METALS

Masters of Educational Technology
& Applied Learning Science

Learn. Create. Innovate.

Virtual Open House

October 10 @ 10 AM EDT

Applications Due December 13th

http://metals.hcii.cmu.edu

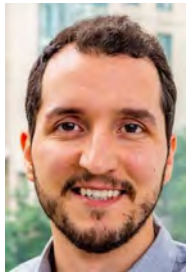**Human-Computer Interaction Institute**

Welcome!

- Ken Koedinger, Director

- Michael Bett, Managing Director

- Jo Bodnar, Program Administrator

Extended Welcome from Our Learning Science Faculty

Vincent Aleven

Paulo Carvalho

Sharon Carver

Jessica Hammer

Erik Harpstead

Lauren Herckis

Ken Holstein

Ken Koedinger

Marti Louw
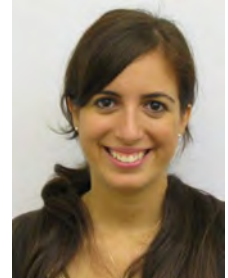
Marsha Lovett

Bruce McLaren

Steven Moore

Amy Ogan

Carolyn Rose

John Stamper

Nesra Yannier

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
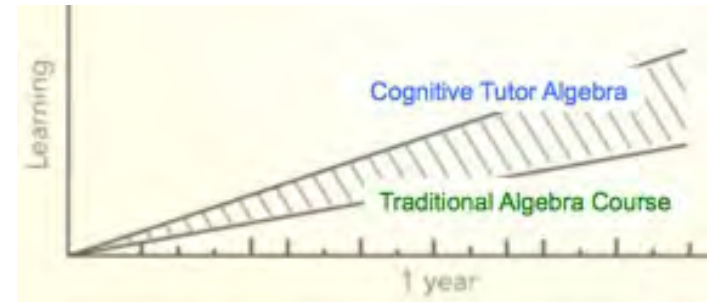 - EDM – Educational Data Mining

CMU Learning Science is Making a Difference

- 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*

Software Tutors Offer Help and Customized Hints
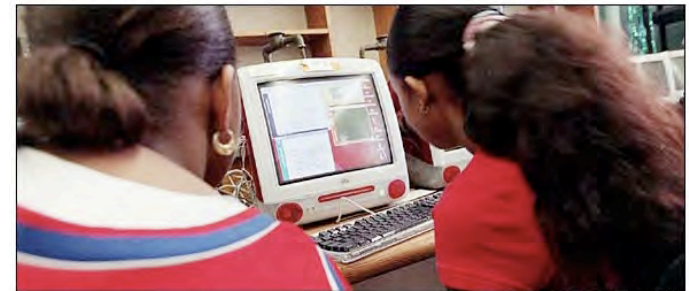
Chris Maynard for The New York Times

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.

Pane et al. (2013). Effectiveness of Cognitive Tutor Algebra I at Scale. RAND.

Traditional College Course
> 100 hours
~ 3% learning gain

Data-driven design & delivery

Adaptive Data-Driven Course
< 50 hours
~ 18% learning gain

Learning Science & Technology Ecosystem at Carnegie Mellon University

LearnLab

Eberly Center
Teaching Excellence & Educational Innovation

ML
MACHINE LEARNING
DEPARTMENT

• Human-
Computer
Interaction
Institute

METALS
Masters of Educational Technology
& Applied Learning Science

lti
Language Technologies Institute

Psychology

Open Learning Initiative

Entertainment Technology Center

Human-Computer Interaction Institute

Many Spinoffs and Local Startups

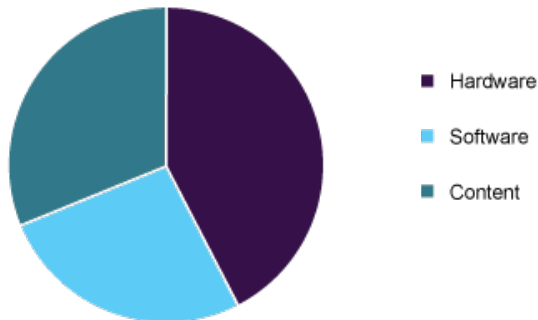# Many Corporate Partners

Human-Computer Interaction Institute

Learning & Training Continues to Boom!!

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

Spending by area

Source: www.grandviewresearch.com

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
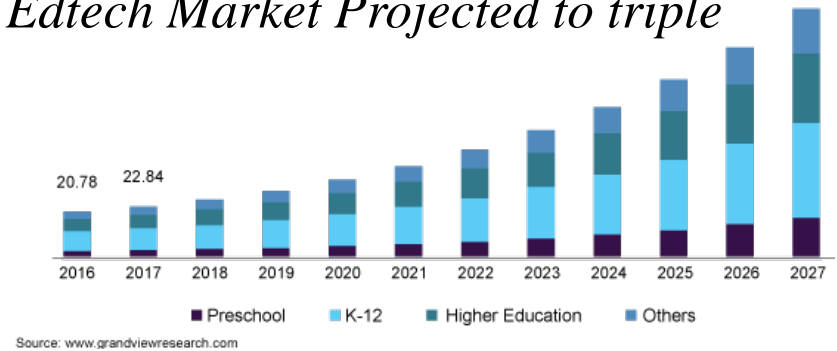
GLOBAL EDUCATION INTELLIGENCE

