Assessing Computational Thinking

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Center for Technology in Learning

SRI International

Assessment Breakout Session

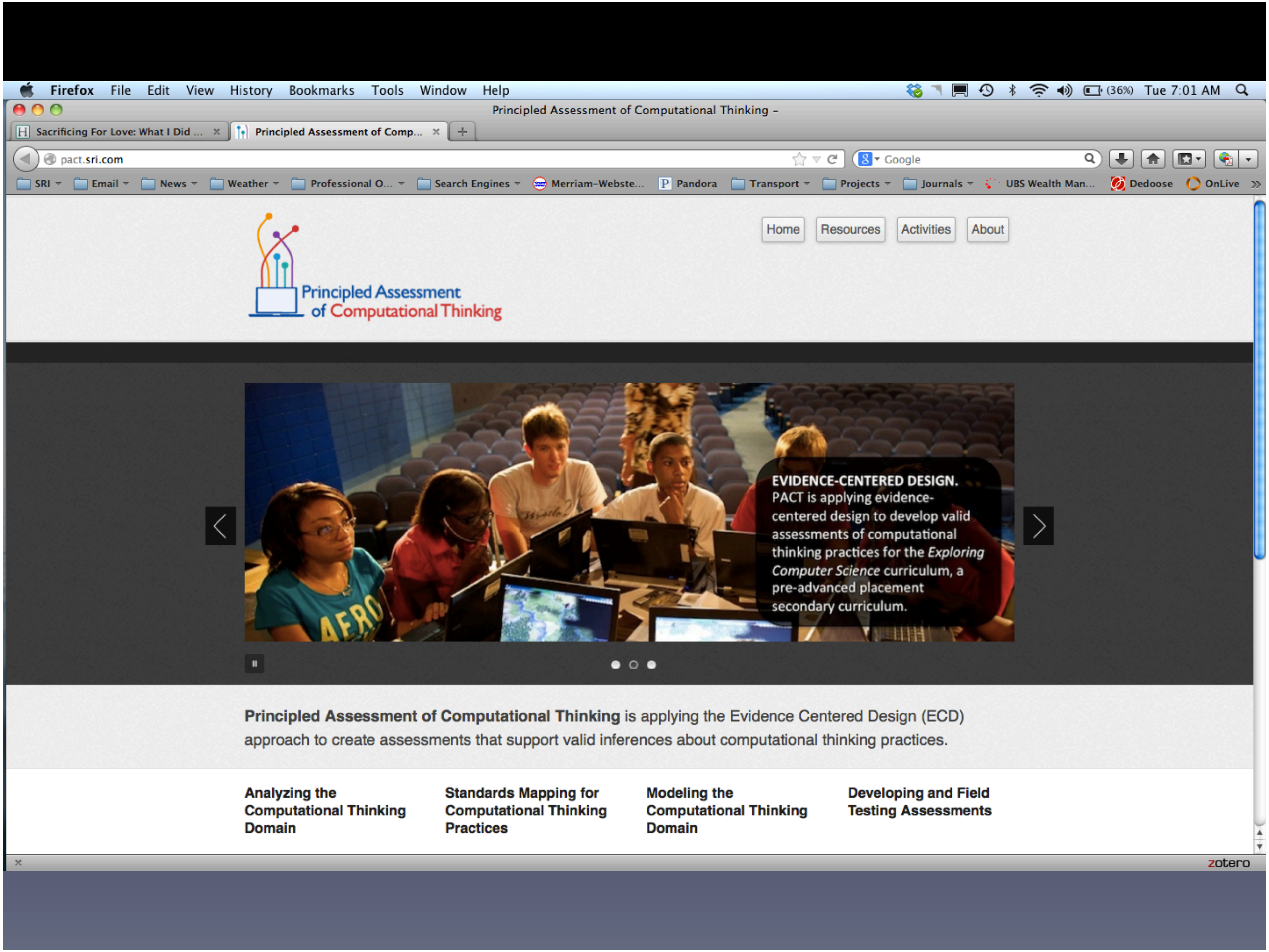
CE21 Community Meeting

January 6-8th, 2014

Orlando, FL

Overview

- Computational Thinking
- Computational Thinking Assessments
- Lessons on the Road to Validity
- Discussion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About
Principled Assessment of Computational Thinking
EVIDENCE-CENTERED DESIGN.
PACT is applying evidence-centered design to develop valid assessments of computational thinking practices for the *Exploring Computer Science* curriculum, a pre-advanced placement secondary curriculum.
Principled Assessment of Computational Thinking is applying the Evidence Centered Design (ECD) approach to create assessments that support valid inferences about computational thinking practices.
Analyzing the Computational Thinking Domain
Standards Mapping for Computational Thinking Practices
Modeling the Computational Thinking Domain
Developing and Field Testing Assessments
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Computational Thinking

Emerging consensus on characteristics of CT, but emphasis, specification and scope vary across use contexts.

Computational Thinking

Various proposed definitions suggest related constructs:

- algorithmic thinking
- modeling
- symbolic representations
- working with patterns

Computational Thinking

Workforce studies (e.g., Malyn-Smith & Lee, 2012) indicate CT involves:

- solving problems
- designing products
- automating systems
- defining, modeling, qualifying and refining systems, processes or mechanisms generally through the use of computers

