WEPAN
Women in Engineering ProActive Network

Transforming Culture in Engineering Education

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.

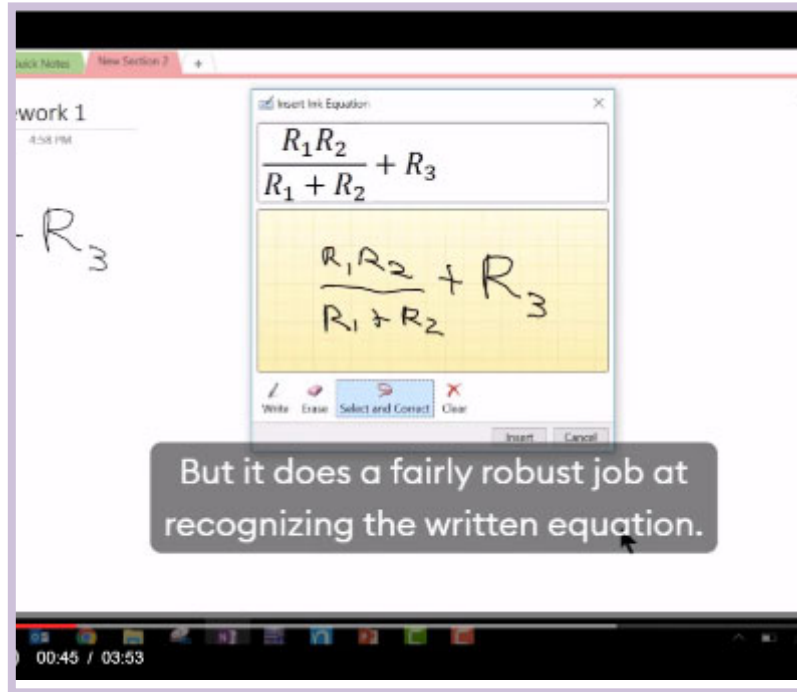Share your response using the "Questions" box.

