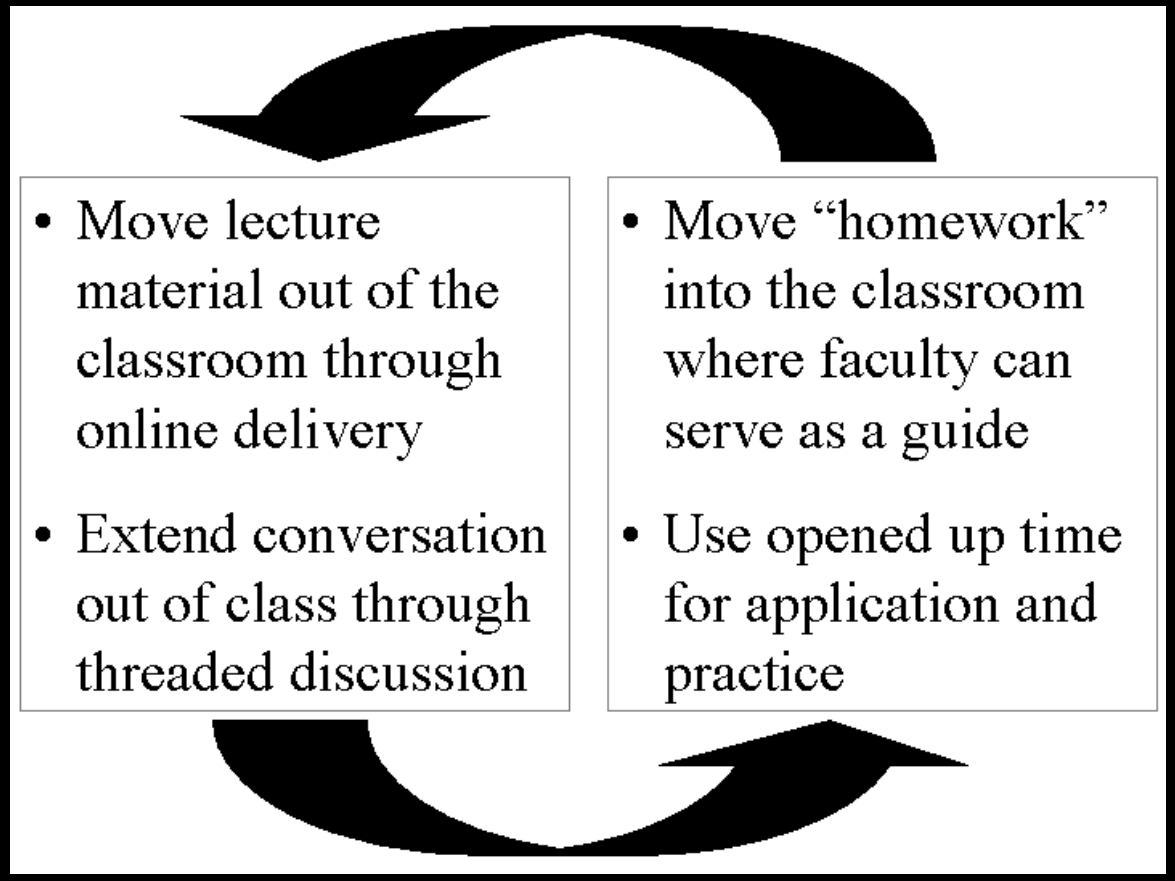
MIDDLE TENNESSEE STATE UNIVERSITY

SUPPORTING CLASSROOM DISCOURSE WITH THE FLIPPED CLASSROOM

Jeremy F. Strayer
James B. Hart
Sarah Bleiler-Baxter

WHAT IS THE FLIPPED CLASSROOM (FC)



The classroom flip (Baker & Mentch, 2000)

VARIED VIEWS OF THE FLIPPED CLASSROOM (FC)

Conflict FC practice →←Research findings

Mathematics Education Research / Leaders

- "Delivering content" with videos is not good teaching!
  - tasks problematize mathematics – students formulate solutions – teachers build instruction on student thinking

FC Leaders: It's not about videos! It's about pedagogy!

