Slide 1

METALS

Masters of Educational Technology & Applied Learning Science

Learn. Create. Innovate.

Virtual Open House

October 14 @ 10 AM EDT

Applications Due December 9th

http://metals.hcii.cmu.edu

Slide 2

Welcome!

- Ken Koedinger,
  Director

- Michael Bett,
  Managing Director

- Jo Bodnar,
  Program Administrator

Slide 3

Extended Welcome from Our Learning Science Faculty

Vincent Aleven · Sharon Carver · Jessica Hammer · Erik Harpstead · Lauren Herckis · Ken Holstein · Ken Koedinger

Chinmay Kulkarni · Marti Louw · Marsha Lovett · Bruce McLaren · Amy Ogan · Carolyn Rose · John Stamper · Nesra Yannier

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Slide 4

Overview

- **CMU & METALS are unique**
- Curriculum
  - Capstone
  - Courses
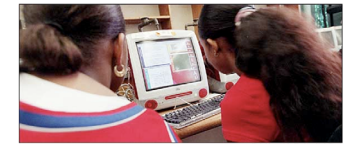- Finances
- Application

Why Carnegie Mellon

- Where Learning Science began
- Alan Newell and Herb Simon
  - Turing Prize Winners
- Created Logic Theorist - first thinking machine
- Created the fields of
  - AI
  - Cognitive Psychology
  - Learning Science
 - EDM – Educational Data Mining

CMU Learning Science is Making a Difference
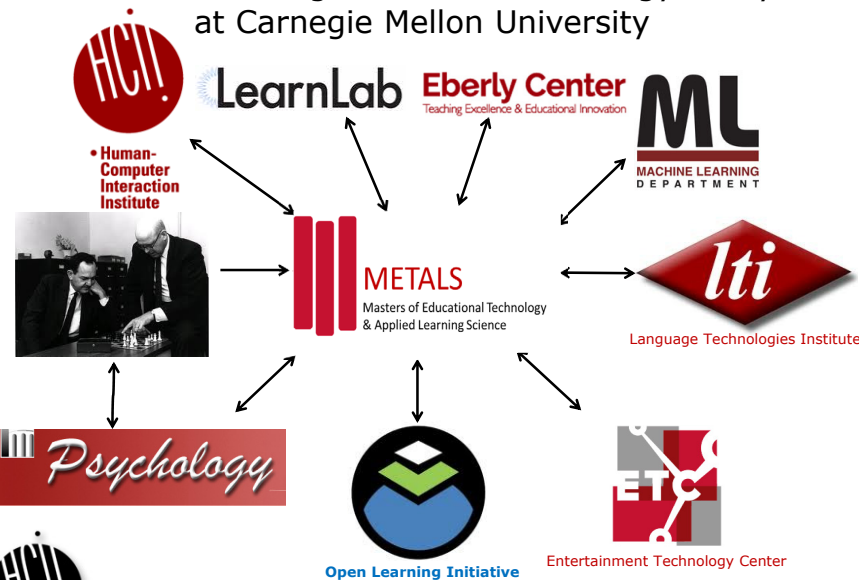

Software Tutors Offer Help and Customized Hints

MATH COACH - Rochelle Brown, left, and Iesha Antonetti, students at Middle School 103 in the Bronx, use Cognitive Tutor software to reinforce math skills. The software is designed to give students individualized instruction when personal attention is scarce.

- Real-world impact of Cognitive Tutors
  - 600K students/year
  - *Doubles achievement!*
  - 2011 sale for ~$95M

- OLI college courses
  - 30+ open online courses
  - *2x faster & better*
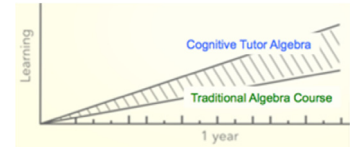
Pane et al. (2013). Effectiveness of Cognitive Tutor Algebra I at Scale. RAND.