Global Decade of EdTech VC

Holon IQ

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

Source: HolonIQ, January 2020

www.holoniq.com

■ Hardware
■ Software
■ Content

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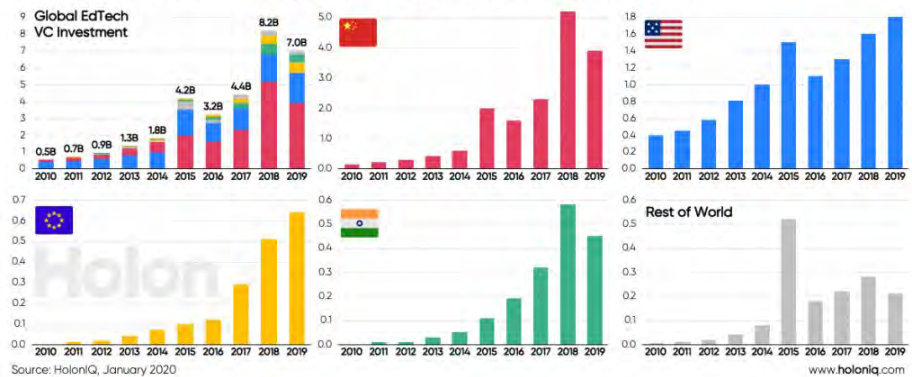
The Education Market is Huge!

- 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)

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Learning & Training Continues to Boom!!

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

HOLONIQ. **EDTECH IN 10 CHARTS**   Holon

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

Source: HolonIQ

2020   2025

Holon IQ   Education is a **Digitisation Outlier**

HOLONIQ. **EDTECH IN 10 CHARTS**   Holon

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

- *Incredible Opportunities*

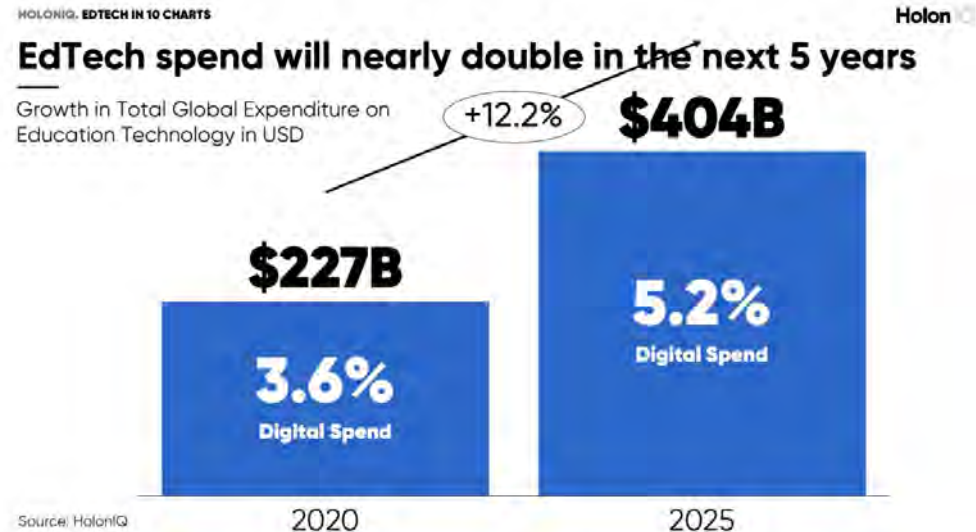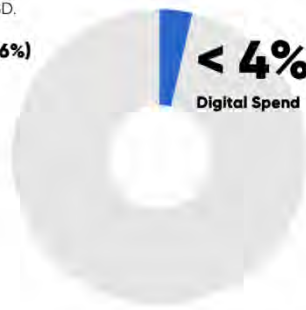**Human-Computer Interaction Institute**