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

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

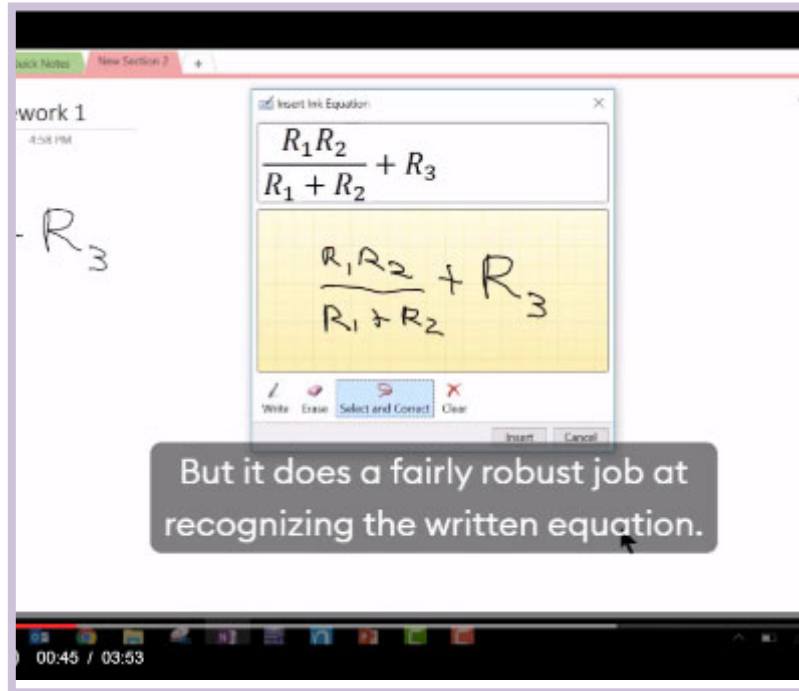$$\frac{R_1 R_2}{R_1 + R_2} + R_3$$

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

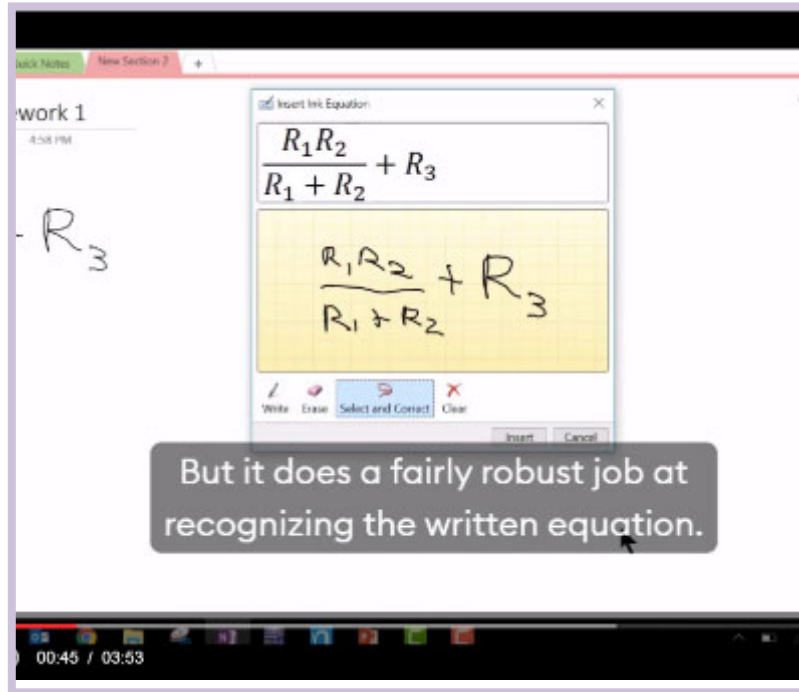But it does a fairly robust job at recognizing the written equation.

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"

![WEPAN logo] Women in Engineering ProActive Network

Asynchronous Rewatching

Who benefits from **watching outside class**? [2]

"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"

"I missed class"

Mobile Lab Pedagogy
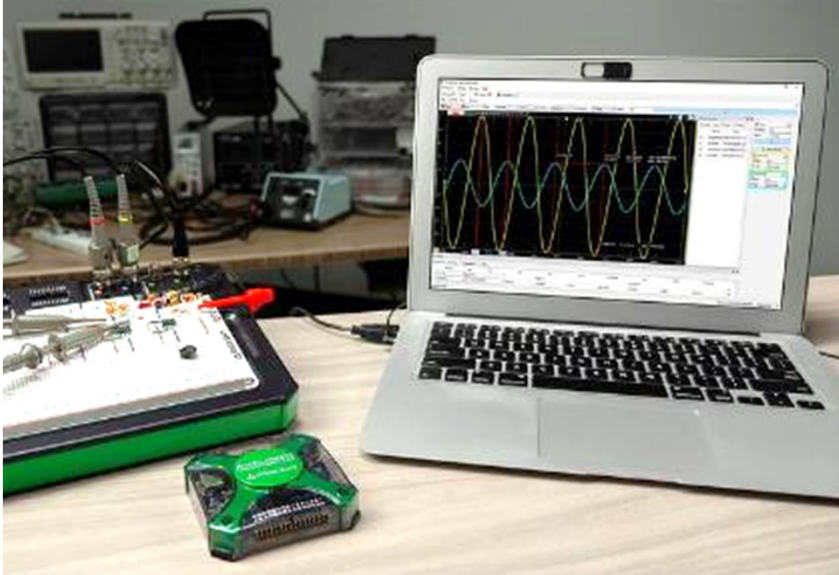
Who benefits from **mobile lab** equipment? [3]

"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"

https://blog.digilentinc.com/test-and-measurement-solutions-for-students-in-the-lab-and-at-home/ Photo used with permission from Digilent.

Universal Design in Higher Ed

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://udloncampus.cast.org

  – http://udltheorypractice.cast.org (book)