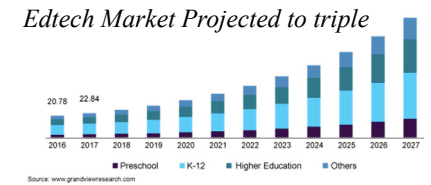## Learning Science & Technology Ecosystem at Carnegie Mellon University

- Human-Computer Interaction Institute
- LearnLab
- Eberly Center — Teaching Excellence & Educational Innovation
- ML — MACHINE LEARNING DEPARTMENT
- METALS — Masters of Educational Technology & Applied Learning Science
- lti — Language Technologies Institute
- Psychology
- Open Learning Initiative
- ETC — Entertainment Technology Center

Many Spinoffs and Local Startups

CARNEGIE LEARNING — LONG + LIVE + MATH
remake learning COUNCIL
acrobatiq by VitalSource
Nori
turnitin
PLAY POWER LABS
TutorGen, Inc. — A Revolution in Learning
h{s}l
SCHELL GAMES
duolingo
BloomBoard

Slide 9

Many Corporate Partners

Logos: RENAISSANCE LEARNING – Accelerating learning for all; CENGAGE Learning; EY – Building a better working world; Houghton Mifflin Harcourt; WESTERN GOVERNORS UNIVERSITY; edmentum; Microsoft; CARNEY; K12; KAPLAN; McGraw Hill Education; turnitin; PEARSON; CARNEGIE LEARNING – LONG + LIVE + MATH; DDI; BloomBoard
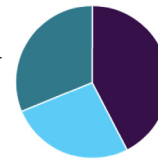

Slide 10

Learning & Training Continues to Boom!!

- *New ideas*
- *New technologies*
- *New companies*
- *New careers*

Spending by area

Edtech Market Projected to triple

20.78 22.84

2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027

■ Preschool ■ K-12 ■ Higher Education ■ Others

Source: www.grandviewresearch.com

GLOBAL EDUCATION INTELLIGENCE

Global Decade of EdTech VC   Holon IQ

Global Education Venture Capital Funding by Year, 2010-2019 in USD Billions

Hardware
Software
Content

Source: www.grandviewresearch.com
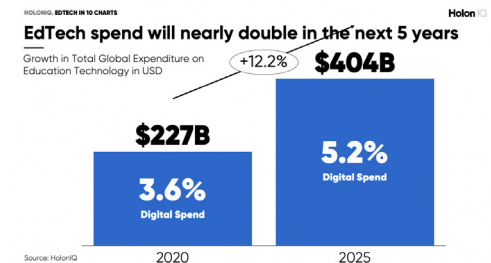

Slide 11
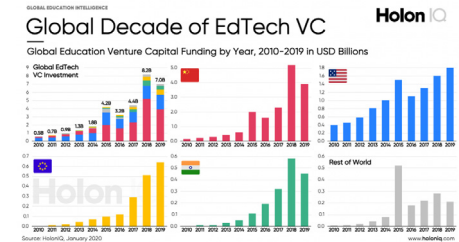
The Edcation Market is Huge!

- 1.5 Billion K12 Students**
- 151 Million Post-Secondary Students**
- Education World market: $6 Trillion*
- EdTech World Market $227 Billion projected to grow to $404B by 2025*
- Venture Capital: $8.2 Billion*

*https://www.holoniq.com/edtech/10-charts-that-explain-the-global-education-technology-market/

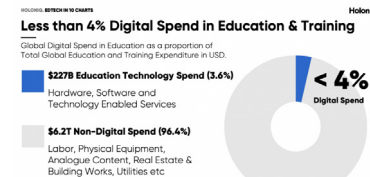**http://data.uis.unesco.org/# (2015 data)

Slide 12

Learning & Training Continues to Boom!!

- *New ideas*
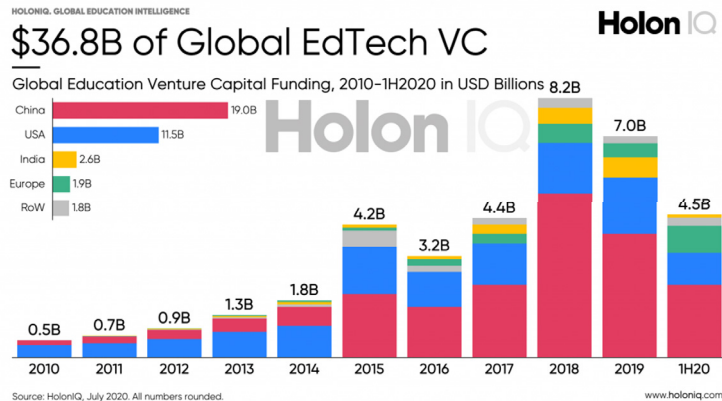- *New technologies*
- *New companies*
- *New careers*

- *Incredible Opportunities*

HOLONIQ: EDTECH IN 10 CHARTS

EdTech spend will nearly double in the next 5 years

Growth in Total Global Expenditure on Education Technology in USD

+12.2% $404B

$227B

3.6% Digital Spend   5.2% Digital Spend

2020   2025

Source: HolonIQ

Holon IQ   Education is a **Digitisation Outlier**

HOLONIQ: EDTECH IN 10 CHARTS

Less than 4% Digital Spend in Education & Training

Global Digital Spend in Education as a proportion of Total Global Education and Training Expenditure in USD.

