Improving Interactive Instruction:

Faculty Engagement Requires Starting Small and Telling All
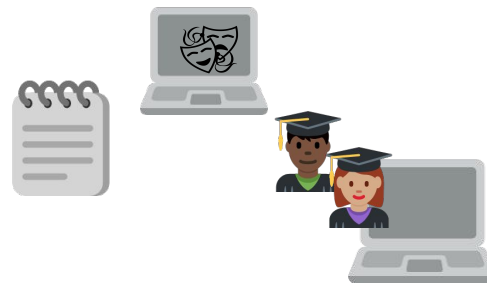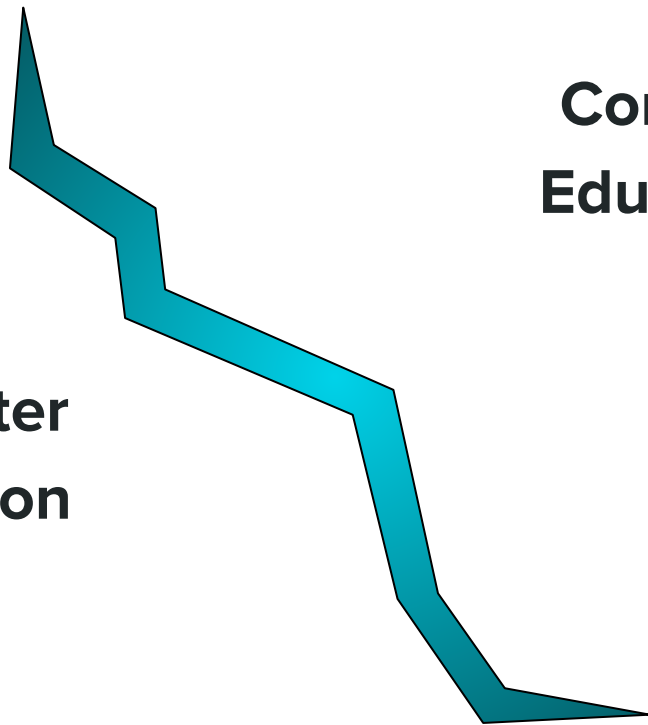
Bailey Kacsmar

