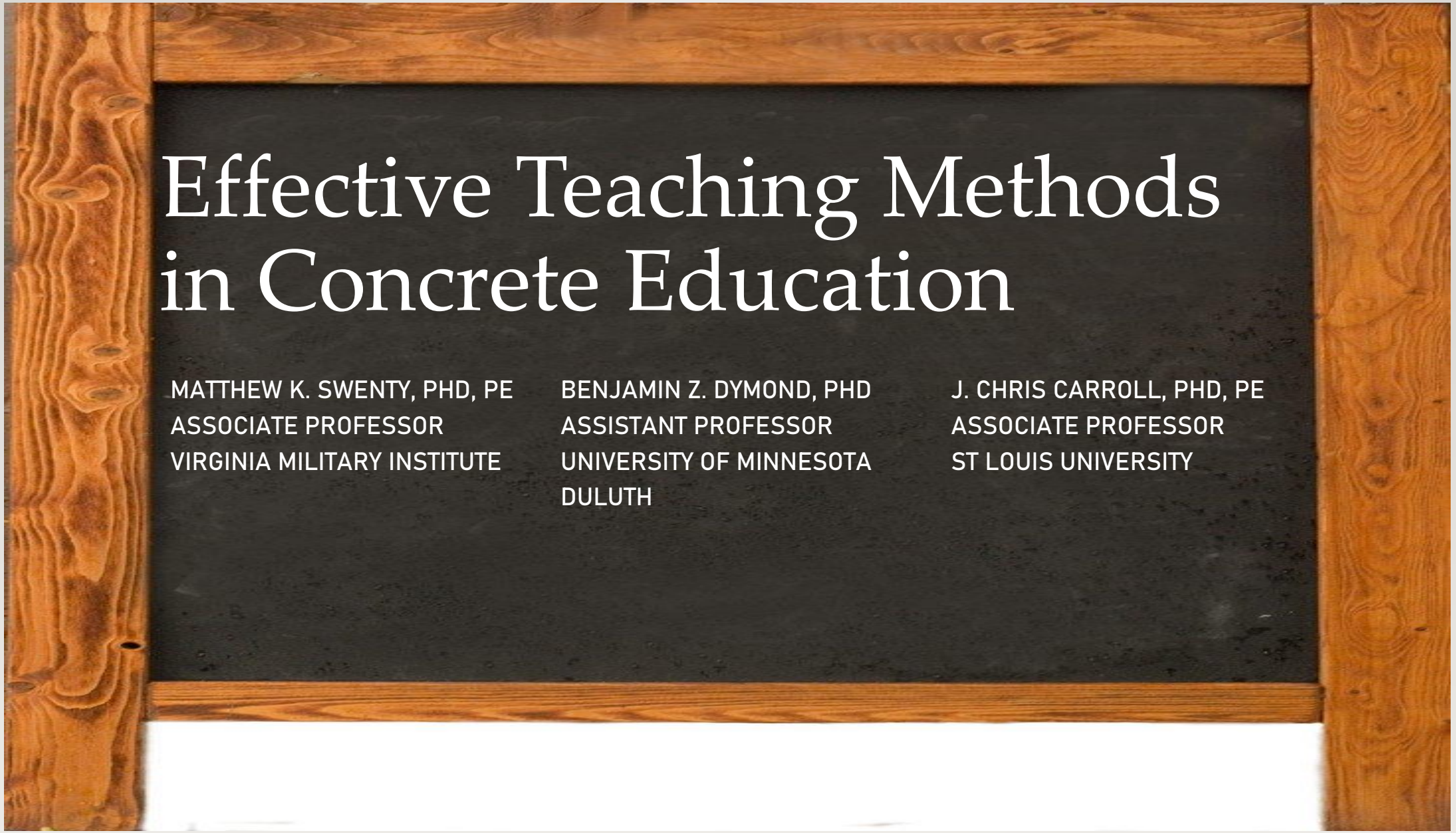

Effective Teaching Methods in Concrete Education

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The following presentation is the first in a series of resources for engineering educators

2. Approaches to Teaching Cement Hydration Processes to Undergraduates
3. Fresh and Hardened Properties of Concrete
4. Innovative Pedagogical Approaches for Concrete Durability
5. Pedagogical Approaches for Additive Manufacturing with Cementitious Materials
6. Effective Teaching Methods for Non-destructive Testing Techniques
7. Pedagogical Techniques used to Teach Detailing of Reinforced Concrete Structures
8. Equivalent Rectangular Stress Block
9. Teaching Flexural Strength Failure Modes in Reinforced Concrete I
10. Non-rectangular Beams
11. Approaches for Teaching Shear Analysis and Design of Reinforced Concrete

The goal is to provide a forum to share ideas and leave behind guidance for anyone involved in teaching concrete topics.