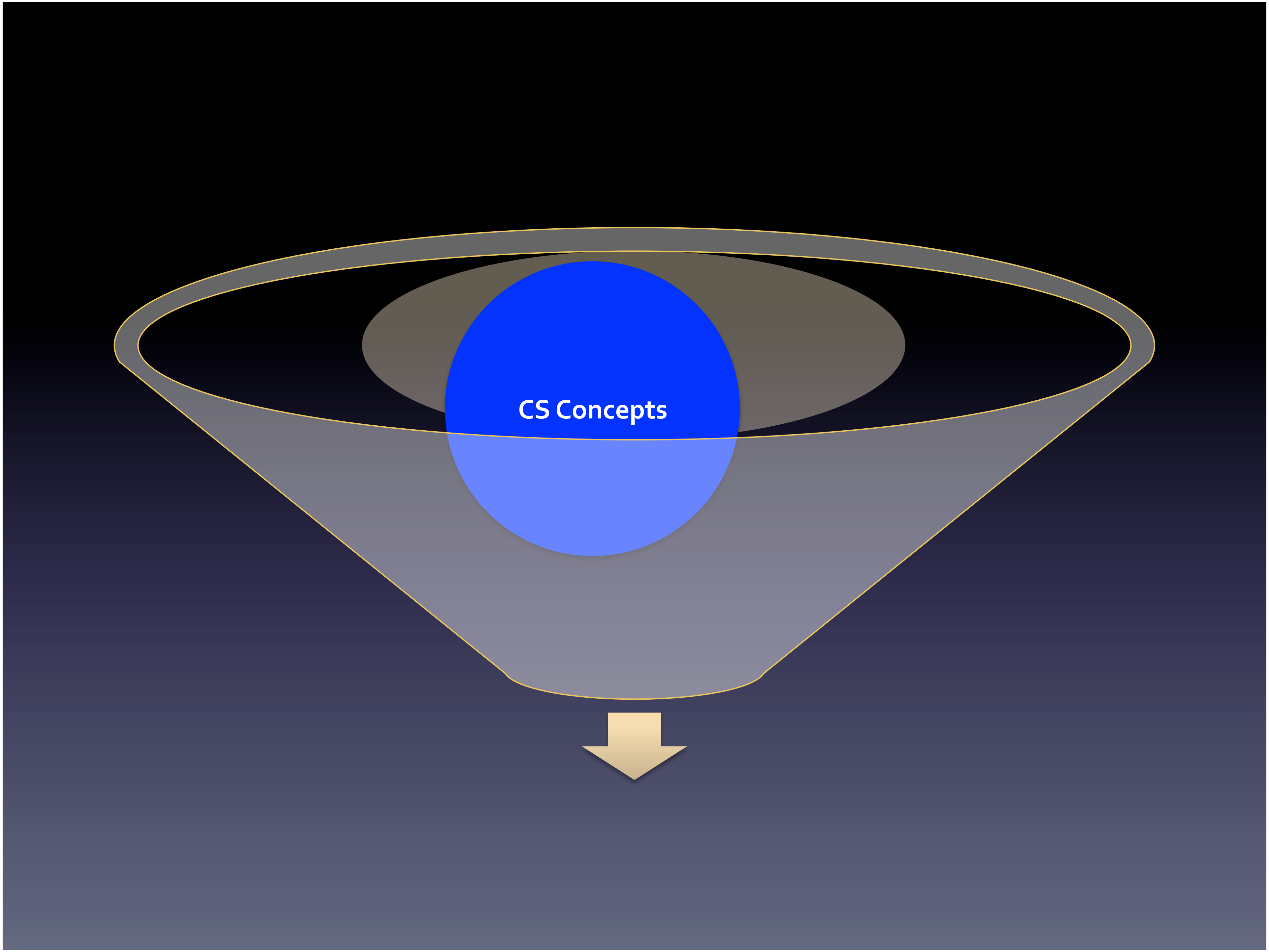
Computational Thinking

At the K-12 level, computational thinking often emphasizes problem solving and data representations (e.g., CSTA/ISTE, 2011).

