEDK at Rice University will use this). You can also record using zoom. [See more Zoom resources at the bottom of the Google Doc.](#)

Whole class zoom meetings (with content delivery, activities for breakout rooms)

Asynchronous videos of content

[Techsmith Relay](#) for Video posting to Canvas (can see who is watching, can add quizzes, sends grades back as a csv file) Canvas can have limited storage space, Techsmith Relay helpful for storage as well

Explore the possibility of cross University Peer-to-Peer Design Progress Reviews (see facilitating student engagement section)

Assessment

Design Documentation, Test Plans, etc

Technical Reports

- Involve students in peer review to keep them engaged in class

Student Zoom/Video Presentations

- Enable "Waiting Room" to control incoming/exiting student teams.
- Or have the entire class present in the same room, have everyone muted, then unmute one team at a time. One group presents, rest of the class listens.
- Have students make 10-12 minute videos and let them choose the format: a PowerPoint Presentation with voice over, a video with props pretending they're giving a demonstration of their product, a music video, a sales pitch video to investors, etc.

Student Posters

- Submit online as Google Slides then create a survey to allow for peer review of each other's posters
- Adobe Spark may be useful mode of presentation

Zoom exams

- Students all log onto Zoom with a camera and audio. Then all receive email with exam in it and take the exam on camera through Zoom or other media. I did this when I taught an online course overseas. Only issue is if they need to write on it then they need access to a printer. Easier if it can be a typed exam and then give more time than normal to accommodate for that.

Peer-assessed Gallery Walk

- Post a design artifact from a design team (poster, last prototype, proposal for test plan etc...) and have members of other teams make comments. Then ask teams to write how they would respond. Assess both the comments from individuals and the response from the teams.
- Try to use a format that allows asynchronous communication and comments
- It will be helpful to assign reviewers so that an individual can do a good job of reviewing the work of one (or at most two) teams.
- Check in as an instructor to provide some summary observations on the comments.

Regular documentation from student teams (Matthew Wettergreen at OEDK at Rice University will use this)

- Following any time unit of prototyping, require each team to produce documentation explaining their work
- Each group (defined as any number of students co-located) should produce a) a 30 second video showing and describing what work they

completed and b) a bulleted list of what they completed. This sets a standard for students that they must plan for and be productive during work periods and also gives them the practice to improve these over time

Modify Course Deliverables for Design

- Identifying what will be the final products for the semester. Normally we (Columbia DBME) have a final prototype and demo, DHF, poster, business plan, and pitch. I propose that, especially with regards to prototyping, final products must be clearly defined for both faculty and students. These products could be:
 - High quality renderings and/or animations, i.e., envisioning the final product and it's prospective use
 - For mechanical or electrical systems, simulations that would inform parts' selections, anticipated performance
 - ML/MV projects: optimize algorithms/classifiers test on non-training data sets. Optimize analysis, .e.g, real-time, cloud-based

Case Studies

FDA Databases

510K (Helpful for Class II)

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm>

Maude

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMAUDE/TextSearch.cfm>

Example Redacted FDA Submission:

<https://www.accessdata.fda.gov/CDRH510K/K170648.pdf>

Product Code Classification Database (quick search):

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPCD/pcdsimplesearch.cfm>

PMA Quicksearch (Helpful for Class III):

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pmasimplesearch.cfm>

DeNovo Database:

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/denovo.cfm>

Establishment and Device Listing (Helpful for all, esp Class 1 exempt):

<https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfrl/textsearch.cfm>

Harvard Business Publishing Simulations (teamwork, leadership, entrepreneurship, economics) *They are offering a zoom webinar March 19th about teaching online.

<https://hbsp.harvard.edu/simulations/>

https://zoom.us/webinar/register/WN_wOWI99o9TyqZAecBkH13CA

Tools

Arduino simulations, etc.

<https://www.tinkercad.com/>

Android Studio:

<https://developer.android.com/studio>

Brainstorming, business models, other templates

<https://mural.co/>

Presentation of multiple modes of information (videos, graphics, etc)

<https://spark.adobe.com/#what-create>

Eagle AutoDesk PCB Design-used for design

<https://www.autodesk.com/products/eagle/overview>

Can order PCBs or vinyl cutter to make a DIY pcb

Fritzing Circuit Design

<https://fritzing.org/home/>

Portfolium can be used by students to curate a portfolio, connected with Canvas

<https://portfolium.com/>

II. Ideas for Traditional Lecture Classes

Content

Content Delivery/Student Engagement Strategies

Limit lecture length, 7-10 mins lecture is a good target length to keep student engaged
Alternate mini-lecture with activities, discussion, polling, etc.