UNIVERSITY OF
WATERLOO

A Divide

Current Computer Science Education Practices

Computer Science Education Research Innovations

Interactive Instruction Innovations

One-minute reflections

Interactive Instruction Innovations

One-minute reflections   Software theater

Interactive Instruction Innovations
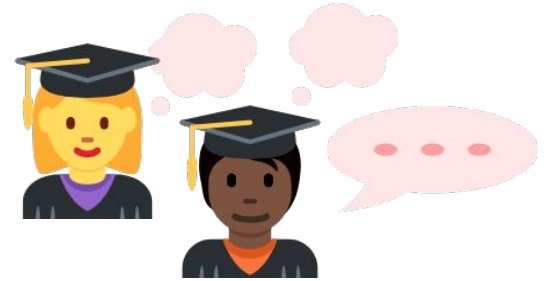
One-minute reflections
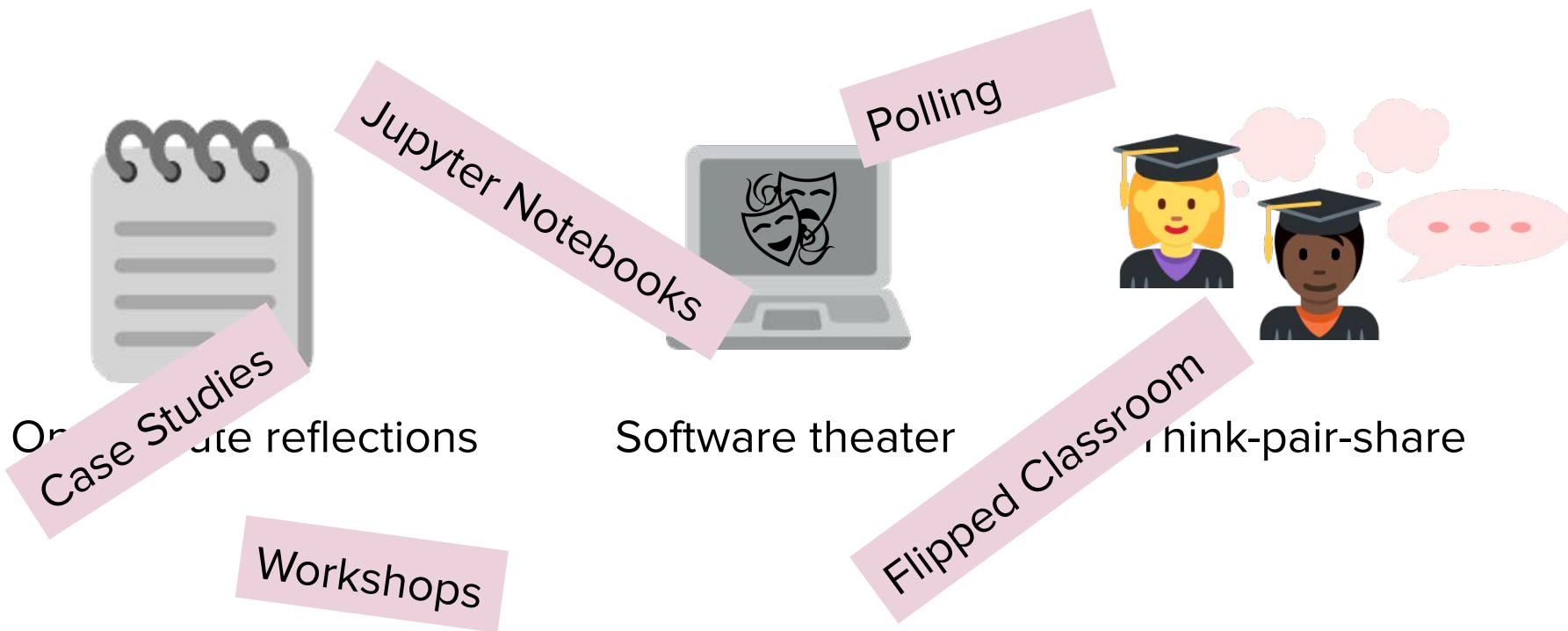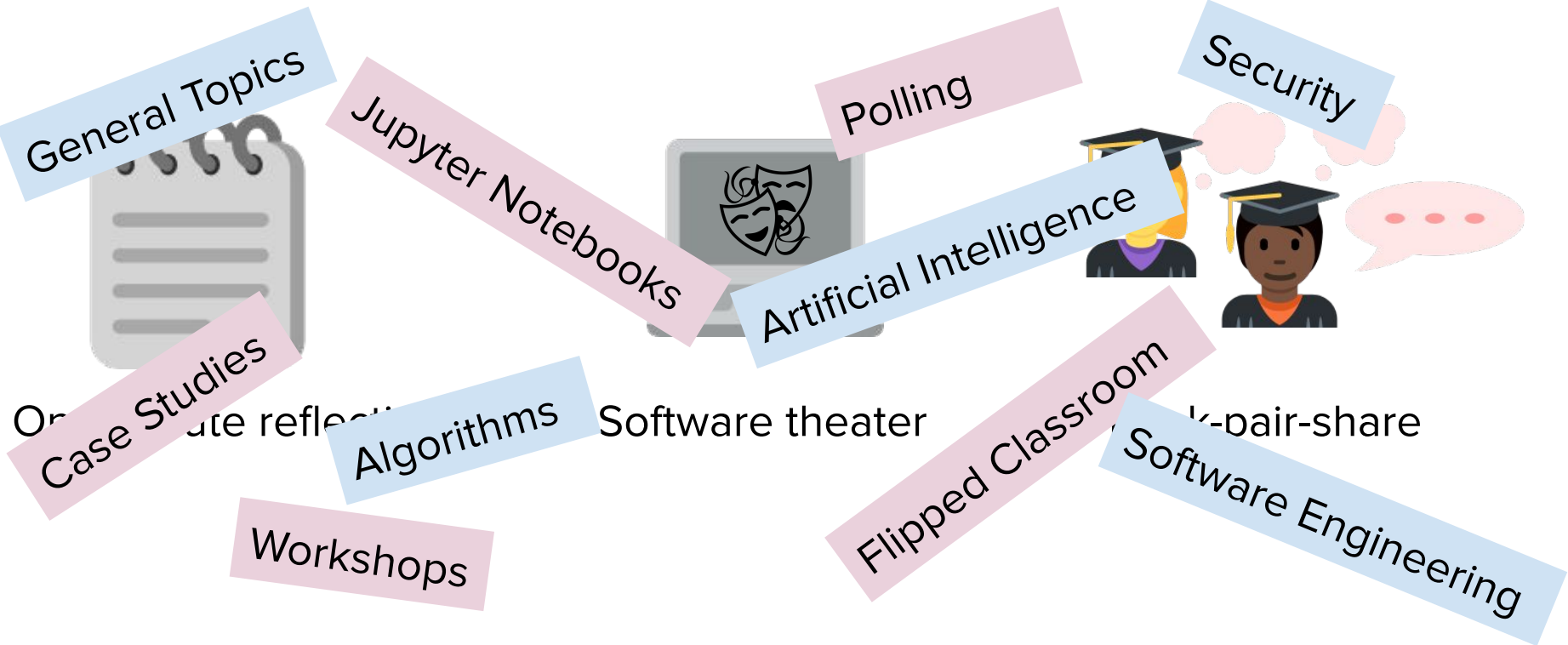
Software theater

