METALS
Masters of Educational Technology & Applied Learning Science

Learn. Create. Innovate.

Virtual Open House

October 15 @ 11 AM EDT
Applications Due December 12th

http://metals.hcii.cmu.edu

Welcome!

- Ken Koedinger, Director

- Michael Bett, Managing Director

Extended Welcome from Our Learning Science Faculty

Vincent Aleven | Justine Cassell | Sharon Carver | Jessica Hammer | Erik Harpstead | Lauren Herckis | Ken Koedinger
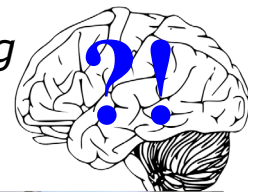
Chinmay Kulkarni | Marti Louw | Marsha Lovett | Bruce McLaren | Amy Ogan | Carolyn Rose | John Stamper

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Science & technology of learning: important, interesting, challenging!!

- Education is *important*
- Unlocking the mysteries of human learning is *interesting*
- Tech innovation is *challenging, fun, powerful*

Intelligent tutors helping city kids catch up in math

Learning games on mobiles in Africa

Virtual labs & MOOCs scaling education

Intelligent exhibits make doing science fun!

Slide 5

Overview

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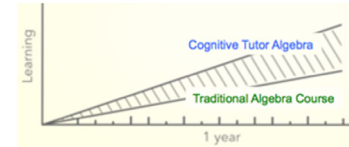 - Courses
- Finances
- Application

Slide 6

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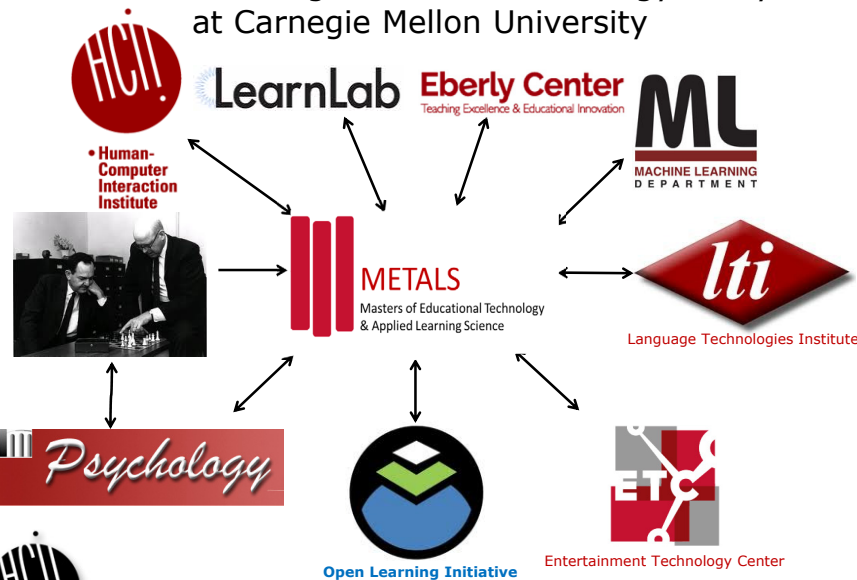
Software Tutors Offer Help and Customized Hints
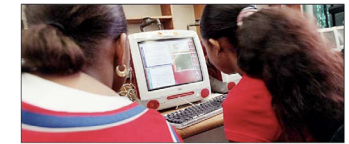
MATH COACH - Rochelle Brown, left, and Iesha Antonetti, students at Middle School 103 in the Bronx, use Cognitive Tutor software to reinforce math skills. The software is designed to give students individualized instruction when personal attention is scarce.

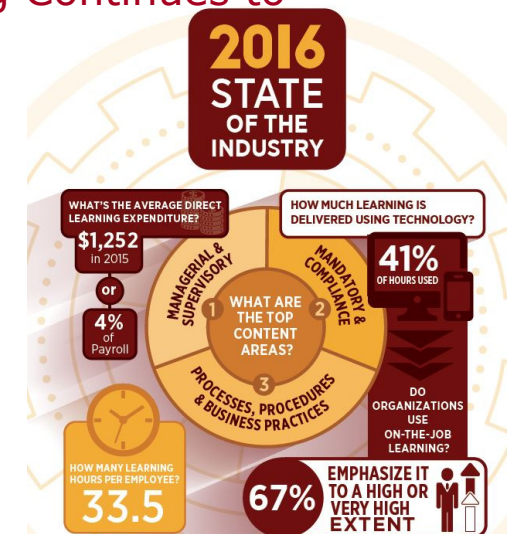Pane et al. (2013). Effectiveness of Cognitive Tutor Algebra I at Scale. RAND.