EdTech Investment Remains High

HOLONIQ, GLOBAL EDUCATION INTELLIGENCE

$36.8B of Global EdTech VC

Global Education Venture Capital Funding, 2010–1H2020 in USD Billions

Holon IQ

China	19.0B
USA	11.5B
India	2.6B
Europe	1.9B
RoW	1.8B

2010: 0.5B
2011: 0.7B
2012: 0.9B
2013: 1.3B
2014: 1.8B
2015: 4.2B
2016: 3.2B
2017: 4.4B
2018: 8.2B
2019: 7.0B
1H20: 4.5B
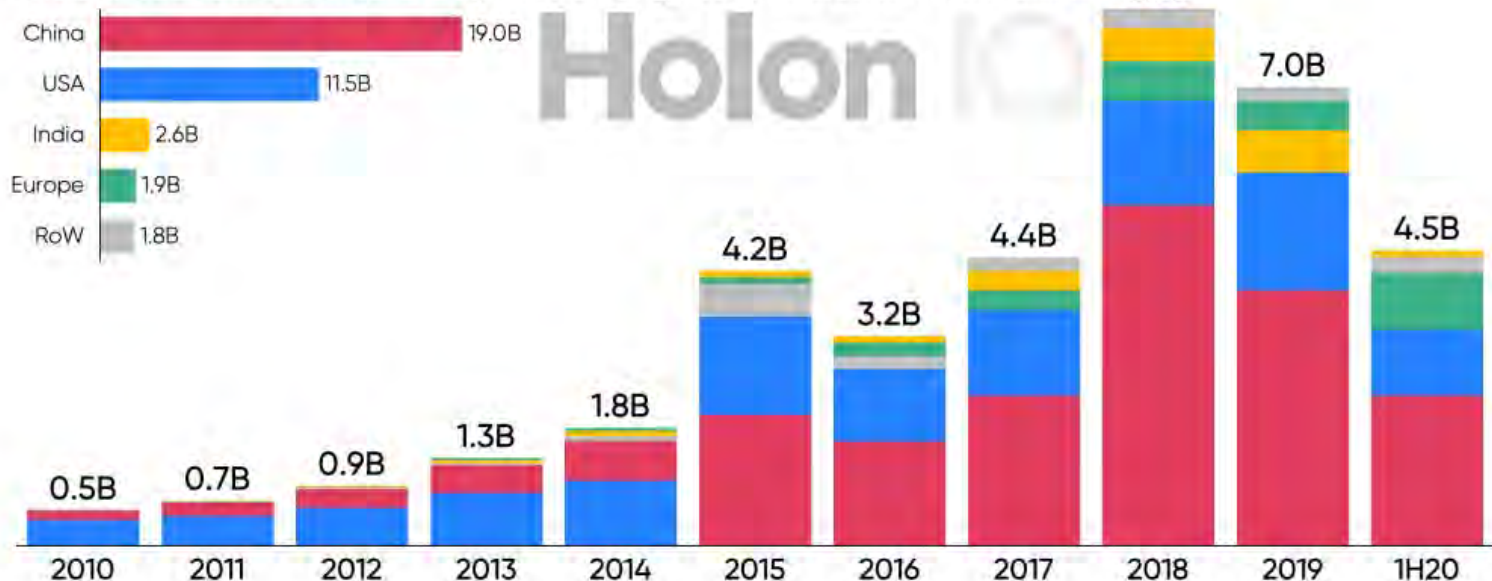
Source: HolonIQ, July 2020. All numbers rounded.

www.holoniq.com

Venture Capital Growth

HOLONIQ. EDTECH IN 10 CHARTS

Holon IQ

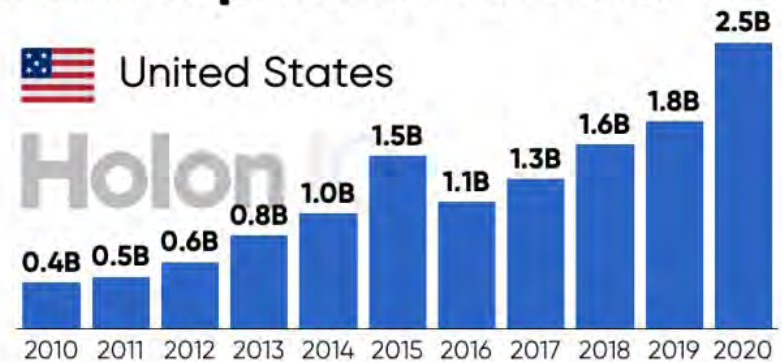## $48B of Global EdTech Venture Capital since 2010

China — 2010: 0.1B, 2011: 0.2B, 2012: 0.3B, 2013: 0.4B, 2014: 0.6B, 2015: 2.0B, 2016: 1.6B, 2017: 2.3B, 2018: 5.2B, 2019: 3.9B, 2020: 10.2B

United States — 2010: 0.4B, 2011: 0.5B, 2012: 0.6B, 2013: 0.8B, 2014: 1.0B, 2015: 1.5B, 2016: 1.1B, 2017: 1.3B, 2018: 1.6B, 2019: 1.8B, 2020: 2.5B

India — 2014: 0.1B, 2015: 0.1B, 2016: 0.2B, 2017: 0.3B, 2018: 0.6B, 2019: 0.5B, 2020: 2.3B

EU + UK — 2014: 0.1B, 2015: 0.1B, 2016: 0.1B, 2017: 0.3B, 2018: 0.5B, 2019: 0.6B, 2020: 0.8B
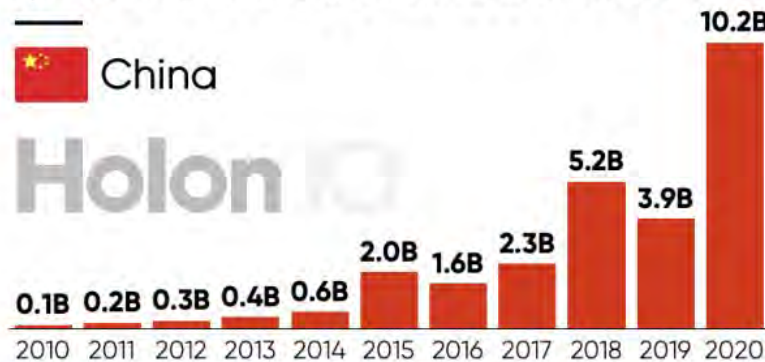
Source: HolonIQ, 4 January 2021. All numbers rounded and may not sum exactly due to rounding.