Think-pair-share

Interactive Instruction Innovations

Jupyter Notebooks

Polling

Case Studies

On_____te reflections

Software theater

Think-pair-share

Flipped Classroom

Workshops

Interactive Instruction Innovations

General Topics

Jupyter Notebooks

Polling

Security

Artificial Intelligence

On...ate reflecti...

Case Studies

Algorithms

Software theater

Flipped Classroom

...k-pair-share

Software Engineering

Workshops

Interactive Instruction Innovations

General Topics

Jup... Notebooks

Increases Accessibility!

Polling

Security

Artificial Intelligence

Benefits students!

Case Studies

On... ate reflec...

Algorithms

Software theater

Flipped Classroom

...k-pair-share

Software Engineering

Workshops

Diversity!

A Divide

Current Science Education Practices

Computer Science Education Research Innovations

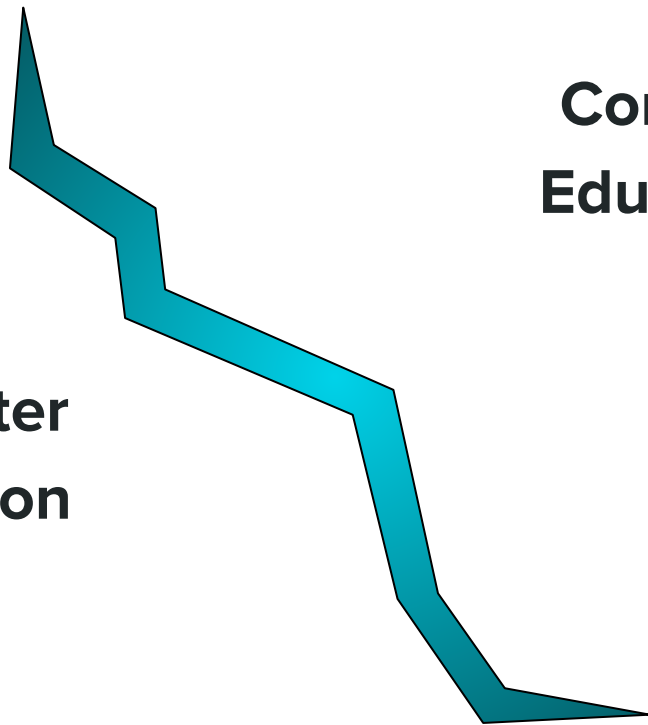Lecture Based Instruction!!!!

Barriers in the Divide

Current Computer Science Education Practices

Computer Science Education Research Innovations

Barriers in the Divide

Student Perceptions

Computer Science Education Research Innovations

Current Computer Science Education Practices

Barriers in the Divide

Student Perceptions

Convincing Faculty
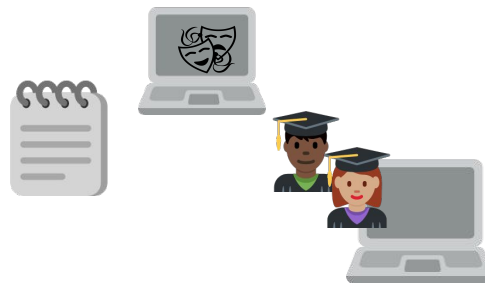
Current Computer Science Education Practices