Computational Thinking Practices

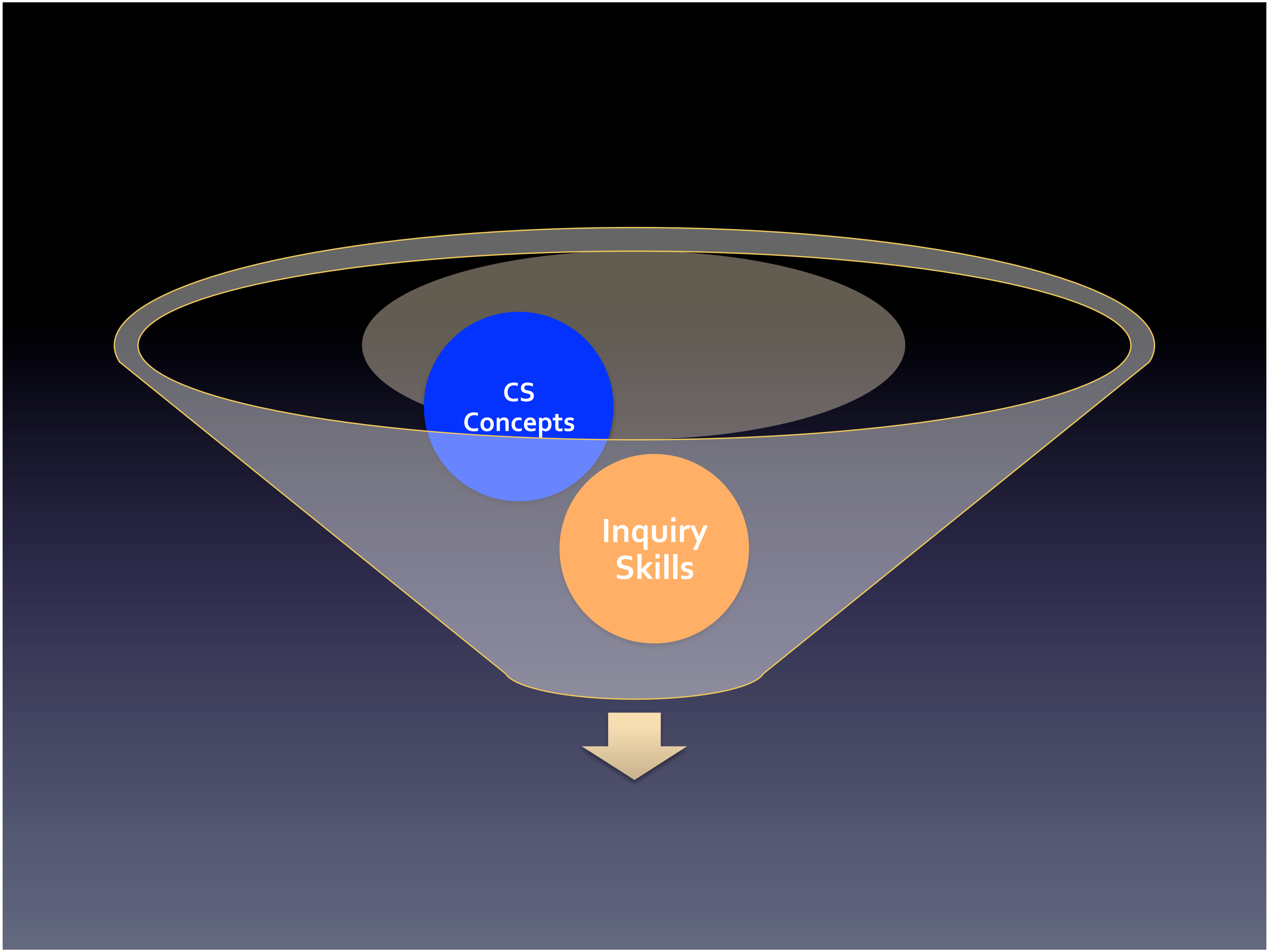
New high school curricula (e.g., CS Principles, ECS) emphasize "computational thinking *practices*".