Learning

- The People
- The Process
- The Dilemma

We think in terms of construction

- Pedagogy
- Constructivism
- Learning Styles
- Motivations

Classical Methods

Many of us learned from and use methods like lectures and deductive learning

The Question WHY?

Why do I need to learn this topic?

How does this affect the “real world” or my world?

What is the best way? (or, what is the right answer)

- In most cases there is not one right way
- Balance and flexibility are key
- Higher order inductive learning can make great connections – Memorable
- A foundation is needed – Deductive methods may be best
- Keeping students active and engaged is always good

Learning Techniques Vary

- We will explore a few
- The companion papers will provide many more examples and applications

Method Description Complexity

Methods	Description	Complexity*
Think-Pair-Share (TPS)	Students think about a concept, pair up to exchange thoughts, and share with a larger group. (Stronge et al. 2004)	Simple, 5 minutes or more, Sharing must be organized in order to keep the class on task.
Peer Discussion (PD)	Students explain topics to one another, share notes, and/or ask each other questions. (Michael 2006; Wankat & Oreovicz 2015)	Simple, 5 minutes or less
Interactive Quizzes (IQ)	Create a competition by breaking the students into groups.– Ask the groups questions and measure their accuracy and quickness to respond. (Wankat & Oreovicz 2015)	Simple/intermediate, 5 minutes or more, Requires preparation of specific questions.
Minute Paper (MinP)	Students have one minute to organize their thoughts related to the day's topics and rank the major points concisely. Students may add their own question at the end to make the assessment interactive. (Angelo & Cross 1993)	Simple, 5 minutes or less at the end of class, May require the review of the submittals.
Muddiest Point (MudP)	Students write a rapid response to one question: "What was the muddiest point in the lecture (discussion, homework assignment, etc.)?" Muddiest means most unclear or most confusing.	Simple, 5 minutes or less, Requires review of the results.
Skeleton Style Notes (SSN)	Note handouts are created without key concepts or without key steps in the example problems. Students must listen to lectures and fill in the missing information. (Dymond et al. 2019)	Simple-complex, 5 minutes to a full class, The creation of the notes takes significant time, but implementation is easy.
Field Trips (FT)	Take students on a short walk to a structure or application near the classroom that demonstrates the relevant topic. (Wankat & Oreovicz 2015)	Simple-intermediate, 10 minutes or more, Could be a simple local walking tour or more complex off-site tour.
Physical Artifacts (PA)	Provide a physical representation or model that can be visualized and explored in class. (Behrouzi 2016)	Simple-complex, 5 minutes or less, Can require differing levels of time to prepare the artifact.

Simple / Quick Techniques

Methods
Think-Pair-Share
Peer Discussion
Interactive Quizzes
Minute Paper
Muddiest Point

PURPOSE

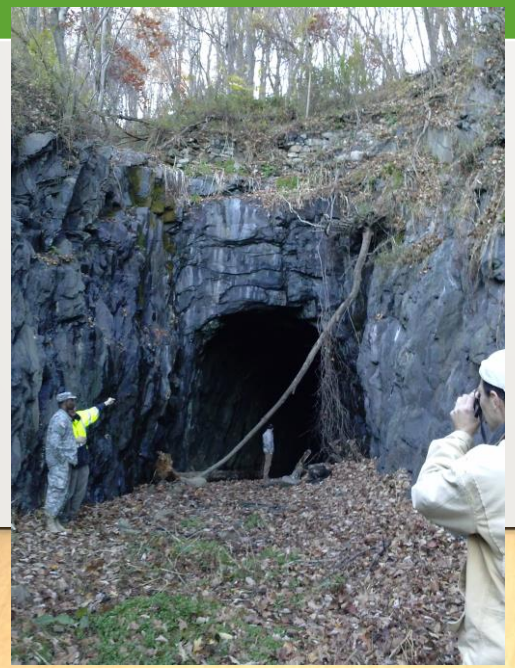
- Provide a short break in presentation style
- They take a few minutes to implement
- May provide feedback to the professor