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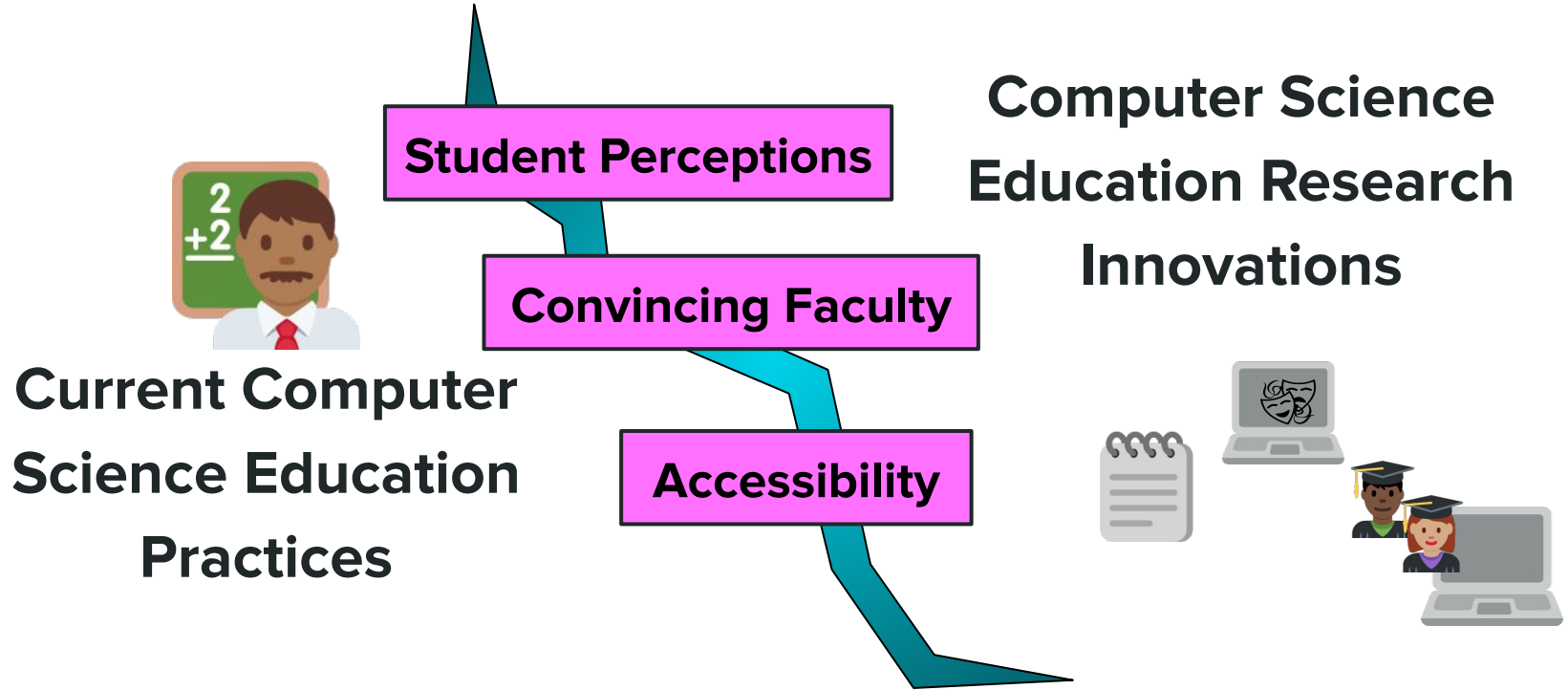
Convincing Faculty

Accessibility

Institutional Barriers

Current Computer Science Education Practices

Computer Science Education Research Innovations
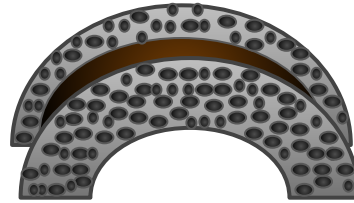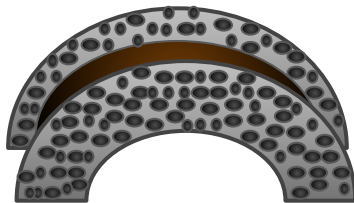
Now what?

Let's build a bridge!

Two Main Goals for Building a Bridge

- Improving the accessibility of education innovations

- Identify a path to propagate innovations from researchers to practitioners

Steps Towards a Bridge

Small Teaching

J. M. Lang. 2016. Small teaching: Everyday lessons from the science of learning. John Wiley & Sons.
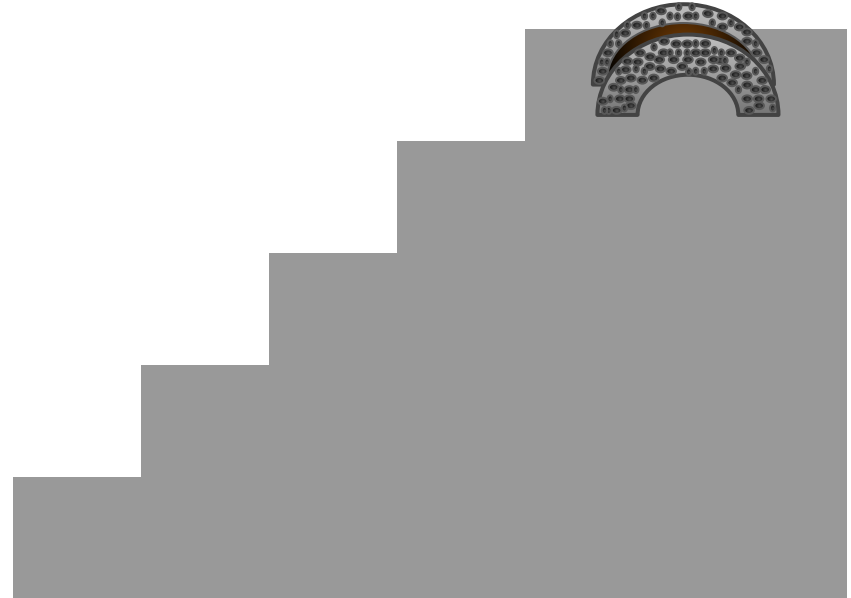
Steps Towards a Bridge