This reflects an orientation toward not just an internal, individual "thinking" but "ways of being and doing" that students should demonstrate when learning and exhibiting computer science knowledge, skills, and attitudes.


CS Concepts

Computational Thinking Practices

Example CS Concepts	Inquiry Skills	Communication & Collaboration Skills
Algorithms	Evaluate	Publish
Programming	Explore	Present
Recursion	Investigate	Build Consensus
Abstraction	Explain	Discuss
Debugging / Testing	Elaborate	Distribute Work
Variables	Modeling	Lead/Manage Teams


CS
Concepts
Inquiry
Skills

Computational Thinking Practices

Example CS Concepts	Example Inquiry Skills	Communication & Collaboration Skills
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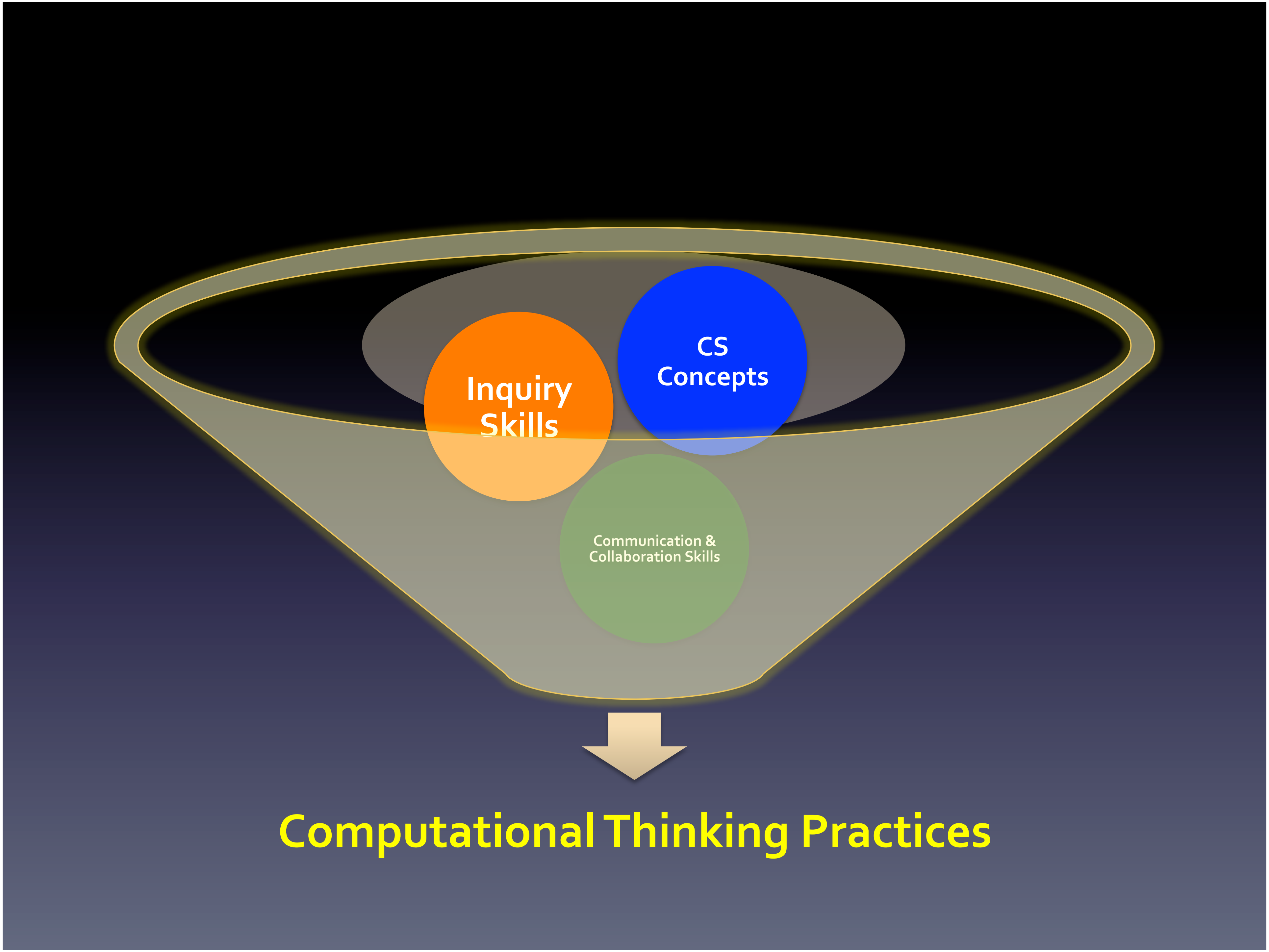
CS
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Computational Thinking Practices