Examples

Interactive Quizzes	Muddiest Point	Peer Discussion
• Write down an example of a classical learning method	• What learning style makes the least sense to you	• Discuss (Virtually) with a peer the learning method you would like to try

Intermediate Techniques

Methods
Field Trips
Physical Artifacts
Skeleton Style Notes



PURPOSE

- Provide a visual and/or a direct application of the topics
- They take a few minutes or more to implement

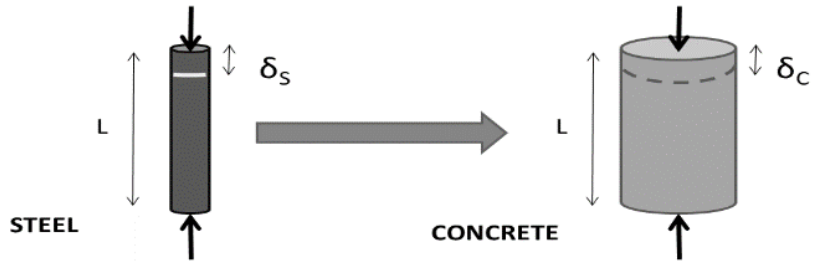
Skeleton Style Notes

Stage 1 – Elastic and Uncracked

Assumptions: 1) Plane sections remain _____
2) The bond is _____ between concrete and rebar.

Knowns: _____
_____
The Section is made of two different materials:
Concrete: f'c =
Ec =
Steel: Es =

We need to transform the reinforced concrete section into an equivalent section of concrete.



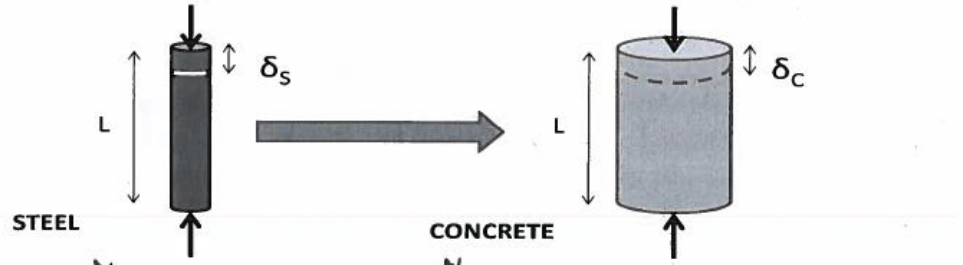
Replace steel with an equally stiff area of concrete. If there is equal stiffness between the two materials, $\delta_S = \delta_C$

Stage 1 – Elastic and Uncracked

Assumptions: 1) Plane sections remain Plane
2) The bond is perfect between concrete and rebar.

Knowns: Section Properties
Applied Moment
The Section is made of two different materials:
Concrete: f'c = Concrete Compressive Strength
Ec = $57{,}000\sqrt{f'_c}$ psi
Steel: Es = 29,000 KSI

We need to transform the reinforced concrete section into an equivalent section of concrete.



Replace steel with an equally stiff area of concrete. If there is equal stiffness between the two materials, $\delta_S = \delta_C$