Small Teaching

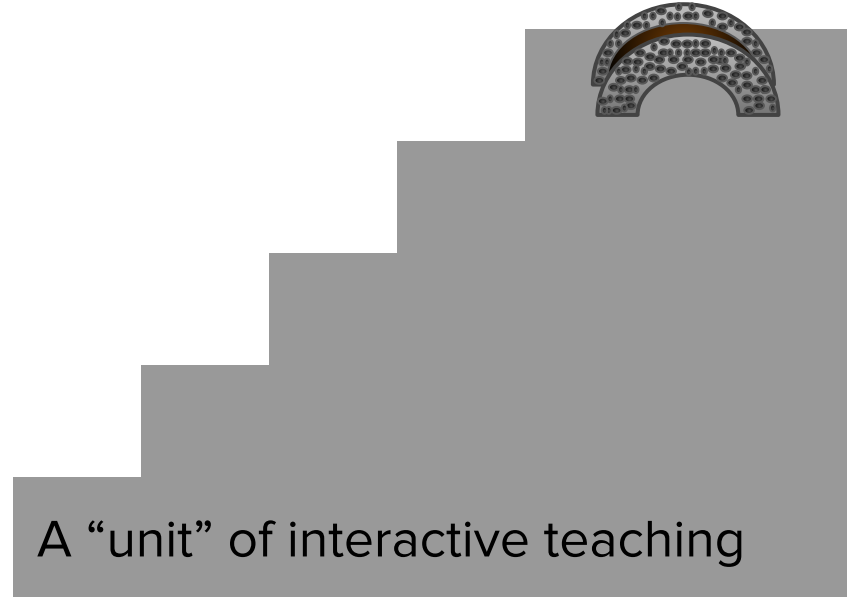A "unit" of interactive teaching
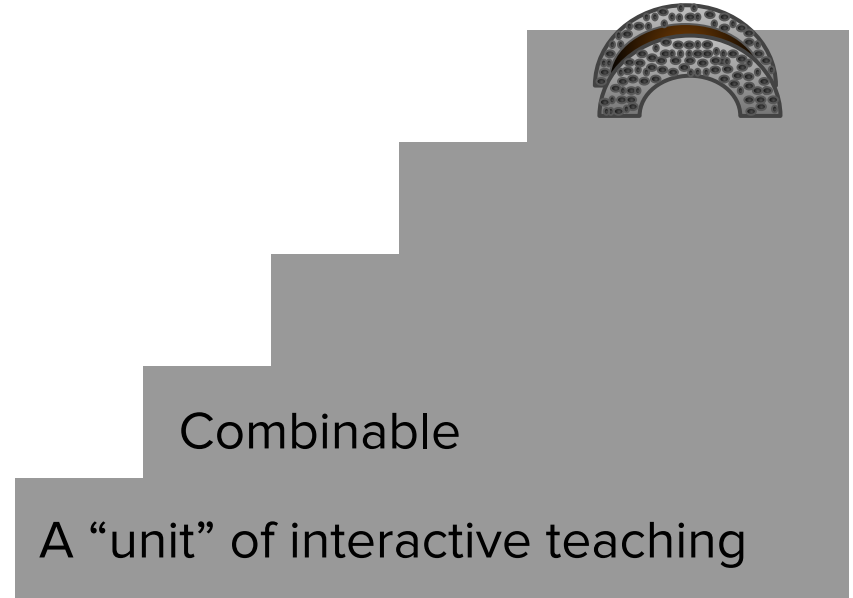
Steps Towards a Bridge

Small Teaching

Combinable

A "unit" of interactive teaching

Steps Towards a Bridge

Small Teaching

Low Overhead

Combinable

A "unit" of interactive teaching

Steps Towards a Bridge

Small Teaching

...what's missing?