$227B Education Technology Spend (3.6%)
Hardware, Software and Technology Enabled Services

$6.2T Non-Digital Spend (96.4%)
Labor, Physical Equipment, Analogue Content, Real Estate & Building Works, Utilities etc

< 4% Digital Spend

Source: HolonIQ, January 2021
Source: HolonIQ

EdTech Investment Remains High

Venture Capital Growth
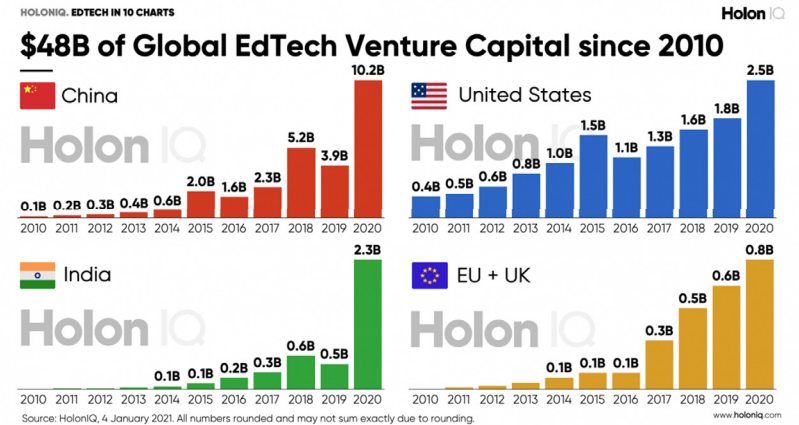
Overview

- CMU & METALS are unique
- **Curriculum**
  - **Capstone**
  - Courses
- Finances
- Application

Human-Computer Interaction Institute

Carnegie Mellon is Unique

Our Values…
Innovative	Interdisciplinary
Inspiring	Business
Influential	Relevant
Quality	Impactful

Our Methods… cutting edge, grounded in theory, drawn from industry

Our Research…collaborative

Our Projects… practical and experiential

Human-Computer Interaction Institute

Major Focus: Capstone Project

- Apply & integrate METALS skills on a two semester-long project
- Be a member of an interdisciplinary teams (4-6 people)
- For an external client
- Learn to interview (CTA), research, write reports & give presentations
- Produce a high fidelity prototype

Learn to Create Evidence-Based Innovations in Learning
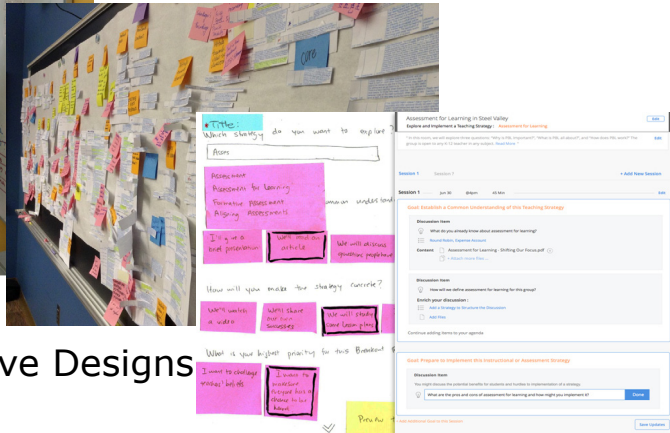
Gather Field Data