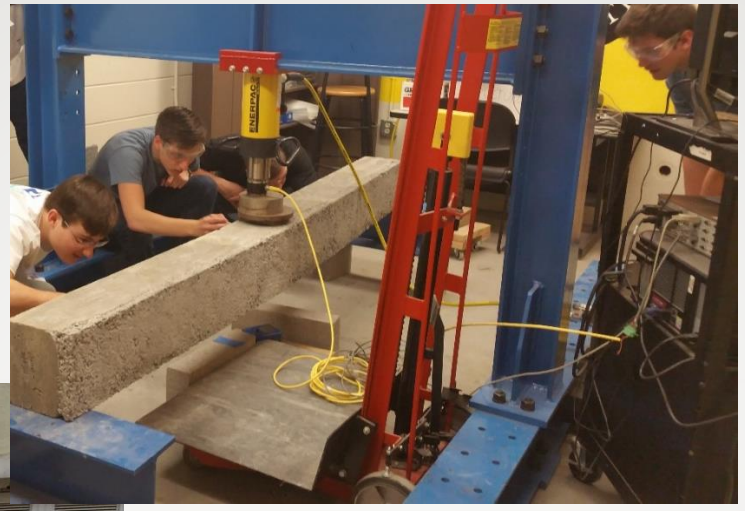
Advanced Techniques

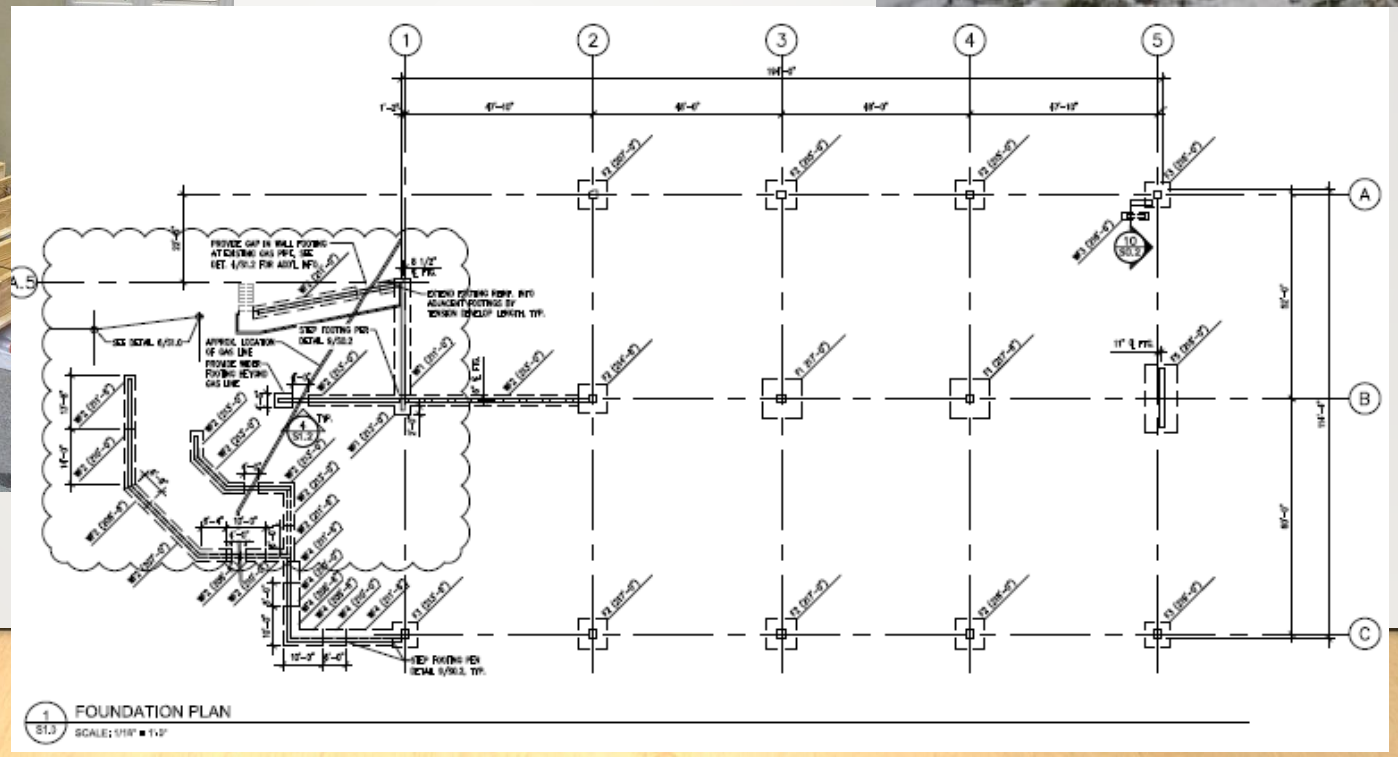
Methods
Problem Based Learning
Project Based Learning
Service Learning
Case Based Teaching
Experiential Learning
Flipped Classroom

PURPOSE

- Integrate projects, cases, and experiences into a course
- Provide higher level learning experiences that are memorable
- Integrate knowledge from multiple topics and even courses

Examples





Lessons Learned

- Be Flexible
- Nothing Works Every Time
- Don’t forget there is a body of knowledge that must be taught
- Don’t try too much too soon
- Students are all very different –
  - They learn different
  - They have different motivations
- Have Fun!
- Collaborate and learn from one another

Conclusion

- This presentation was meant to provide an overview of teaching methods
- There are numerous more in depth descriptions and examples in the paper
- Please watch the following presentations for more details and examples
- Teaching is one of the most rewarding professional experiences I have had
- Good luck and please share your ideas and experiences too!



Active Learning

- Participation
- Learning is a verb
- This is not a new category
- Engage = Think, Discover, Retain, and Interest