Hidden Treasure:
Universal Design Practices in Post-Pandemic Engineering Education
Practices to Keep

Think of a practice that your institution is using in response to the pandemic, that you consider a “keeper”—something to continue even when distancing requirements end.

Share your response using the “Questions” box.
Responses

- Many of these practices are multi-purpose; they allow students to engage in ways that best fit their circumstances.
Universal Design

The working group of architects, product designers, engineers, and environmental design researchers at the North Carolina State University Center for Universal Design define **universal design** (UD) as:

“the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design” [1].
Recorded & Captioned Lectures

“\(\frac{R_1 R_2}{R_1 + R_2} + R_3\)"

“\(\frac{R_1 R_2}{R_1 + R_2} + \frac{R_3}{R_1 + R_2}\)"

But it does a fairly robust job at recognizing the written equation.

Who benefits from captioning?

“I have trouble understanding or processing speech”

“I don’t have a quiet place to study”

“I remember/can translate written text better than spoken words”
Control Lecture Speed

Who benefits from pause and rewind?

“"I have difficulty paying attention for long periods of time”

“I get hung up or perseverate on small details”

“I keep getting interrupted by others who need me”
Asynchronous Rewatching

“"I am still learning how to take notes on this subject”

“"I was too busy writing that I couldn’t really listen”

“"I need to move my body to concentrate”

Who benefits from watching outside class? [2]

“"I missed class”

But it does a fairly robust job at recognizing the written equation.
Mobile Lab Pedagogy

“I can’t spend much time on campus”

“Fine-tuning knobs is difficult—I prefer the keyboard and other assistance from the PC”

“I have never worked with this stuff before—I don’t want others to see me fumbling around”

Who benefits from mobile lab equipment? [3]

https://blog.digilentinc.com/test-and-measurement-solutions-for-students-in-the-lab-and-at-home/ Photo used with permission from Digilent.
How do we design educational practices with UD perspective?

- Multiple frameworks for educational application of UD
- Universal Design of Instruction
  - DO-IT at Univ. of Washington, Sheryl Burgstahler
  - “UD promotes an expanded goal to make products and environments welcoming and useful to groups that are diverse with respect to many dimensions, including gender, race, ethnicity, age, socioeconomic status, ability, veteran status, disability, and learning style”. [4] (emphasis mine)
Universal Design for Learning

- UDL is a framework developed by CAST
  - [http://www.cast.org](http://www.cast.org)
  - [http://udloncampus.cast.org](http://udloncampus.cast.org)
  - [http://udltheorypractice.cast.org](http://udltheorypractice.cast.org) (book)

- ACCESS Project at Colorado State
  - [http://accessproject.colostate.edu](http://accessproject.colostate.edu)

- UDL-Universe at Sonoma State University
  - [https://enact.sonoma.edu/udl](https://enact.sonoma.edu/udl)
What is UDL?

- The UDL guidelines identify design principles that support three primary classes of learning networks within the brain [5]:

  - The **why** of learning
  - The **what** of learning
  - The **how** of learning

[https://udlguidelines.cast.org](https://udlguidelines.cast.org)
UDL Guidelines

https://udlguidelines.cast.org/binaries/content/assets/udlguidelines/udlg-v2-2/udlg_graphicorganizer_v2-2_numbers-no.pdf
The “What” of Learning

Provide multiple means of Representation

Recognition Networks
The “WHAT” of Learning

Resourceful & Knowledgeable
Known Best Practices in Teaching

**Provide options for Comprehension**
- Activate or supply background knowledge
- Highlight patterns, critical features, big ideas, and relationships
- Guide information processing and visualization
- Maximize transfer and generalization

**Provide options for Language & Symbols**
- Clarify vocabulary and symbols
- Clarify syntax and structure
- Support decoding of text, mathematical notation, and symbols
- Promote understanding across languages
- Illustrate through multiple media
Move to Electronic Materials

Provide options for Perception

- Offer ways of customizing the display of information
- Offer alternatives for auditory information
- Offer alternatives for visual information

- Options are built-in to many electronic formats
- Use accessibility checker, Math ML
- Recording and auto-captioning

*Not just for students with sensory impairment!*
The “Why” of Learning

Provide multiple means of Engagement

Affective Networks
The “WHY” of Learning

Purposeful & Motivated
Support Growth and Persistence

Provide options for **Self Regulation**
- Promote expectations and beliefs that optimize motivation
- Facilitate personal coping skills and strategies
- Develop self-assessment and reflection

- Growth mindset
- Discipline-specific tools to evaluate one’s growth
- How to use mistakes (technical or social)

- Clear expectations for beginners
- Facilitate community-building within the major

Provide options for **Sustaining Effort & Persistence**
- Heighten salience of goals and objectives
- Vary demands and resources to optimize challenge
- Foster collaboration and community
- Increase mastery-oriented feedback
Promote Interest, Combat Threats

Provide options for Recruiting Interest

- Optimize individual choice and autonomy
- Optimize relevance, value, and authenticity
- Minimize threats and distractions

- Can be challenging for engineering faculty
- Need to consider curriculum from other perspectives
The “How” of Learning

Provide multiple means of
Action & Expression

Strategic Networks
The “HOW” of Learning

Strategic & Goal-Directed
Multiple Means of Action & Expression

Provide options for Physical Action
- Vary the methods for response and navigation
- Optimize access to tools and assistive technologies

- Not just paper & pencil
- Keyboard / voice
- Ink-to-math or TeX
- Instruction on alternatives

- Choice of media for work
- Reduce extraneous cognitive load
- Semi-synchronous communication

Provide options for Expression & Communication
- Use multiple media for communication
- Use multiple tools for construction and composition
- Build fluencies with graduated levels of support for practice and performance
Support Executive Function

Provide Options for Executive Function

• Guide appropriate goal-setting
• Support planning and strategy development
• Facilitate managing information and resources
• Enhance capacity for monitoring progress

• Educational social capital, neurodivergence affect EF
• Not usually the domain of engineering faculty
• Possibly the area with the most potential to effect change
UD Needed in Engineering Ed

• Universal Design has not been used widely in engineering education, but that is changing [6-9].

• Unfortunately, research on the experiences of neurodiverse groups in engineering has often been met with negativity. In [10] an anonymous researcher is quoted as saying:

  “Our previous work was on other status groups, including women in STEM fields, high performing students of color, and children of immigrants. We have never been marginalized in the scientific arena before this study of students with learning disabilities. The general population and the scientific community did not appear to understand that students with learning disabilities are capable of high levels of achievement if given the opportunity.”

• Nonetheless, the STEM student body is neurodiverse [11].
Main Takeaways

• UDL practices promote broad inclusion without “catering” to specific groups or requiring extensive knowledge about neurodiversity.
• Pick a practice you think is reachable and build it into your curriculum (or support others in doing so).
• Check out electronic accessibility guidelines at your institution or others, and update documents.
• Diverse constituencies will be able to use materials in their own way to overcome physical, sensory, psychological, and logistical barriers to success in engineering.
References


Questions?

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