www.holoniq.com

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Overview

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

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

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

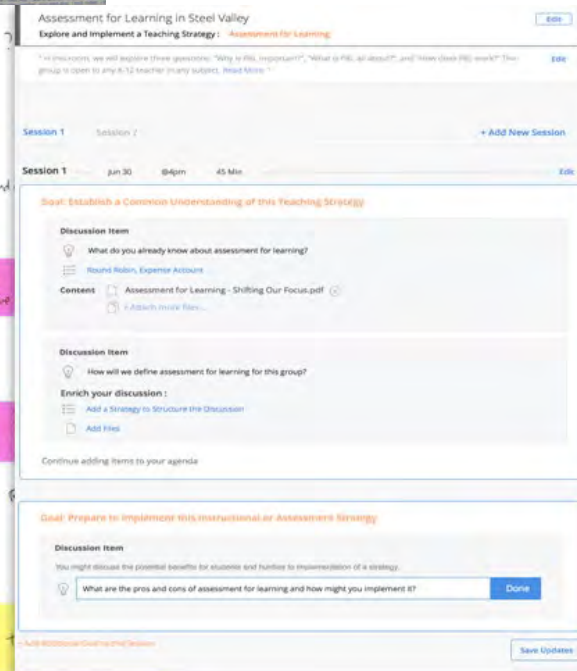# Learn to Create Evidence-Based Innovations in Learning

Gather Field Data

Review Literature

Professional Learning Community
6 articles
| mutual support | flexibility
motives

Professional Development
6 articles
content-focused | structure | facilitation

Computer Supported Collaborative Learning
8 articles
motivation | scripts | social network

Online Community
1 book, 1 article
contributions | commitment |
newcomers | bahaviors

Literature Review

Research and Design Methods
3 books, 2 articles
| contextual design | experimental design
human-centered deisgn

Behavioural Change
1 book, 1 article, 3 videos
ability | trigger | motivation |
simplicity cycles | interpersonal trust

Education Policy
2 articles
standards | evaluation

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Understand Needs

Understand Research

Create Effective Designs

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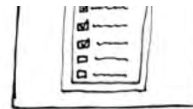# ...And design some more. Then do it all over again, but better!
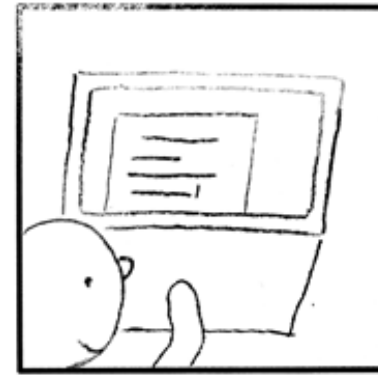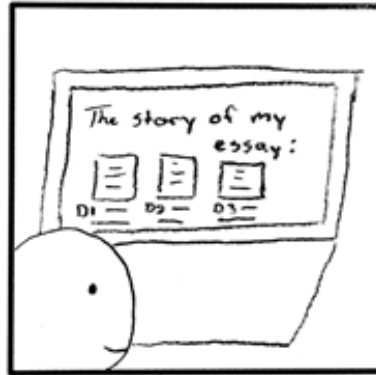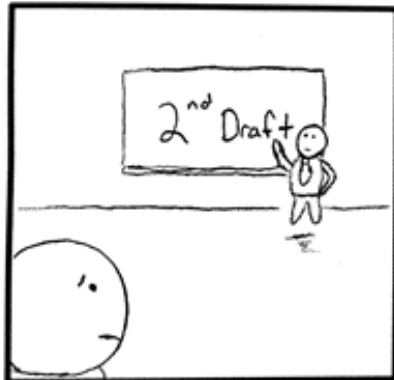
See my colleagues earning a new badge and showing off via SNS

Add "earning this badge" to the goal list
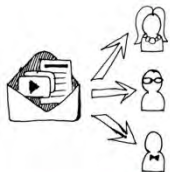
Do your portfolio to demonstrate your skill

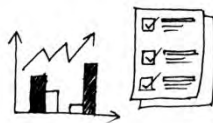Keep track of tasks &progress towards your goals

Central place for you to review resources related to your goal

Instant notifications when you receive feedback

Invite trusted ones (coaches + peers) for evaluation and feedback

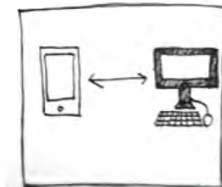System automatically integrates feedback and generate analysis

Awarded with the badge: now show off on SNS

Quickly exchange questions, thoughts, videos, images, and files with your coach

Reminders to complete tasks or keep up habits

Seamlessly integrated across devices & with other services (if you so choose)