- Deliver content outside class to transform in-class learning
  - active engagement – student-centered – conceptual understanding

What does it mean to deliver content / engage students?

RESEARCH-SUPPORTED TEACHING PRACTICES

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.

NCTM (2014). *Principles to Actions*. NCTM: Reston, VA.

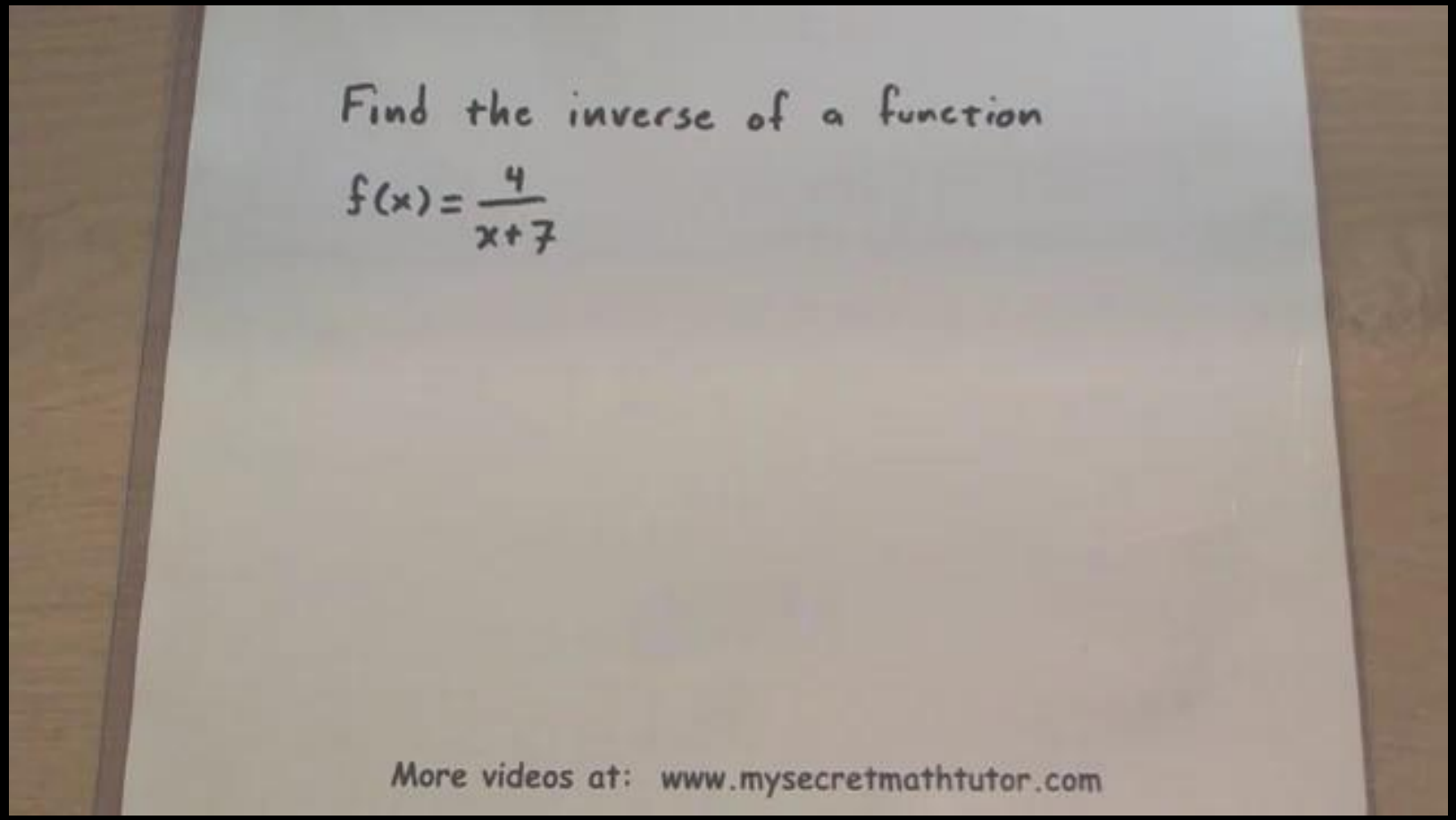
A WAY FORWARD

Focus on ***teaching practices***, not ***content delivery***

Definition of the Flipped Classroom:

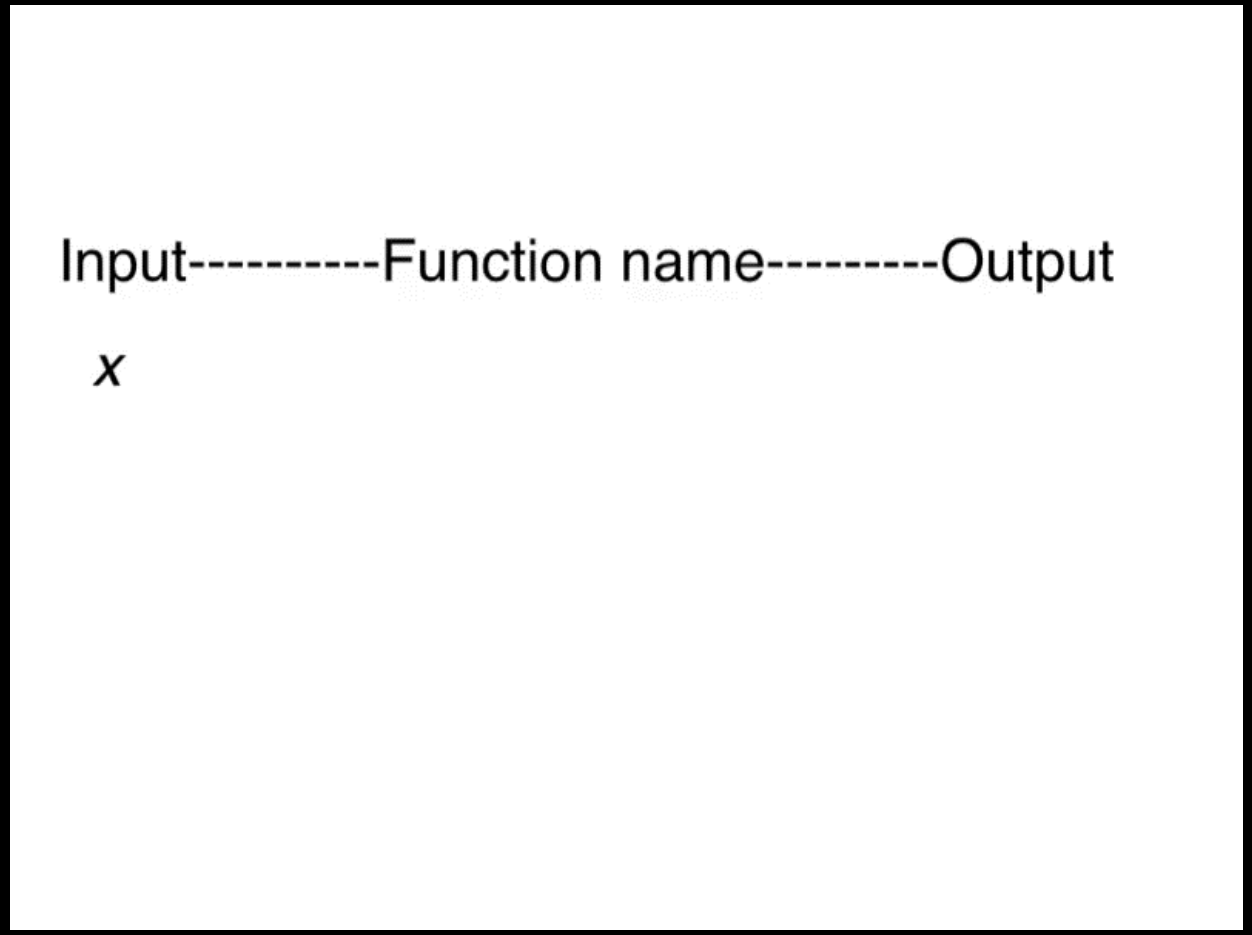
- Teachers use the flipped classroom when they enact teaching practices outside of class using communication technologies in order to efficiently enact teaching practices during class.