Traditional College Course > 100 hours ~ 3% learning gain → Data-driven design & delivery → Adaptive Data-Driven Course < 50 hours ~ 18% learning gain

Slide 7

Learning Science & Technology Ecosystem at Carnegie Mellon University

HCII — 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

Slide 8

Learning & Training Continues to Boom!!

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

Report on industry trends
https://www.td.org/Professional-Resources/State-Of-The-Industry-Report

2016 STATE OF THE INDUSTRY

WHAT'S THE AVERAGE DIRECT LEARNING EXPENDITURE? $1,252 in 2015 or 4% of Payroll

HOW MUCH LEARNING IS DELIVERED USING TECHNOLOGY? 41% OF HOURS USED

WHAT ARE THE TOP CONTENT AREAS? 1 MANAGERIAL & SUPERVISORY 2 MANDATORY & COMPLIANCE 3 PROCESSES, PROCEDURES & BUSINESS PRACTICES

DO ORGANIZATIONS USE ON-THE-JOB LEARNING?

HOW MANY LEARNING HOURS PER EMPLOYEE? 33.5

67% EMPHASIZE IT TO A HIGH OR VERY HIGH EXTENT

SPONSORED BY: BELLEVUE UNIVERSITY

atd RESEARCH

The Ed Market is Huge!

- 1.5 Billion K12 Students**
- 151 Million Post-Secondary Students**
- Education World market: $6 Trillion*
- EdTech World Market $152 Billion*
- Venture Captial: $8.2 Billion*

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

**http://data.uis.unesco.org/#

Many Spinoffs and Local Companies

CARNEGIE LEARNING • acrobatiq by VitalSource • DDI® • duolingo • NoRILLA Novel Research-based Intelligent Lifelong Learning Apparatus • turnitin • h{s𝕝 • BloomBoard • imagine learning • SCHELL GAMES

Many Corporate Partners

WESTERN GOVERNORS UNIVERSITY www.wgu.edu • CARNEY • KAPLAN • PEARSON • EY Building a better working world • RENAISSANCE® • Houghton Mifflin Harcourt • edmentum • McGraw Hill Education • turnitin • CARNEGIE LEARNING

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

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Major Focus: Capstone Project

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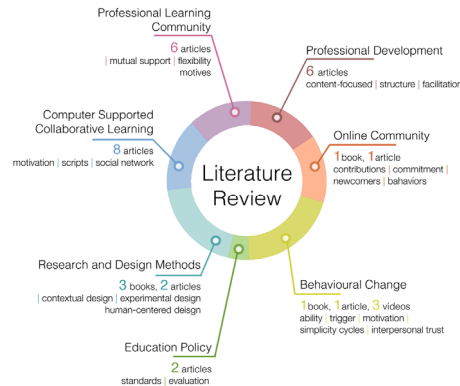- Produce a high fidelity prototype

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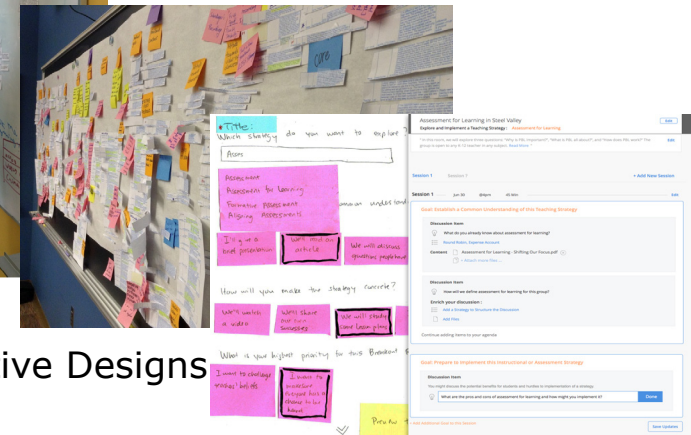
Gather Field Data