Low Overhead

Combinable

A "unit" of interactive teaching

Steps Towards a Bridge

Small Teaching

How do you start??

...what's missing?

Low Overhead

Combinable

A "unit" of interactive teaching
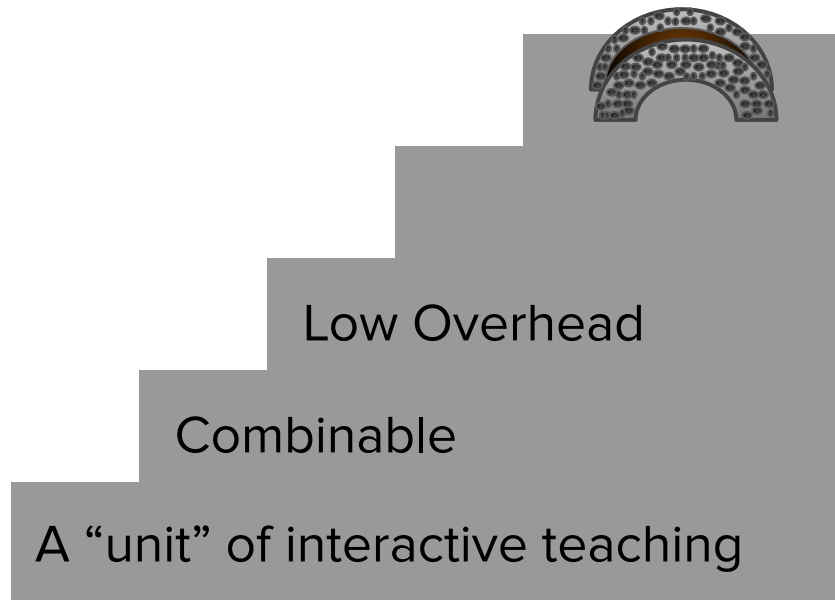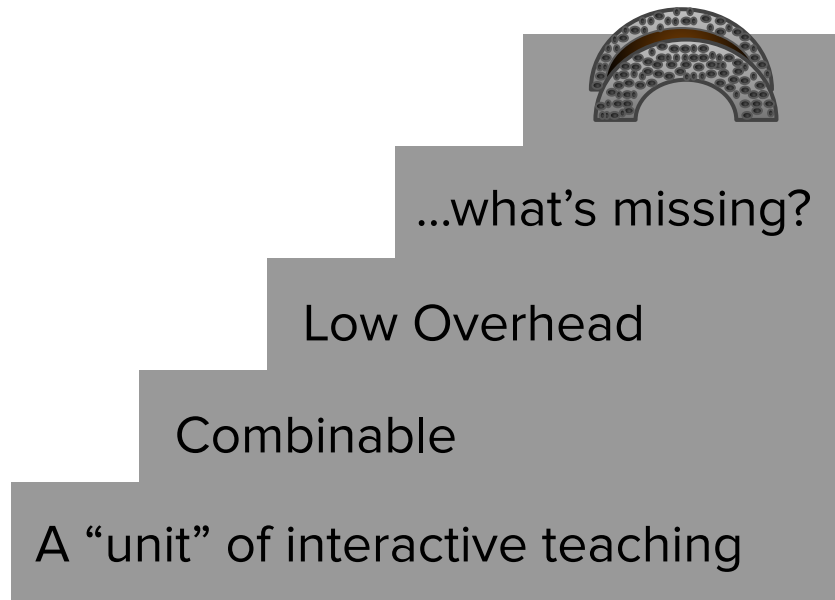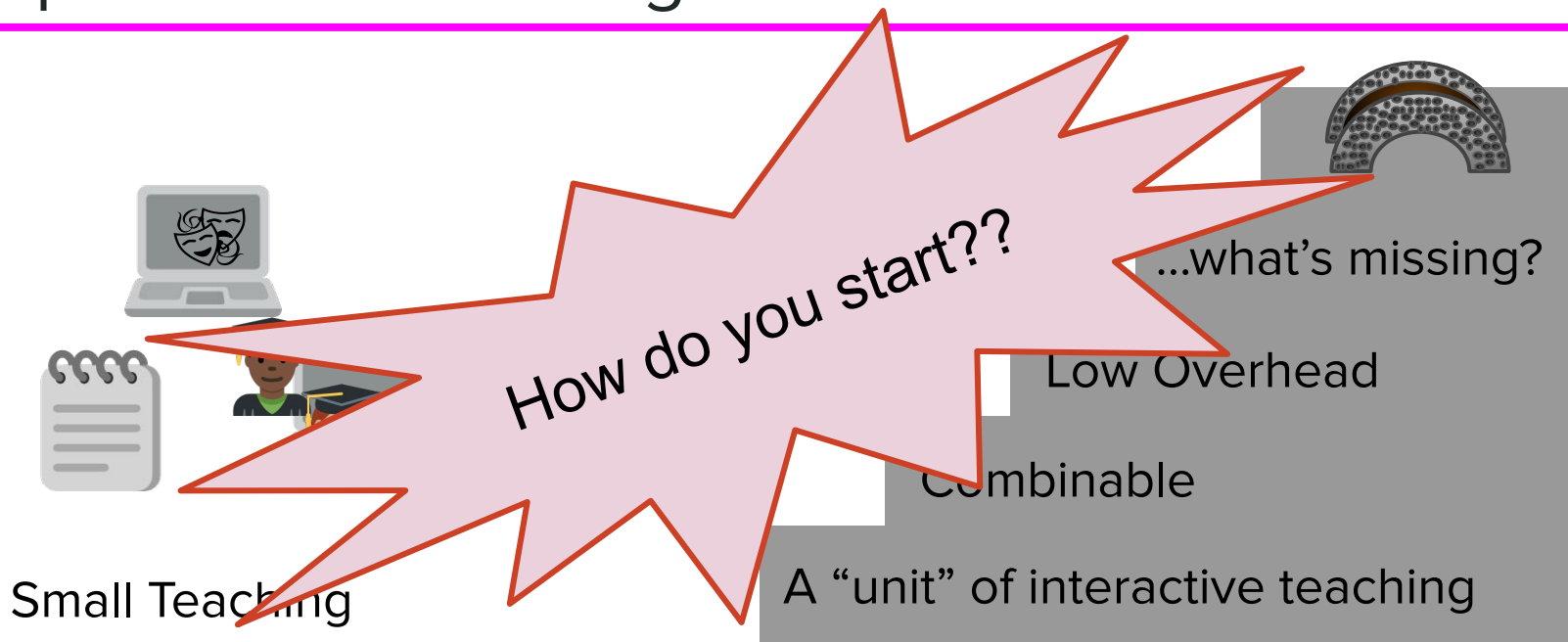
Finding the bridge?
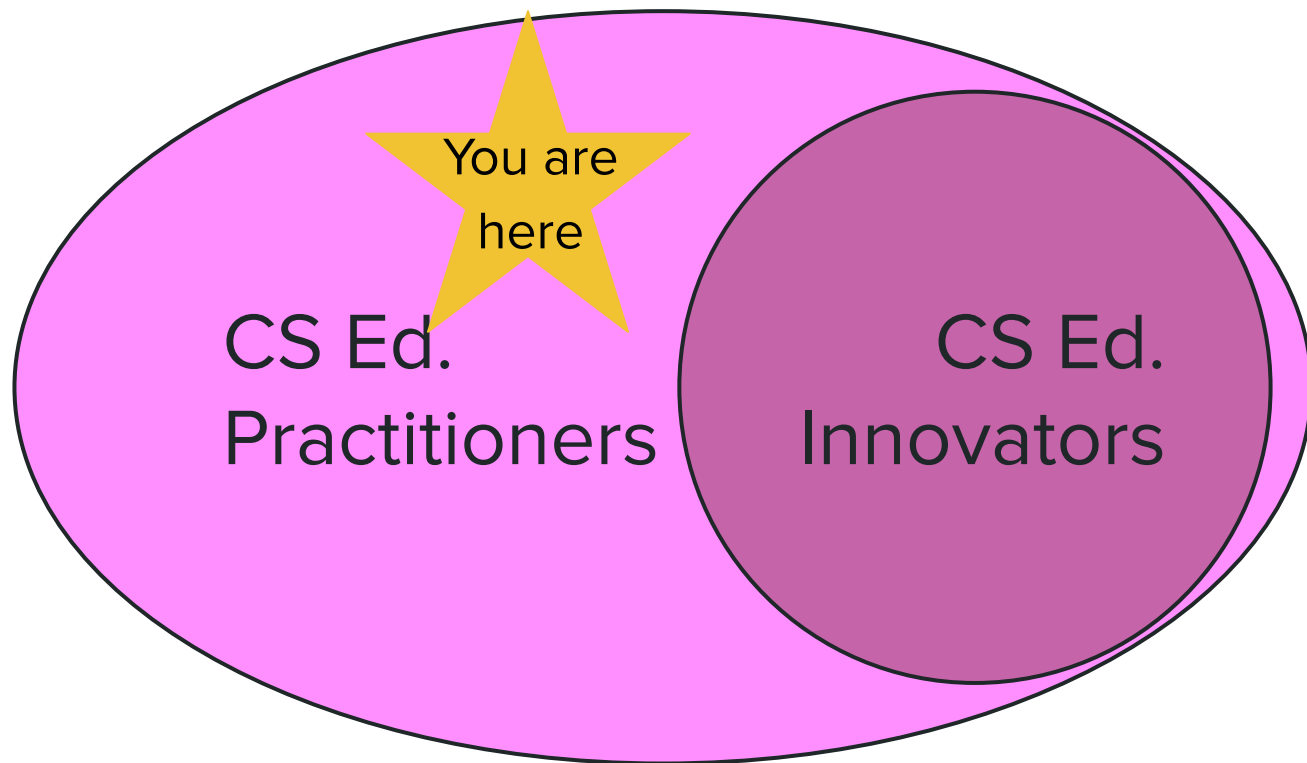
A Few More Steps...