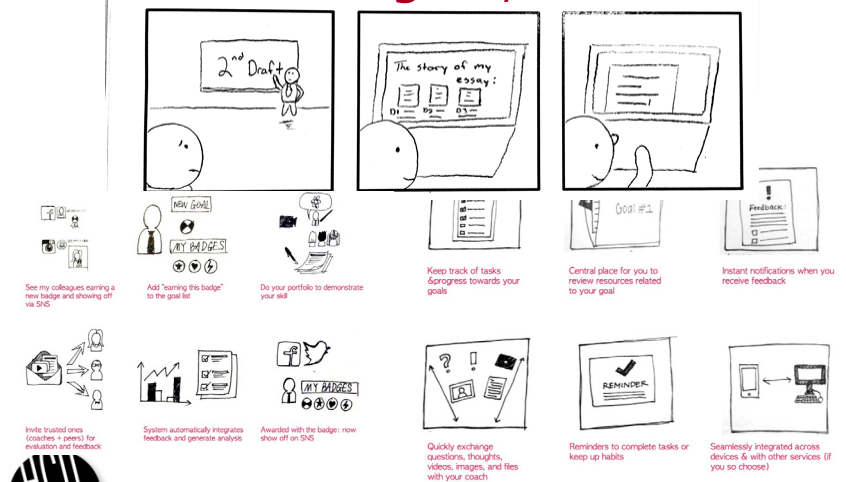### Review Literature

Understand Needs

Understand Research

Create Effective Designs

…And design some more. Then do it all over again, but better!

Overview

- CMU & METALS are unique
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  - **Courses**
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METALS Core Courses

- **E-Learning Design Principles & Methods**
- **Educational Goals, Instruction and Assessment**
- **Interaction Design Overview**
- **Tools for Online Learning**
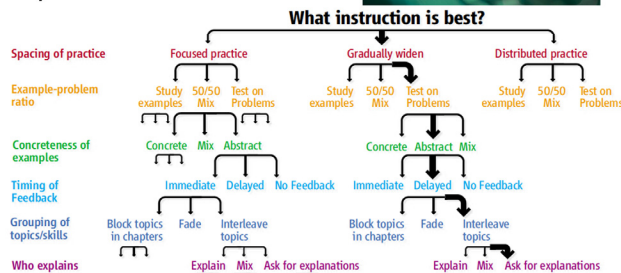- **Capstone Project**

E-Learning Design Principles & Methods

- Gain a *broad understanding* of the field and literature.
- Know when to apply *evidence & theory*
- Learn how to adapt *methods* to specific needs
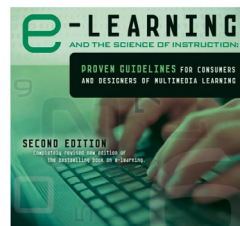
Ken Koedinger
TA: Mimi McLaughlin

Understand the best form of instruction

- More assistance vs. more challenge
  - Basics vs. understanding
  - Education wars in reading, math, science…
- Researchers like binary oppositions too. We just produce a lot more of them!
  - Massed vs. **distributed** (Pashler)
  - Study vs. **test** (Roediger)
  - **Examples** vs. problem solving (Sweller …)
  - **Direct instruction** vs. discovery learning (Klahr)
  - Re-explain vs. **ask for explanation** (Chi, Renkl)
  - **Immediate** vs. **delayed** (Anderson vs. Bjork)
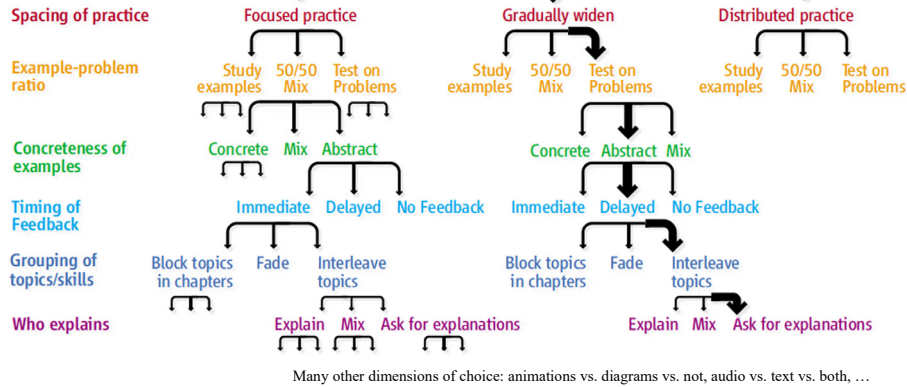 - **Concrete** vs. **abstract** (Pavio vs. Kaminski)
  - …
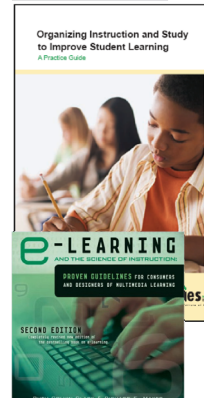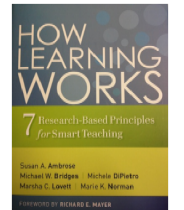
Koedinger, K. R., & Aleven, V. (2007). Exploring the assistance dilemma in experiments with cognitive tutors. *Educational Psychology Review, 19*(3), 239-264.