Review Literature

Literature Review

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 | behaviors

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

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

Education Policy
2 articles
standards | evaluation

Understand Needs

Understand Research

Create Effective Designs

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…And design some more. Then do it all over again, but better!
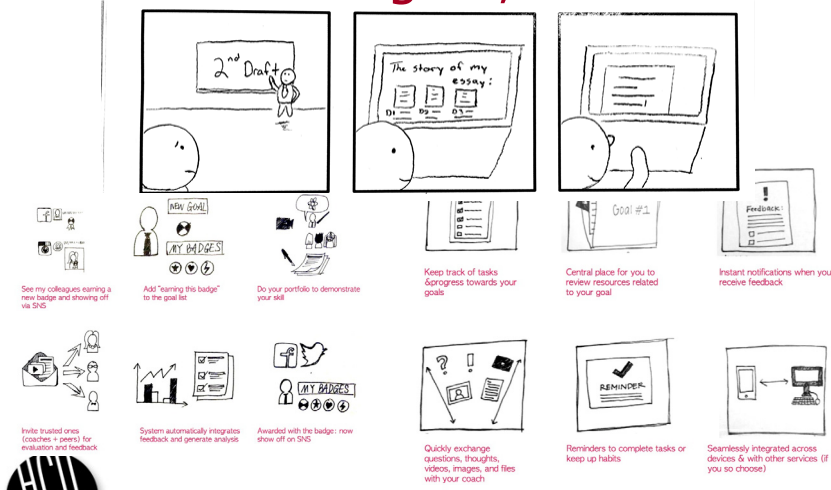
Slide 18

Overview

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Slide 19

METALS Core Courses

- **E-Learning Design Principles & Methods**

- **Educational Goals, Instruction and Assessment**

- **Interaction Design Overview**

- **Tools for Online Learning**

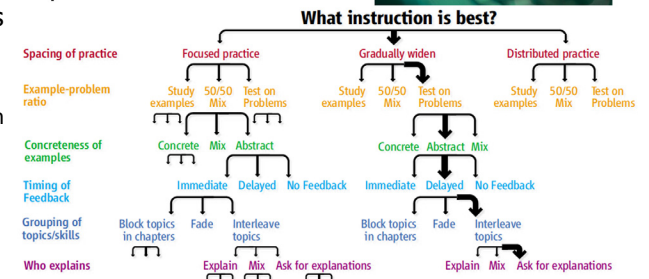- **Capstone Project**

Slide 20

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
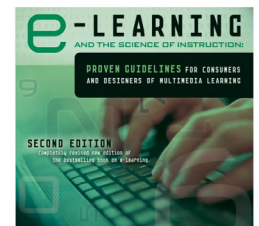
Ken Koedinger
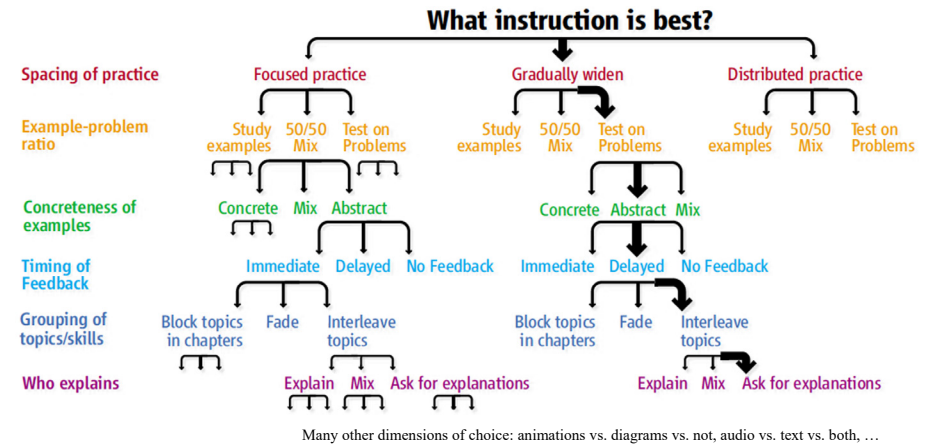TA: Mimi McLaughlin