Computing Education
Research Artifacts

A Few More Steps

Computing Education Research Artifacts

- Why artifacts?

- What is an artifact in CSER?

- How will we ensure quality artifacts?

Why Artifacts?

- Ideally, there would be a dataset of CS Ed Innovations

- Documented for re-usability

- Evaluated for motivating to students and administrators

- Accessible with varying time and resource requirements

What is an artifact?

CS Ed Artifact

What is an artifact?

CS Ed Artifact - Submitted by CS Ed Researchers

What is an artifact?

CS Ed Artifact

Type: lecture activity, flipped classroom, tool/software, framework...

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⋮

Not all inclusive, but it is a start.

Ensure Quality Artifacts

1) Calls for Artifacts

Ensure Quality Artifacts

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2) Artifact Review Committees

Ensure Quality Artifacts

1) Calls for Artifacts

Artifact Review Committees

Include Junior Researchers

Try it?

Unconditionally Secure: One-Time Pad

Message:

| x_0 | x_1 | x_2 | | x_n |

...

$\oplus$

Key:

| k_0 | k_1 | k_2 | | k_n |

...

=

Ciphertext:

| y_0 | y_1 | y_2 | | y_n |

...

Rule: $y_i = x_i + k_i \pmod 2$

Provably Security for One-Time Pad

<Ciphertext is uniformly distributed independent of the plaintext distribution>

x_i = 0 with probability p (x_i = 1: 1-p),

k_i = 0 with probability 0.5 (k_i = 1: 0.5),

y_i = 0 with probability:

$p(y_i = 0)$ $= p(x_i = 0) \, p(k_i = 0) + p(x_i = 1) \, p(k_i = 1)$

$= 0.5p + 0.5(1-p)$

$= 0.5$

Improving Interactive Instruction

What do we want to teach?

- A technique?

What do we want to teach?

- A technique?

- A theorem

What do we want to teach?

- A technique?

- A theorem

- A problem solving strategy?

- …

Example: What if it is a many-time pad?

Key: K?

Ciphertext$_1$= message$_1$ xor K = 2c15491000043130b1000290a1b

Ciphertext$_2$= message$_2$ xor K = 3f16421617175203114c020b1c

Your turn, goal: Learn the english messages.

Hmmm…what do I know these are made of…and definitely contain?

Example: What if it is a many-time pad?

Key: K?

Ciphertext$_1$ = mes... ...c1549100043130b1000290a1b

Ciph... ...$_2$ xor K = 3f16421617175203114c020b1c

What happens?

Your turn, goal: Learn the english messages.

Hmmm…what do I know these are made of…and definitely contain?

Example: What if it is a many-time pad?

Key: K?

Ciphertext$_1$ = mes~~~~~~~~~c1549100~~~3130b1000290a1b

Ciph~~~~~~~~~~~~~$_2$ xor K = 3f16421~~~~~~~~~~1~~~0b1c

What happens?

Students get stuck…

Your turn, goal: Learn the en~~~~~

Hmmm…w~~~~~
these are m~~~e of…
definitely c~ntain?

Example: What if it is a many-time pad?

Act.

Key: K?

Ciphertext$_1$ = mes... ...c1549100...43130b1000290a1b

Ciph... ...$_2$ xor K = 3f16421... ...1...0b1c

Your turn, goal: Learn the en...

What happens?

Students get stuck…

Hmmm…wh... ...
these are m...e of...

Why?

A small example that…

- Supports trial and error

- Discussion

- Changing approach to problem

Takeaways

- Small, low effort, teaching innovations can increase access

- Teaching innovations need to be taught

- Education research artifacts engage junior researchers and discipline isolated researchers

- Above all, guide instructors, help build change

Thank you