Use of iPad or other tablet device to record the mini lectures with diagrams/slides. This is similar to teaching via the blackboard or whiteboard. I use 'Explain Everything' and import to Blackboard via [Panopto](#) or [Kaltura](#) for Compass users. Augment with a discussion board and utilize zoom to facilitate discussion regarding the questions.

Many universities have licenses for Zoom, BlueJeans, Skype, or a similar meeting software that can record live sessions and link to your LMS for viewing by students asynchronously.

[JoVE](#): Check if your University has a subscription to JoVE, an online video resource. They have biomedical engineering and bioengineering-specific videos on different topics. *Updated: Free through 6/15/20

[Wiley online resources](#) are now freely available to students and educators through the end of Spring 2020.

Having good success with Mural (<https://mural.co/>) virtual whiteboards for in class exercises. I Create a single board with templates for teams to brainstorm while in Zoom breakout rooms. As a class we can move around the whole board to discuss team directions. Mural has been a great partner, offering flexible licenses and creating training specifically for educators.

Assessments

[Guidelines for Online Exams/Quizzes](#): a guide to help reduce cheating in online assessment from George Washington University

Canvas Quiz Tool - LMS integrated quiz tool that autogrades multiple choice questions
<https://community.canvaslms.com/docs/DOC-10152-415241475>

Article re: Online Proctoring Services

<https://www.insidehighered.com/digital-learning/article/2017/05/10/online-exam-proctoring-catches-cheaters-raises-concerns>

Oral Exams

Case Studies

National Center for Case Studies Teaching in Science:
<https://sciencecases.lib.buffalo.edu>

Tools

[Gradescope](#) - Useful for managing online homework submissions, has great tools for programming assignments in particular. It also reads bubble sheet exams if you go that way. Allows for rubric style grading and electronic return of graded submissions to students.

- From gradescope: "We are providing free access to Gradescope Complete for new courses created through June 30, 2020. We have also upgraded all existing 2020 courses.

[One Note](#) - an easy way to have multiple users take notes on a single notebook. Can be used for portfolio or team meetings remotely. App, web (through Office 365), and desktop versions.

III. Ideas for Engineering Lab Classes

Content

Case Studies from Previous Year's Lab: Provide data from the previous year lab write ups and have students reverse design the experiment, could ask students to analyze raw data and generate lab reports.

[PhysioNet](#) - Physiological Data from different experimental setups (ECG, gait and balance, EEG, images, etc.). PhysioNet also supports challenges, which invite participants to tackle clinically interesting questions that are either unsolved or not well-solved.

- Perhaps the largest database on PhysioNet is the [MIMIC database](#), which contains routine electronic health record data and physiological signals acquired in hospital from critical care patients. The database curators recently wrote a [textbook](#) on the database, which includes case studies (Part III) of analyses of electronic health record data designed to be carried out by students (with [accompanying code](#)). For example, [Chapter 26](#) provides a case study on estimating respiratory rate from two signals commonly measured by wearables, which can be replicated following the instructions [here](#).

[BIOPAC](#) has some digital labs if you can have students remote-in to software housed on engineering workstations. Can use to analyze data in platforms and/or process data using datasets already in the digital environment.

[Labview tutorials and labs online](#), have students learn LabVIEW from home and see demos of API and data acquisition protocols

[NScope](#), portable electronics lab with oscilloscope, function generator, power supply, and open API. Requires USB dongle for student to buy and free software for labs.

[JoVE](#): Check if your University has a subscription to JoVE, an online video resource. They have biology, biomedical engineering, and bioengineering-specific videos on different topics, including laboratory protocols. *Updated: FREE through 6/15/20

[OpenSim](#) Tug of War March Madness (could be a competition across schools):
OpenSim Muscle model simulation focused on muscle kinetics/kinematics, using

OpenSim (online from Stanford, free). Biomechanics simulations.

<https://simtk-confluence.stanford.edu/display/OpenSim/Designing+a+Muscle+for+a+Tug-of-War+Competition>

Machine Learning LDA Classifier (for prosthesis control, or other)

Could use pre-recorded emg data (8 channels Norax EMG or 4 channel Biopac), have pairs come in and record data and then spend a few weeks coding the classifier and generating a confusion matrix output

[JMP](#) Data analysis software. They have compiled info to facilitate online teaching with JMP, see [This recent blog](#).