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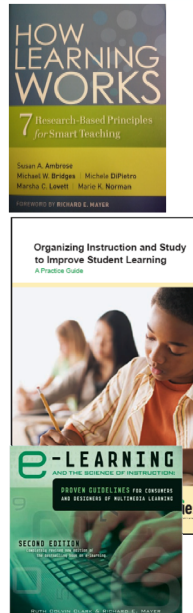
Koedinger, K. R., & Aleven, V. (2007). Exploring the assistance dilemma in experiments with cognitive tutors. *Educational Psychology Review, 19*(3), 239-264.

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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	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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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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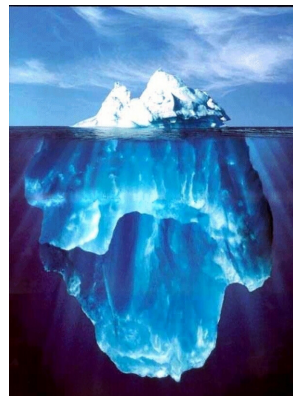
Creating Cognitive Models is not Obvious

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?
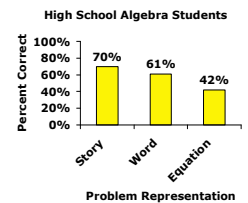
Word Problem

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

| Story | Word | Equation |
| 70% | 61% | 42% |

Percent Correct — Problem Representation

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

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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

Reading, and Seminar Discussion
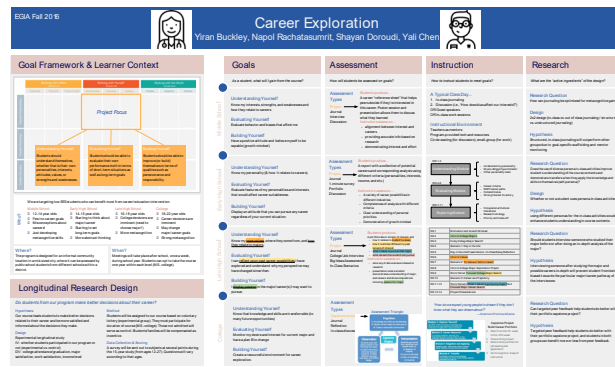
Figuring Out How this All Works…

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

Slide 1

Final Presentation & Poster

Career Exploration

EGIA Fall 2016

Slide 2

Poster Session

Slide 3

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

Slide 4

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

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

Psychology

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

UX 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

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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
  - business
  - any educational content domain

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

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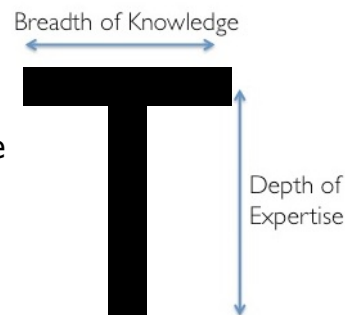# What You Will Be Able to Do After METALS? Part 2

- *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

- 2019-2020
  - 3 Semesters (4 semester option available)
  - $23,175 per semester
  - ~$27,000 for living expenses
  - $96,525 commitment (for 3 semester option)
- 2019-2020 Tuition Not Set
- Currently offering small merit-based tuition assistance ($1000-$4000/semester)
  - Not guaranteed
  - If you are skilled & passionate, let us know!

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Application Guidelines

- Apply Online
  - https://applygrad.cs.cmu.edu/apply/index.php?domain=1
- Applications Due December 12th
- Applications Must Demonstrate
  - Your interest in EdTech and/or Learning Science
  - Past relevant experience/training
  - Plans after you graduate
- GREs
  - Expected 165 Quantitative, 160 Verbal
  - But we look at the entire application…
- TOEFL
  - 25 or better in 3 out of 4 sections and
  - 23 or better in speaking

Questions?

http://metals.hcii.cmu.edu

Applications Due December 12th