Computational Thinking Practices

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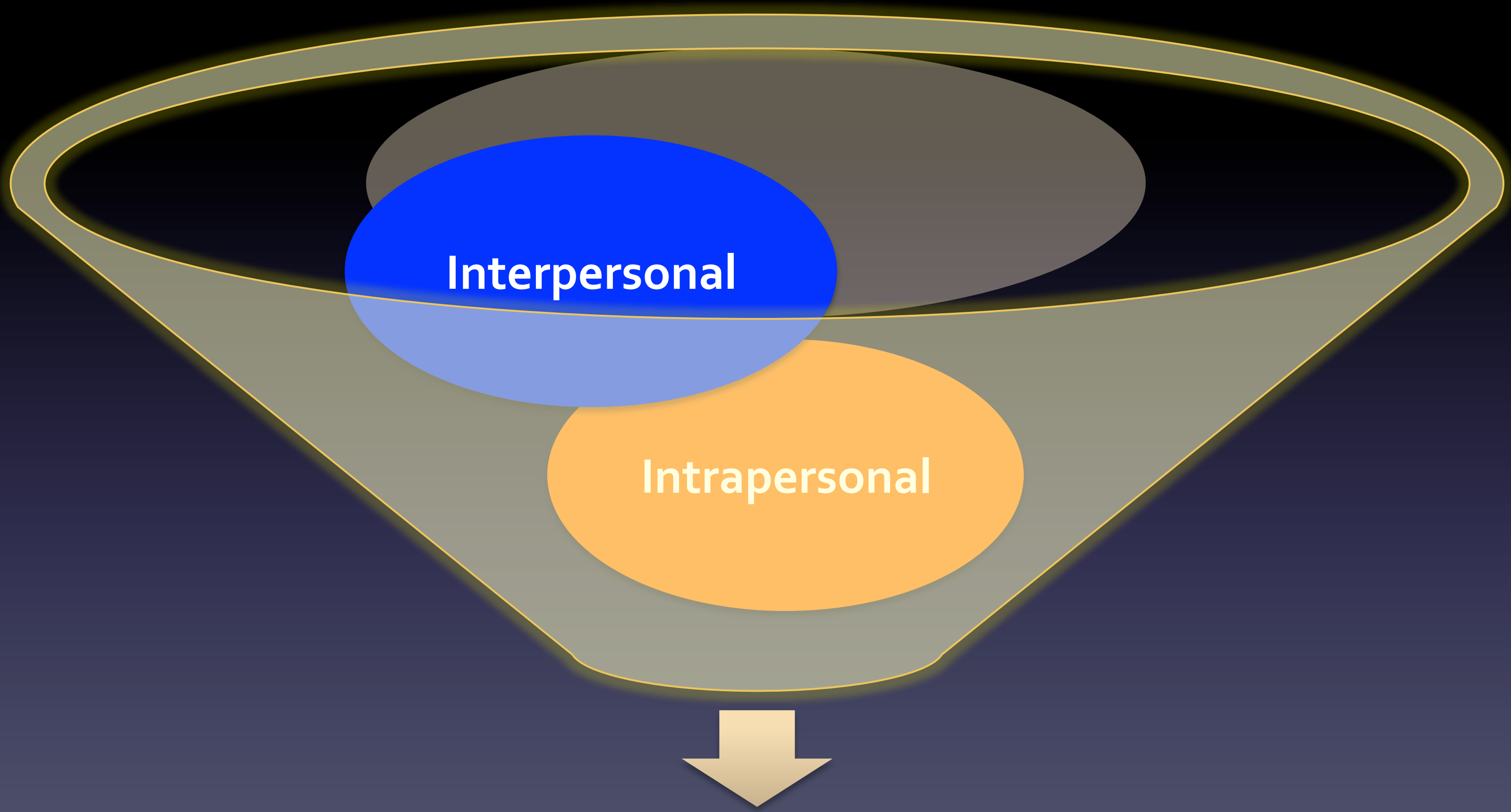
Integration