- ACCESS Project at Colorado State

  – http://accessproject.colostate.edu

- UDL-Universe at Sonoma State University

  – 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]:
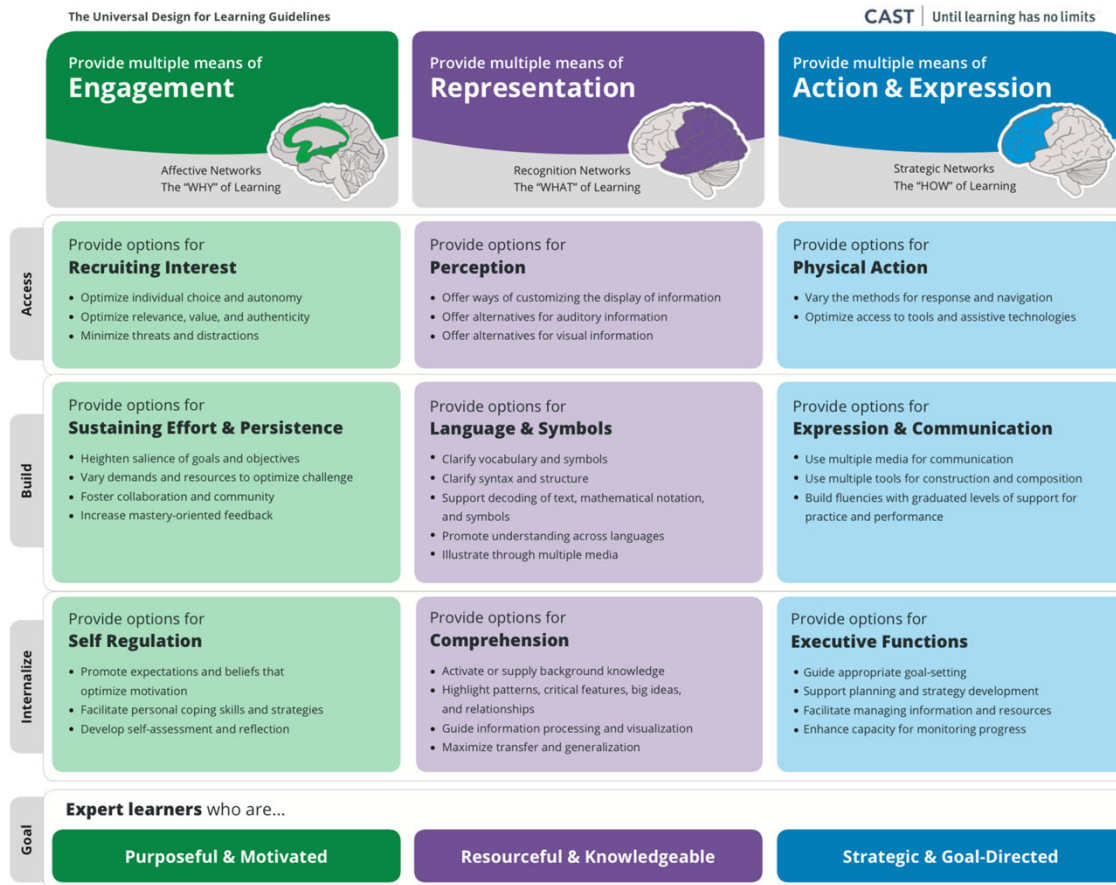

The **why** of learning   The **what** of learning   The **how** of learning

https://udlguidelines.cast.org

UDL Guidelines

The Universal Design for Learning Guidelines

CAST | Until learning has no limits

	Provide multiple means of **Engagement** Affective Networks The "WHY" of Learning	Provide multiple means of **Representation** Recognition Networks The "WHAT" of Learning	Provide multiple means of **Action & Expression** Strategic Networks The "HOW" of Learning
Access	Provide options for **Recruiting Interest** • Optimize individual choice and autonomy • Optimize relevance, value, and authenticity • Minimize threats and distractions	Provide options for **Perception** • Offer ways of customizing the display of information • Offer alternatives for auditory information • Offer alternatives for visual information	Provide options for **Physical Action** • Vary the methods for response and navigation • Optimize access to tools and assistive technologies
Build	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	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	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
Internalize	Provide options for **Self Regulation** • Promote expectations and beliefs that optimize motivation • Facilitate personal coping skills and strategies • Develop self-assessment and reflection	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 **Executive Functions** • Guide appropriate goal-setting • Support planning and strategy development • Facilitate managing information and resources • Enhance capacity for monitoring progress
Goal	**Expert learners** who are... **Purposeful & Motivated**	**Resourceful & Knowledgeable**	**Strategic & Goal-Directed**

udlguidelines.cast.org | © CAST, Inc. 2018 | Suggested Citation: CAST (2018). Universal design for learning guidelines version 2.2 [graphic organizer]. Wakefield, MA: Author.

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

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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

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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].

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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

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[3]   S. S. Holland, C. J. Prust, R. W. Kelnhofer, and J. Wierer, "Effective utilization of the Analog Discovery board across upper-division electrical engineering courses," in *ASEE Annual Conference and Exposition*, New Orleans, LA, 2016.

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[5]   A. Meyer, D. H. Rose and D. Gordon, *Universal Design for Learning: Theory and Practice*, Wakefield, MA: CAST Professional Publishing, 2014.

[6]   S. R. Ross, "Supporting your neurodiverse student body using the Universal Design for Learning framework," in *IEEE Frontiers in Education Conference*, Covington, KY, 2019.

[7]   M. Lord, "Radical Inclusion", *ASEE Prism,* November 2020.

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[9]   N. W. Moon, T. T. Utschig, R. L. Todd, and A. Bozzorg, "Evaluation of Programmatic Interventions to Improve Postsecondary STEM Education for Students with Disabilities: Findings from SciTrain University," *Journal of Postsecondary Education and Disability*, vol. 24, no. 4, pp. 331–349, 2011.

[10]   L. P. Thurston, C. Shuman, and B. J. Middendorf, "Postsecondary STEM Education for Students with Disabilities: Lessons Learned from a Decade of NSF Funding*," Journal of Postsecondary Education and Disability* vol. 30, no. 1, pp. 49–60, 2017.

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Questions?

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