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METALS Core Courses

- E-Learning Design Principles & Methods

- Evidence-Based Educational Design (EdDesign)

- Interaction Design Fundamentals
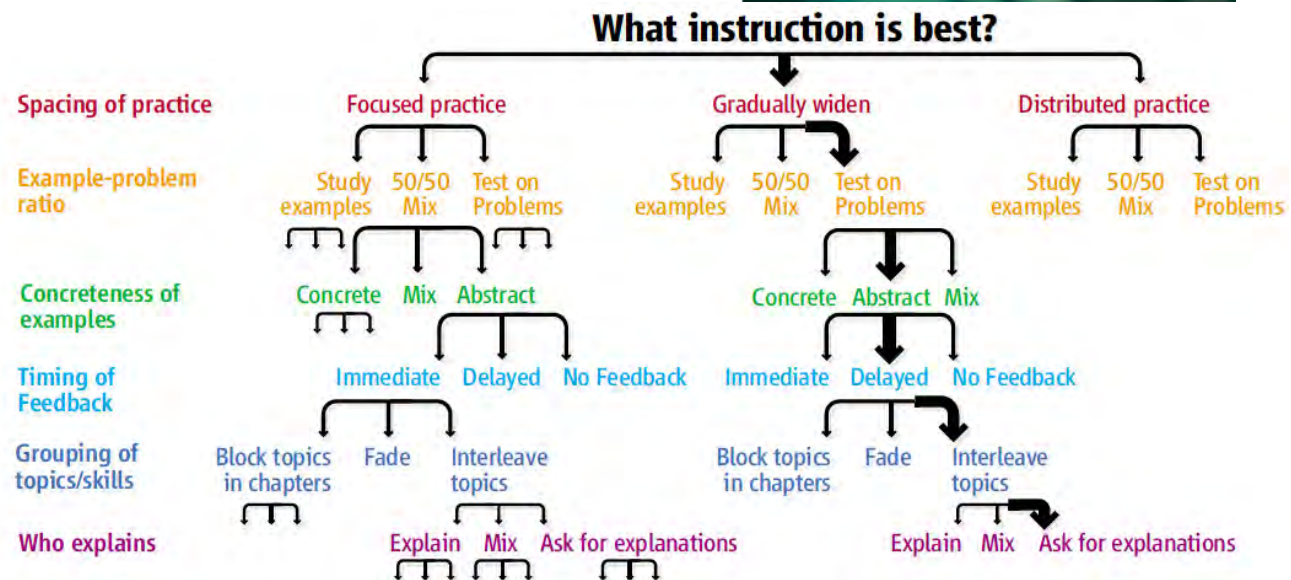
- Tools for Online Learning

- 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

Paulo Carvalho

What instruction is best?

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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)
  - ...
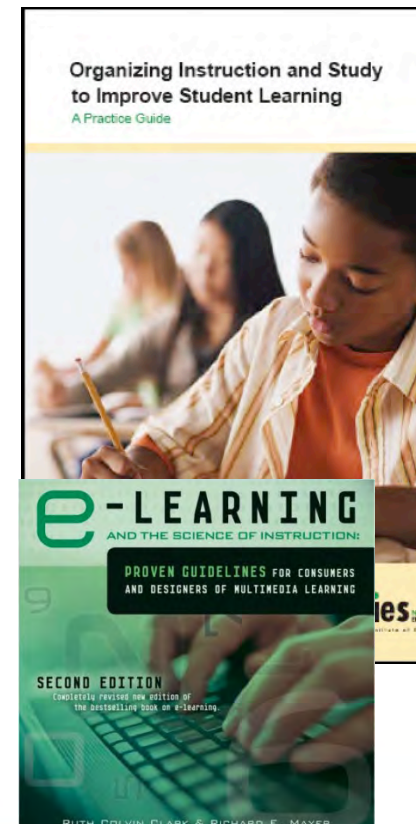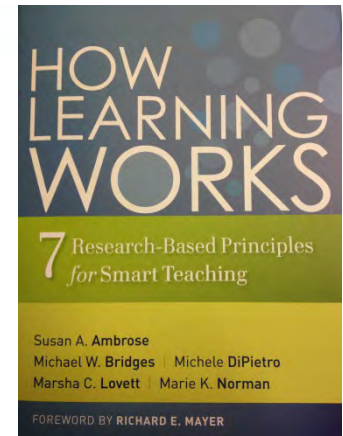
Koedinger, K. R., & Aleven, V. (2007). Exploring the assistance dilemma in experiments with cognitive tutors. *Educational Psychology Review, 19*(3), 239-264.