Computational Thinking Practices

Exploring Computer Science	Computer Science Principles
Analyze the effects of developments in computing	Analyzing Problems and Artifacts
Design and implement creative solutions and artifacts	Developing Computational Artifacts
Apply abstractions and models	Abstracting
Analyze their computational work and the work of others	Analyzing Problems and Artifacts
Connect computation with other disciplines	Connecting Computing
Communicate computational thought processes, procedures and results to others	Communicating
Collaborate with peers on computing activities	Collaborating

Noncognitive Skills?

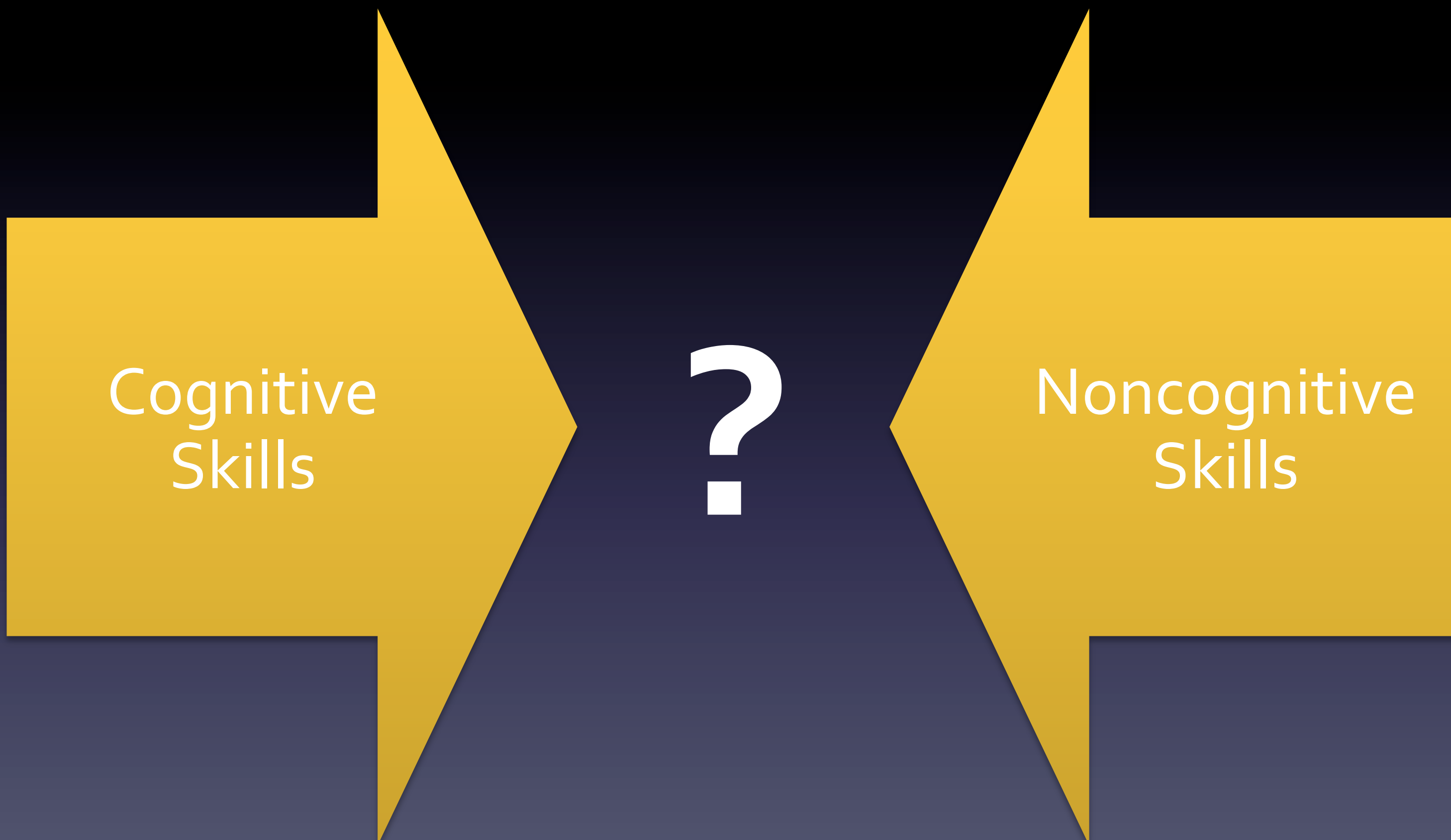


Computational Thinking Practices

Noncognitive Skills

Interpersonal Skills	Intrapersonal Skills
Communication	Self-efficacy
Teamwork/collaboration	Self-concept
Leadership	Persistence
Cultural awareness	Organization
Tolerance for diversity	Time management

Computational Thinking Practices



Computational Thinking

The Common Core State Standards include standards related to computational thinking practices in mathematics such as problem and abstraction.

The Next Generation Science Standards include standards dealing with engineering design and describe "using mathematical and computational thinking" as an essential practices for modeling and analyzing and interpreting data.

Computational Thinking Assessments

Postsecondary Education

- FCS1
- CS Major Field Assessment
- GRE Subject Assessment

Secondary Education

- AP CS
- CS Principles
- Exploring Computer Science

Computational Thinking Assessments

Challenges

- Programming language
- Conceptual vs. syntactic knowledge
- Cognitive and noncognitive factors
- CT in non-CS domains (e.g., science, mathematics)
- Limited validity evidence to support desired uses

Lessons on the Road to Validity

Assessment Validity

"…degree to which evidence and theory support the interpretations of test scores [in the context of proposed test uses]."

Standards for Educational and Psychological Testing, pg. 9 – 1999: AERA, APA, NCME

Lessons on the Road to Validity

Lesson #1:

Assessments are ***not*** "plug and play"

Lessons on the Road to Validity

Lesson #1:

Assessments are ***<u>not</u>*** "plug and play"