Slide 1

Instructional Complexity
How many instructional options are there?

More help, *passive* ←———————→ More challenge, *active*

What instruction is best?

	Focused practice	Gradually widen	Distributed practice
Spacing of practice			
Example-problem ratio	Study examples / 50/50 Mix / Test on Problems	Study examples / 50/50 Mix / Test on Problems	Study examples / 50/50 Mix / Test on Problems
Concreteness of examples	Concrete / Mix / Abstract	Concrete / Abstract / Mix	
Timing of Feedback	Immediate / Delayed / No Feedback	Immediate / Delayed / No Feedback	
Grouping of topics/skills	Block topics in chapters / Fade / Interleave topics	Block topics in chapters / Fade / Interleave topics	
Who explains	Explain / Mix / Ask for explanations	Explain / Mix / Ask for explanations	

Many other dimensions of choice: animations vs. diagrams vs. not, audio vs. text vs. both, …

>3^{15*2} = 205 trillion options!

Koedinger, Booth, Klahr (2013). Instructional Complexity and the Science to Constrain It. *Science*.

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Slide 2

What instructional choices are best for a particular course?

- Choices depend on a deep understanding of the content
  - A "cognitive model"
- But - do course designers know what they know?

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Slide 3
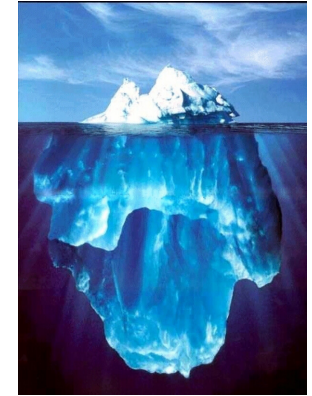
Creating Cognitive Models is not Obvious

Which is hardest for algebra students?

Story Problem

As a waiter, Ted gets $6 per hour. One night he made $66 in tips and earned a total of $81.90. How many hours did Ted work?
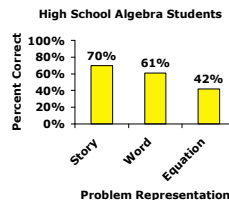
Word Problem

Starting with some number, if I multiply it by 6 and then add 66, I get 81.90. What number did I start with?

Equation

x * 6 + 66 = 81.90

Math educators say:
story or word is hardest

Equations are hardest for students…

Expert blind spot!
Experts do not know what they know: They are incorrectly think equations are easy for students

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Slide 4

Educational Goals, Instruction, and Assessment

Students will learn to use scientifically-based principles & practical strategies for:

- developing learner models & educational goals based on analysis of the knowledge, skills, and dispositions required for understanding and mastery
- aligning the instructional program and its valid assessment with learners and goals
- considering additional aspects of learning environments that may impact implementation and evaluation

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Reading, and Seminar Discussion

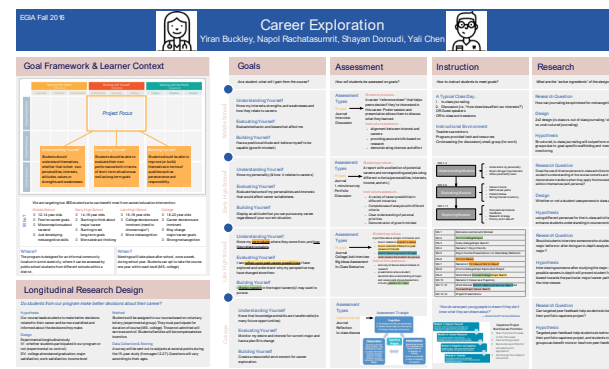# Figuring Out How this All Works…

Course Project

Actually
Apply
Course
Big Ideas

1. Context & Initial Resources
2. Anticipated Learner Profile
3. Learning Goal Specification
4. Assessment Design
5. Instructional Design
6. Research Design

Final Presentation & Poster

Poster Session

Tools For Online Learning

- This course is expected to give you
  - an overview of current educational technology.
  - hands on experience with educational technology used in online learning
- Hands on projects every couple of weeks
- Final project build out a complete course module

Topics Include

- Overview of Educational Technology
- Learning Management Systems
- Accessibility
- Adaptive Learning
- Conversational Agents
- Data-Driven Design and Development
- Online Courseware