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Instructional Complexity
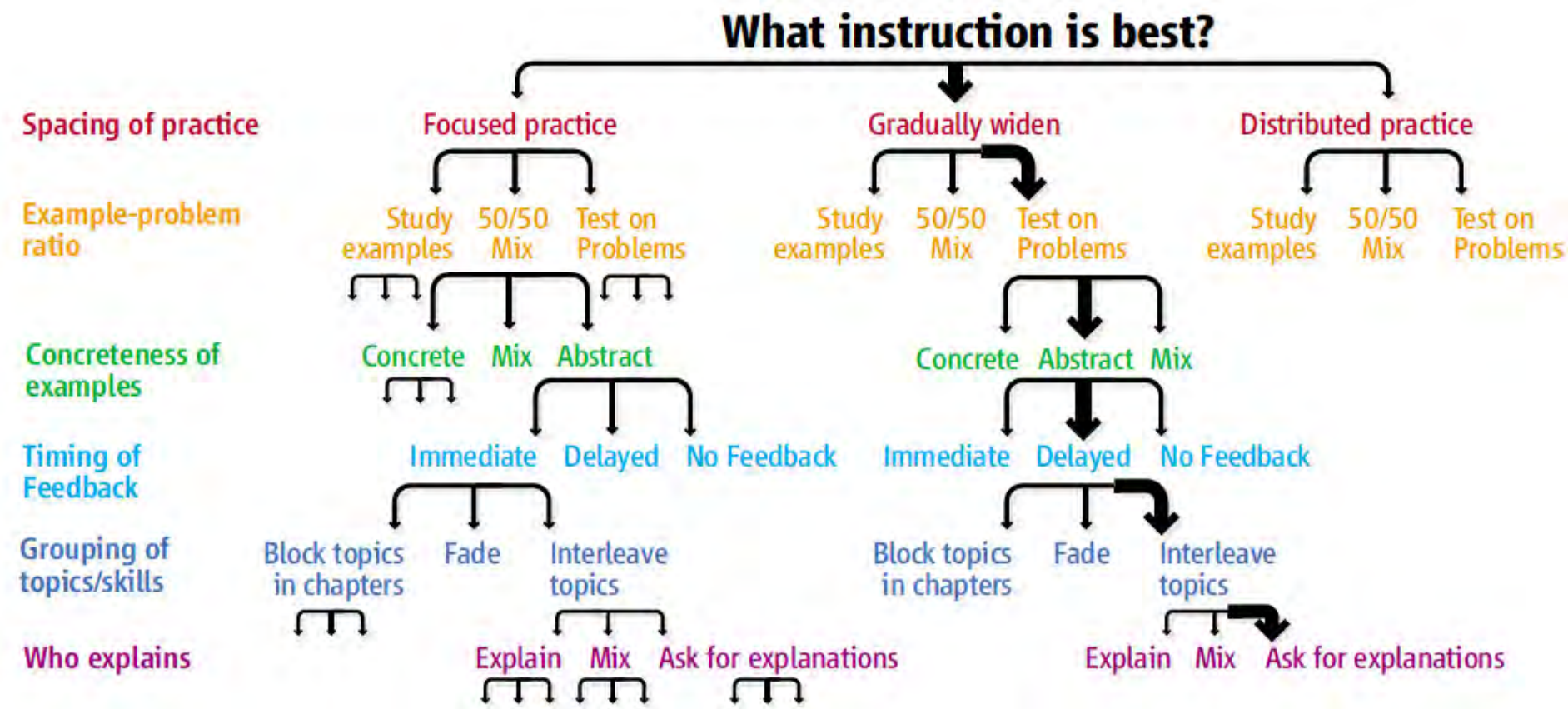How many instructional options are there?

More help, *passive* ⟷ More challenge, *active*

What instruction is best?

Spacing of practice	Focused practice	Gradually widen	Distributed practice

Example-problem ratio: Study examples, 50/50 Mix, Test on Problems (Focused practice); Study examples, 50/50 Mix, Test on Problems (Gradually widen); Study examples, 50/50 Mix, Test on Problems (Distributed practice)

Concreteness of examples: Concrete, Mix, Abstract (Focused); Concrete, Abstract, Mix (Gradually widen)

Timing of Feedback: Immediate, Delayed, No Feedback (Focused); Immediate, Delayed, No Feedback (Gradually widen)

Grouping of topics/skills: Block topics in chapters, Fade, Interleave topics (Focused); Block topics in chapters, Fade, Interleave topics (Gradually widen)

Who explains: Explain, Mix, Ask for explanations (Focused); Explain, Mix, Ask for explanations (Gradually widen)