EXAMPLE: WHAT TEACHING PRACTICES ARE PRESENT?



1. goals
2. reasoning/PS tasks
3. representations
4. discourse
5. purposeful questions
6. conceptual understanding
7. productive struggle
8. student thinking

EXAMPLE: WHAT TEACHING PRACTICES ARE PRESENT?



1. goals
2. reasoning tasks
3. representations
4. discourse
5. purposeful questions
6. conceptual understanding
7. productive struggle
8. student thinking

ACTIONS OF THE PRACTICES

Teachers' actions

Students' actions

NCTM (2014). *Principles to Actions.* NCTM: Reston, VA.

Pose purposeful questions Teacher and student actions	
What are *teachers* doing?	**What are *students* doing?**
Advancing student understanding by asking questions that build on, but do not take over or funnel, student thinking. Making certain to ask questions that go beyond gathering information to probing thinking and requiring explanation and justification. Asking intentional questions that make the mathematics more visible and accessible for student examination and discussion. Allowing sufficient wait time so that more students can formulate and offer responses.	Expecting to be asked to explain, clarify, and elaborate on their thinking. Thinking carefully about how to present their responses to questions clearly, without rushing to respond quickly. Reflecting on and justifying their reasoning, not simply providing answers. Listening to, commenting on, and questioning the contributions of their classmates.

THE PROBLEM

Describe what process would undo the given function process.

a) A function f multiplies its input values x by 5, that is $f(x) = 5x$. For example, if you multiplied an input of 7 by 5, your output would be 35.

   (i) What process undoes the process of multiplying each input value by 5?

   (ii) Define a function h that undoes the process of f.

   (iii) If you input 35 into the function h, the inverse process of f that you defined in (ii), what is the output? (Carlson, Oehrtman, and Moore 2013, p. 101)

DISCUSSION

You receive these student responses. What would your next steps be as a teacher?