Content Delivery/Student Engagement Strategies

Team-based learning - TBL is a pedagogy that uses collaborative pre-work, an individual quiz, a group quiz, and a team peer assessment. This is typically done in class with scratch off cards, but this offers an online way to follow the process - UIUC (Amos) [Article in Education for Chemical ENGINEERS about using TBL in a first year class](#) www.intedashboard.com -- it's used for TBL online, Assessment

Writing/presentation training

- Critical thinking through review/critique of reports
- Sample Rubrics
 - <http://ecee.colorado.edu/~mathys/ecen2250/pdf/ReportRubric.pdf>
 - [ASEE paper Grading the Capstone Written Design Reports: A Comparison of External Judges and Faculty Scores](#)
 - [Purdue Guide to Writing Technical Reports](#)

Assessment

Virtual lab practical - make a quiz in LMS and embed videos of techniques and images and have students critique and answer questions about techniques/images

Case Studies

- Give students old lab reports (names redacted) and have them critique the experiment/results/etc or reverse design the protocol.
- Do a review of a published article or review paper on a technique related to class

Tools

Visible Heart Lab (U of Minnesota) This lab has various videos related to cardiac anatomy, tutorials, imaging resources

<http://www.vhlab.umn.edu/atlas/index.shtml>

Lab Video Demos - using high quality videos of techniques can be an effective way to ensure that students understand a protocol while not able to perform it in person

Sigma Cell Culture Videos-presentations about cell culture

<https://www.sigmaaldrich.com/life-science/cell-culture/learning-center/cell-culture-videos.html>

ThermoFisher Videos

<https://www.thermofisher.com/us/en/home/references/gibco-cell-culture-basics.html>

BioRAD Videos

<https://www.youtube.com/channel/UCuxoeifh8VFy-SxllarGZnQ>

JoVE: Journal of Visual Experiments

<https://www.jove.com/science-education-library> Check if your University has a subscription to JoVE, an online video resource. They have biology, biomedical engineering, and bioengineering-specific videos on different topics, including laboratory protocols. *Updated: Free through 6/15

IV. Facilitating Student Engagement Overall

It can be challenging to gauge student understanding and get feedback, thoughts on how to improve this below.

Delivery Strategies

[Article about Asynchronous versus Synchronous Online Teaching](#)

Hrastinski, S. (2008). Asynchronous and synchronous e-learning. *Educause quarterly*, 31(4), 51-55.

Asynchronous

Synchronous

Individual/Team calls with Faculty

Articles

[Online Discussion Boards](#)

Inside Higher Ed | March 27, 2019

Discussion boards are likely familiar to the millions of students who have taken at least one online course, and to plenty of face-to-face students as well. Though many instructors place less grading weight on discussion board participation compared with exams or essays, the value of interaction between students can't be underestimated.

[General Article about Value of Class Discussions \(not specific to online\)](#)

The Chronicle | Date unknown

Most every college teacher has experienced that anxiety-producing moment when a promising class discussion fizzles out. It's important for professors to use active-learning strategies, but why does accomplishing that task sometimes feel so difficult?

Lectures/Polling/ Answering Student Questions

Two options for Interactive polling during presentations

<https://www.mentimeter.com/> (Free option has some decent functionality)

<https://www.polleverywhere.com/>

<https://piazza.com/subjects/engineering> - WikiStyle Q&A, Polling, Anonymous Question Asking, LaTeX Eqn Editor, Other Functionality (Free)

<https://www.slido.com>- Rapid audience response with up/downvoting; good for activities such as "Nominating Questions" or "Muddiest Point"

<http://www.questionpress.com> -Audience response and assessment (cheap for faculty, free for students)

<https://www.loom.com/> - Loom video recordings for instructors and students (free)

[Blackboard Collaborate](#) - built in polls / live questions within a classroom tool (Not Free, but part of some institutional VLEs).

Whole-Class Discussions

Canvas Discussion Boards

Zoom

Canvas Pages

Bluejeans

Small-Group Work

[Zoom Breakout Rooms](#) - support page from Zoom on setting up and managing breakout rooms

[Bluejeans](#)- video conferencing, breakout rooms option, host interactive video events

[Slack](#)

Microsoft Teams

[Discord](#) - Primarily used in the gaming community. [This blog post](#) shows how it could be adapted for creating a dynamic virtual classroom (text, audio, synchronous and asynchronous video, etc.)

Dropbox

Google Drive

[Google Jamboard](#) - Works like a whiteboard and free software can be used on tablet or phone. Turning on assistive drawing tools generates text or shapes.

[Trello](#) - FREE, great for managing multiple teams working on projects!

[Link to Document for Tips for student groups working remotely](#) - This document is intended to provide students with some guidelines on how to effectively and efficiently execute projects virtually.

[Hypothes.is](#) - Group annotation software. Could be useful for projects that require literature review

[Mural.io](#) - Virtual whiteboard / brainstorming software. Much like

<https://miro.com/education/> - Virtual whiteboard / excellent templates for user/customer journey, gantt charts, designing user flow, etc.

[Blackboard Collaborate](#) - Breakout rooms as part of a whole class session, with oversight from tutors / moderators. (Not Free, but part of some institutional VLEs).

Engage students across Universities?