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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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?
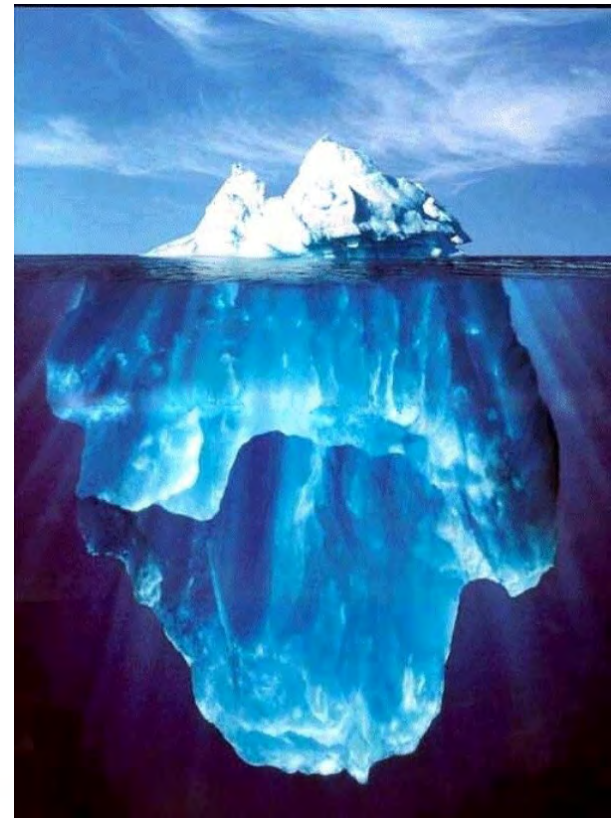
Creating Cognitive Models is not Obvious

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?
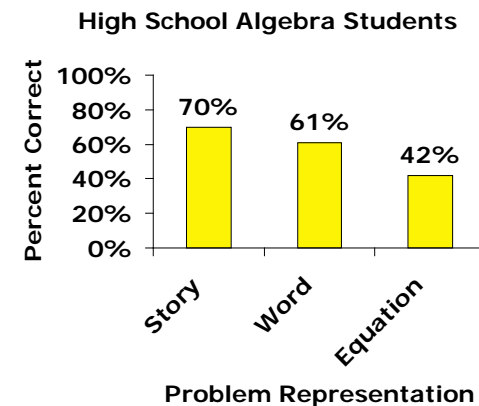
Word Problem

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…

High School Algebra Students

Percent Correct — Story 70%, Word 61%, Equation 42%

Problem Representation

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

Evidence Based Educational Design

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

Reading, and Seminar Discussion

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Figuring Out How this All Works…
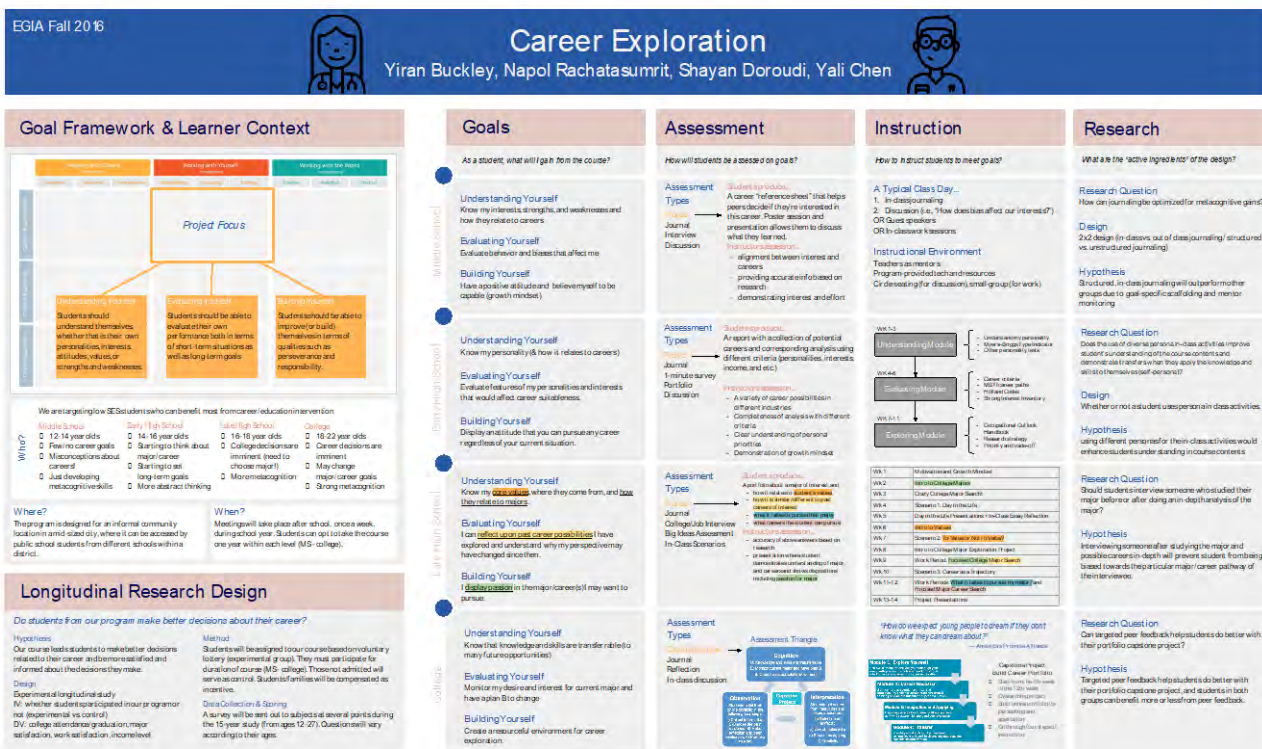
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Course Project
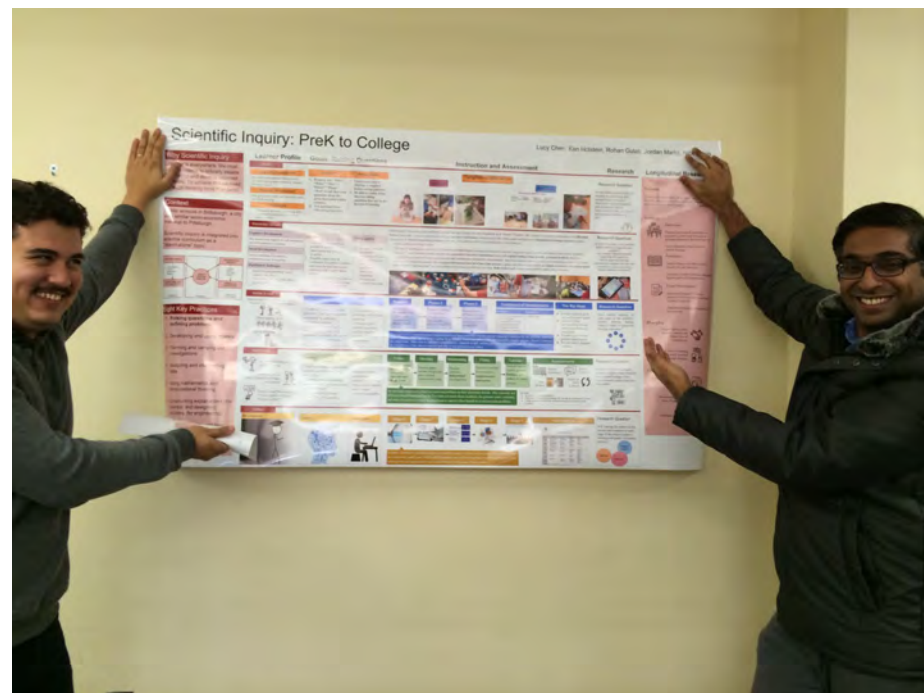
Actually
Apply
Course
Big Ideas