$$h - f(x)) \quad (1)$$

$$h(f(x)) = \frac{5}{x} \quad (2)$$

$$h(f^{-1}(x)) = \frac{x}{5} \quad (3)$$

$$\frac{f(x)}{5} \quad (4)$$

$$h(f(x)) = \frac{f(x)}{5} \quad (5)$$

$$h(x) = \frac{x}{5} \quad (6)$$

$$h^{-1}(f(x)) \quad (7)$$

$$h(y) = \frac{y}{5} \quad \text{where} \quad y = f(x) \quad (8)$$

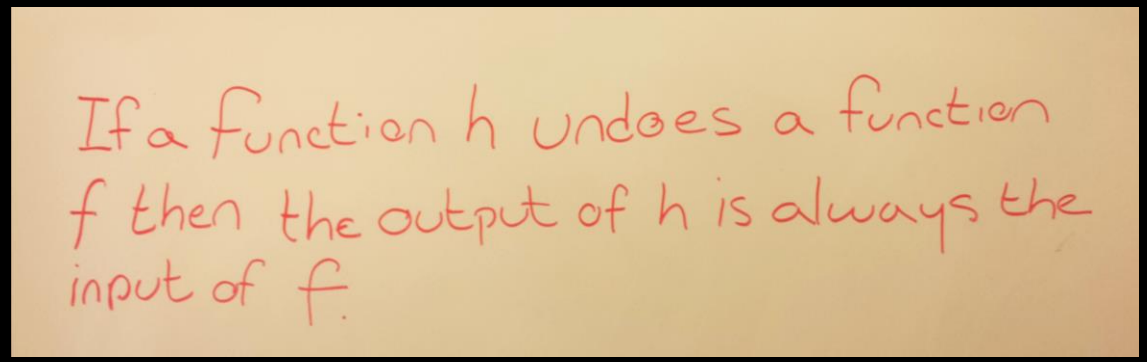
$$h(x) = \frac{f(x)}{5} \quad (9)$$

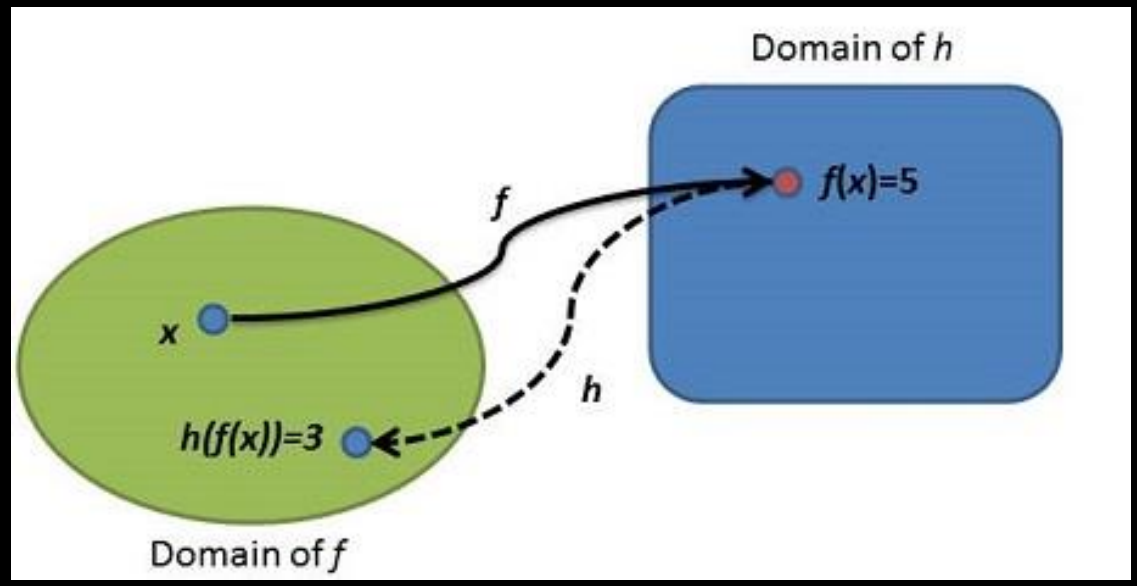
JAMES' PEDAGOGICAL MOVES

Students struggled to agree on a correct definition for *h*.

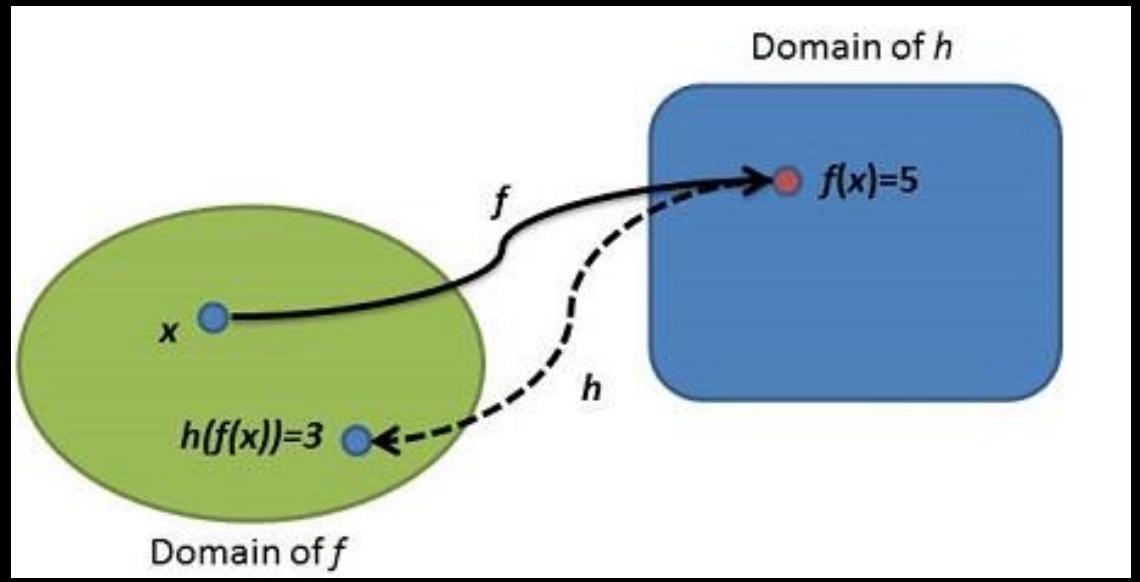
James made an in-the-moment instructional decision and asked students to complete the following sentence:

"If a function *h* undoes a function *f*, then..."