Now that everyone is remote, perhaps it will be possible to now facilitate teams across different universities to review work, discuss projects (Group from Uni 1 has 30 min call with Group from Uni 2, provide feedback to each other, can remove any specific details that would cause IP concern)

Written Exams/Midterms

Students setup webcams of themselves taking the exam, while instructors and TAs watch remotely. With Zoom grid view feature, instructor can see when student raises hand if there is a question. Practicality depends on class size. Students email results when done. Could be multiple choice format, so just letters need to be emailed along with photographs showing student work.

Gradescope offers a new online assessment mode. Currently in beta, online assignments let you create questions directly on Gradescope. Students will be able to log in and submit responses within the Gradescope interface. For some types of questions (multiple choice, select all, and fill-in-the-blank), you can also indicate the correct answer ahead of time, and student submissions will be automatically graded.

<https://www.gradescope.com/help#help-center-item-online-assignment-outline-edit>

V. Relevant Articles/Tools/Links/Suggested Practices

[Online Lectures should be Live](#)

Blog: Edatscale.org | April 8, 2020

Illinois faculty who teach large courses share experience in teaching online and cite many benefits to live lectures.

[Illinois Bioengineering faculty transitions to online teaching](#)

University of Illinois at Urbana-Champaign | March 27, 2020

Faculty and TAs in Bioengineering at the University of Illinois at Urbana-Champaign share stories of moving online.

[Workload Calculator for Online](#)

Center for Teaching Excellence, Rice University

Somewhat surprisingly, there is very little research about the amount of time it takes the average college student to complete common academic tasks. Use this estimator to get an idea using self-reported estimates of how much total time students spend on academic work outside of class.

[NILOA Shared Doc](#)

National Institute for Learning Outcomes Assessment (NILOA) | March 26, 2020

In the spirit of providing a synthesis and go-to-resource for the transition to remote work and learning for faculty, staff, and students, NILOA is maintaining a Google Document with tailored resources to assist in this momentous shift.

[How to Be a Better Online Teacher](#)

The Chronicle | 2017

General tips on how to create effective online environments

Zoom Best Practices - Two quick and easy step by step guides to using Zoom

[Twitter threadunwrap](#)

[University of Minnesota](#)

[Teaching Practices- Just released resources](#)

Association of College and University Educators | March 13, 2020

List of resources and recommendations that can be immediately put to use by instructors, to benefit both faculty and their students.

[Tips for Working Remotely](#)

Trig | March 10, 2020

Q&A report from people who have been working at home for years on how to set up an effective environment to work from home and minimize distractions.

[Copyright guide on shifting to online classes](#)

University of Illinois Library | Updated March 11, 2020

A simple guide to online copyright laws and how to navigate copyright.

[Going online in a hurry](#)

The Chronicle | March 9, 2020

A short list of advice for faculty members who need to move online, fast, with the twin goals of maintaining instructional continuity as much as possible and finishing the semester strong.

[Going online as a prototype](#)

Blogger Rebecca Barrett-Fox | March 12, 2020

A nice reminder that your class is NOT the highest priority of their OR your life right now. Release yourself from high expectations right now, because that's the best way to help your students learn.

[So You Want to Temporarily Teach Online](#)

Inside Higher Ed | March 11, 2020

If you're considering an abrupt move to online teaching, Stephanie Moore and Charles B. Hodges have practical advice for instructors in the short term.

[Preparing for Emergency Online Teaching](#)

The Chronicle of Higher Education | March 12, 2020

This issue of Teaching, a weekly newsletter from a team of Chronicle journalists, includes information about how Clemson University is preparing its instructors to teach online, how other colleges are transitioning to remote teaching and links to online teaching resources.

[Navigating Uncertain Times: How Schools Can Cope With Coronavirus](#)

EdSurge | March 2020

This guide from EdSurge contains tips and how-to's, examples from schools and community resources for educators adapting to teaching online, remote work and the latest coronavirus developments.

[Coronavirus Resources: Teaching, Learning and Thinking Critically](#)

The New York Times | Last Updated March 16, 2020

This page contains resources for teachers and students to stay updated on the outbreak, think critically about information, consider essential questions about the pandemic and what it tells us about our world today and teach and learn when schools are closed.

[How to Reconnect With Students and Strengthen Your Remote Course](#)

The Chronicle of Higher Education | APRIL 09, 2020

The latest issue of the weekly newsletter Teaching that focuses on ideas around how to structure a supportive learning environment, and how that might apply to an emergency situation such as this, where many students struggle to stay focused, or find it difficult to learn with unfamiliar systems and technologies.

[8 Ways to Be More Inclusive in Your Zoom Teaching](#)

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Tips from Kelly A. Hogan who is associate dean of instructional innovation at the University of North Carolina at Chapel Hill.