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

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Example Elective Courses

Technology

Personalized Online Learning

Design of Educational Games

Applied Machine Learning

Computational Models of Discourse Analysis

Design & Engineering of Intelligent Information Systems

Role of Technology in Learning in the 21st Century

The Big Data Pipeline

Mobile Service Innovation

Learning Science

Cognitive Development

Human Expertise

Applications of Cognitive Science

Research Methods for the Learning Sciences

Role of Technology in Learning in the 21st Century

Scientific Research in Education

Learning Analytics and Educational Data Science

Design

Human Factors

Stats: Experimental Design for Behavioral and Social Sciences

Design of Educational Games

Service Design Social Perspectives in HCI

Computer Science Perspectives In HCI

Research Methods in Human Centered Design

Learning Media Design

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

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
  - business

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

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

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
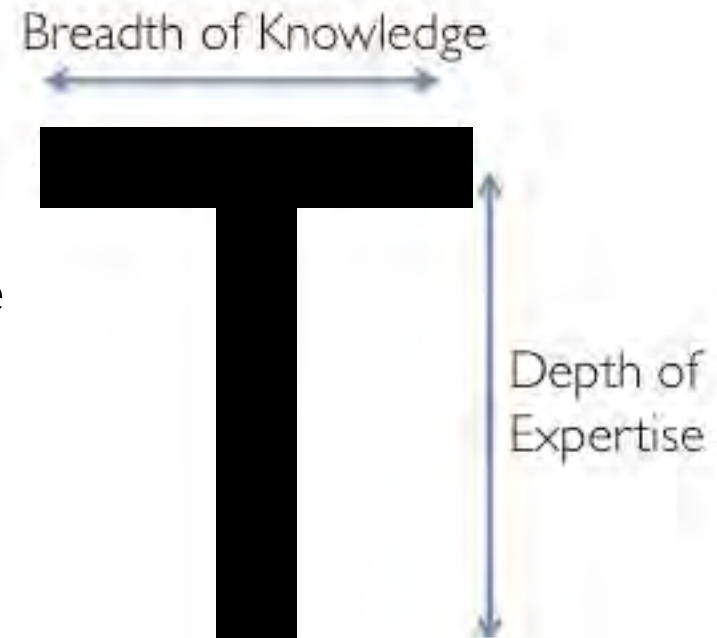
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Finances

- 2023-2024
  - 3 Semesters (4 semester option available)
  - $24,900 per semester
  - ~$27,000 for living expenses
  - ~$100,000 commitment (for 3 semester option)
- 2024-2023 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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Application Guidelines

- Apply Online
  - https://applygrad.cs.cmu.edu/apply/index.php?domain=1
- Applications Due December 13th at 3PM EST
- Applications Must Demonstrate
  - Your interest in EdTech and/or Learning Science
  - Past relevant experience/training
  - Plans after you graduate
- GRE 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
    - 24 or better in speaking
  - DuoLingo English Test is an option
  - IELTS

Questions?

http://metals.hcii.cmu.edu

Applications Due December 13th

Human-Computer Interaction Institute