JAMES' PEDAGOGICAL MOVES



If a function h undoes a function f, then ...

The input of h is always the output of f.

If a function h undoes a function f, then whenever h is applied to an output of f, we have to get the original input into f.

A RETURN

Linking in-class learning with the pre-class video.

$$h - f(x)) \tag{1}$$

$$h(f(x)) = \frac{5}{x} \tag{2}$$

$$h(f^{-1}(x)) = \frac{x}{5} \tag{3}$$

$$\frac{f(x)}{5} \tag{4}$$

$$h(f(x)) = \frac{f(x)}{5} \tag{5}$$

$$h(x) = \frac{x}{5} \tag{6}$$

$$h^{-1}(f(x)) \tag{7}$$

$$h(y) = \frac{y}{5} \quad \text{where} \quad y = f(x) \tag{8}$$

$$h(x) = \frac{f(x)}{5} \tag{9}$$

Janelle: "Formula 1 does not work at all -- *h* should use division, not subtraction."

Willard: "Right, Janelle, and Formula 2 doesn't work either, because we should divide by 5, not by *x*.''

Jesse: "I guess Formula 3 is kinda composing *h* with itself -- that doesn't work."

Janelle: "Right, Jesse. Formulas 4 and 7 don't tell us what to do when we input something into *h*, but I don't know about the others. They all look kinda the same."

Willard: "Yeah, Janelle. I don't know about the others. I mean, don't formula (6), $h(x) = \frac{x}{5}$, and formula (5), $h(f(x)) = \frac{f(x)}{5}$, just say the same thing?"

Janelle: "Maybe. But I don't get how *x* can be one thing and then another in the same problem ... if Formula 6 is correct, then you start with $x = 7$ in *f* earlier in the problem, but later you say $x = 35$ in *h* for formula (6). I don't get it."

Jesse: "Yeah, Janelle, I get what you're saying."

JAMES' PEDAGOGICAL MOVES

James: "Everybody, remember that when we are working with functions, x is not a fixed value, but can take on many different values. It's really just a placeholder."

Brent: "Yeah, OK. If that's true, I guess [Formula 6] is probably the best answer."

(A large majority of the class nods in agreement.)

Susan: "I don't know, Brent. Since h needs to work on the output of f, I think [Formula 8] is better."

James: "Why is that, Susan?"

Susan: "Well, it's got $f(x)$ as the input into h."

RESEARCH-SUPPORTED TEACHING PRACTICES

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.

NCTM (2014). *Principles to Actions*. NCTM: Reston, VA.

A WAY FORWARD

Focus on ***teaching practices***, not ***content delivery***

Definition of the Flipped Classroom:

- Teachers use the flipped classroom when they enact teaching practices outside of class using communication technologies in order to efficiently enact teaching practices during class.

DESIGN PRINCIPLES FOR FLIPPED INSTRUCTION

1. Flipped Classroom Principle 1 (FCP1)
   Use out-of-class tasks to encourage student reflection and elicit a response from students.
2. Flipped Classroom Principle 2 (FCP2)
   Use in-class tasks to build new knowledge as part of a learning community;
3. Flipped Classroom Principle 3 (FCP3)
   Connect out-of-class and in-class tasks using the same instructional approach.

CONCLUSION

How have you used (or how might you imagine using) the Flipped Classroom model to implement reform-oriented, research-supported teaching practices?

- Hurdles?
- Your classroom?

REFERENCES

Strayer, J.F., Hart, J.B., & Bleiler, S.K. (2015). Fostering instructor knowledge of student thinking using the flipped classroom, *PRIMUS*. *25*(8), 724-735.

Strayer, J.F., Hart, J.B., & Bleiler, S.K. (in press). Kickstarting discussions with the flipped classroom, *Mathematics Teacher*.

Strayer, J.F. (in press). Classroom flip designs for learner-centered instruction in Reigeluth, C. M. (Ed.) *Instructional-Design Theories and Models Vol. IV*.