Example Elective Courses

Technology	Learning Science	Design
Personalized Online Learning	Cognitive Development	Human Factors
Design of Educational Games	Human Expertise	Stats: Experimental Design for Behavioral and Social Sciences
Applied Machine Learning	Applications of Cognitive Science	Design of Educational Games
Computational Models of Discourse Analysis	Research Methods for the Learning Sciences	Service Design Social Perspectives in HCI
Design & Engineering of Intelligent Information Systems	Role of Technology in Learning in the 21st Century	Computer Science Perspectives In HCI
Role of Technology in Learning in the 21st Century	Scientific Research in Education	Research Methods in Human Centered Design
The Big Data Pipeline	Learning Analytics and Educational Data Science	Learning Media Design
Mobile Service Innovation		Learner Experience Design

General Electives Continued

- Crowd Programming
- Entrepreneurship
- Designing for Service
- Web Accessibility
- Gadgets, Sensors and Activity Recognition in HCI
- Machine Learning Text Mining
- Advanced Web Design
- Designing Human Centered Software
- Social Perspectives in HCI
- Language and Statistics
- Decision Making Under Uncertainty

  - \>100 others in other part of the university, if approved
    - Business, CFA, H&SS, CS, Robotics, Entertainment Technologies

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We want students who are:

- Passionate about using technology to develop better learning outcomes
- With a wide variety of backgrounds including:
  - computer science
  - design
  - psychology
  - education

On the Philosophy…

- METALS education provides students
  - Skills to engineer & implement innovative & effective educational solutions
  - Real-world project-based experience
  - Team management

- You will learn about all of software development, psychology, & design
  - You will not become an expert in all in 1 year
  - You will learn to communicate with specialists in other areas

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What You Will Be Able to Do After METALS? Part 1

- Design, develop, & implement *innovative, effective, & desirable* educational solutions
- *Innovative*
  - Use state-of-the-art technologies
    - AI, machine learning, language technologies, intelligent tutoring systems, mixed reality, …
- *Effective*
  - Apply cognitive & social psychology principles to instructional design, analysis, & redesign
  - Design & evaluate using cognitive task analysis, data mining, statistics, experimentation

## What You Will Be Able to Do After METALS? Part 2

- *Desirable*
  - Design skills to enhance learning *and* enjoyment
- *Innovative*: Analytic, psychometric & educational data mining skills
- *Putting it together*: Develop continual improvement programs that employ experiments & analytics to reliably identify best practices & opportunities for change

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Gain Breadth & Expertise

- You may already possess expertise in some of these areas, but not in all.
- METALS will
  - Deepen your prior expertise
  - Broaden your knowledge in new areas
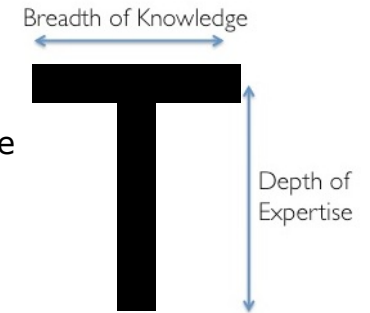
Breadth of Knowledge

Depth of Expertise

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Finances

- 2021-2022
  - 3 Semesters (4 semester option available)
  - $23,855 per semester
  - ~$27,000 for living expenses
  - $100,000 commitment (for 3 semester option)
- 2022-2023 Tuition Not Set
- Currently offering small merit-based tuition assistance ($1000 - $5000/semester)
  - Not guaranteed
  - If you are skilled & passionate, let us know!
- Scholarships – see METALS FAQ page
  - BiPOC and BLM scholarships (GEM) information

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Human-Computer Interaction Institute

Application Guidelines

- Apply Online
  - https://applygrad.cs.cmu.edu/apply/index.php?domain=1
- Applications Due December 9th
- Applications Must Demonstrate
  - Your interest in EdTech and/or Learning Science
  - Past relevant experience/training
  - Plans after you graduate
- GRE optional but strongly encouraged/preferred
  - Expected 165 Quantitative, 160 Verbal
  - But we look at the entire application…
- English Proficiency is required!
  - TOEFL
    - 25 or better in 3 out of 4 sections and
    - 23 or better in speaking
  - DuoLingo English Test is an option
  - IELTS

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Questions?

http://metals.hcii.cmu.edu

Applications Due December 9th

Human-Computer Interaction Institute