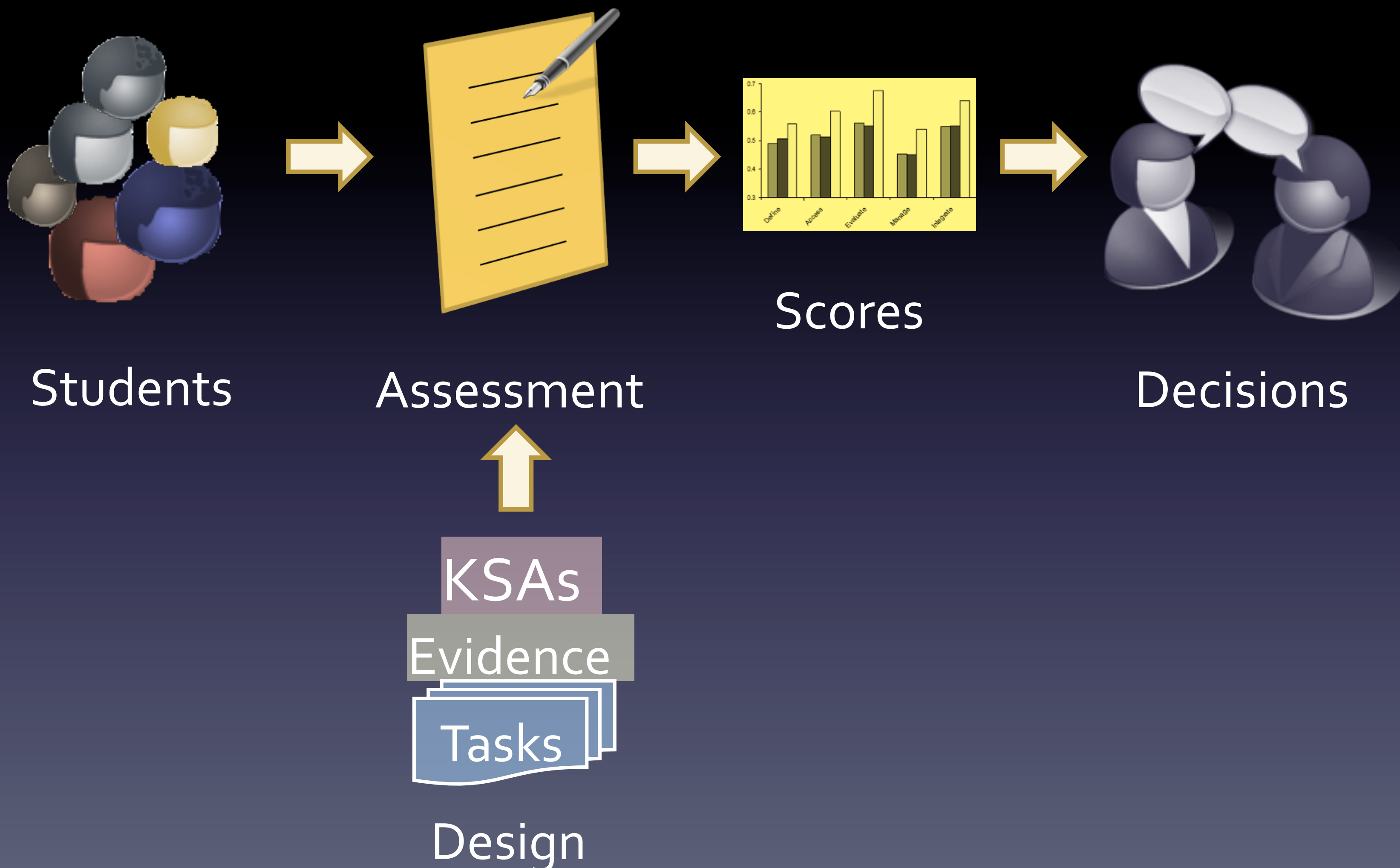
Need to *check compatibility between instruction and assessment* in terms of the targeted knowledge and skills, what counts as evidence of those targets, and the types of tasks that elicit the evidence.

Lessons on the Road to Validity

Lesson #2:

Validity is use-specific

Validity is Use-Specific



Lessons on the Road to Validity

Lesson #3:

Assessment design focuses on evidence, **not**

just creating innovative tasks

Lessons on the Road to Validity

Lesson #3:

Assessment design focuses on evidence

Assessment Design

- What **KSAs** do I want to assess?
- What would be **evidence** of those KSAs?
- What **tasks** would elicit the correct evidence?

Final Comments

- The train has already left the station.
- Future opportunities & challenges:
  - Putting the cart before the horse, particularly with regard to validity
  - Connecting implementation with learning outcomes
  - Relating cognitive and noncognitive factors
  - Game-based assessment & learning analytics

Discussion

- Possible discussion questions:
  - How are you assessing CT in your settings?
    - Targeted knowledge and skills?
    - Types of evidence?
    - Tasks to elicit evidence?
  - What are some of the successes/challenges you have experienced when assessing CT in your settings?
  - Promising new approaches for assessing CT?