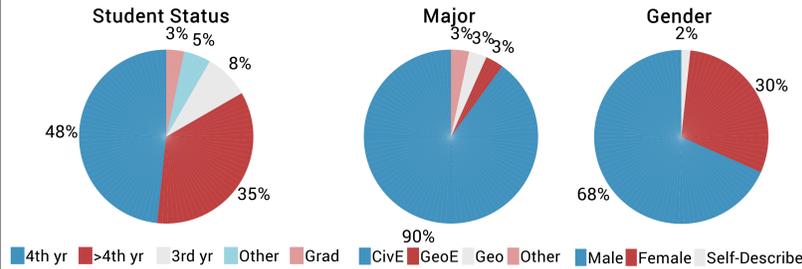# Introducing a structured design assignment to an intro water resources engineering course: effects on cognitive skills, self-efficacy, and perception of value

Carolyn B. Voter *cvoter@wisc.edu*

BACKGROUND

Course Description:
CEE 311 Hydroscience is an introductory water resources engineering course at UW-Madison required for civil engineers. There are 60-70 students each semester, mostly senior civil engineers.

Fall 2016 Student Demographics

Student Status: 4th yr 48%, >4th yr 35%, 3rd yr 8%, Other 5%, Grad 3%
Major: CivE 90%, GeoE 3%, Geo 3%, Other 3%
Gender: Male 68%, Female 30%, Self-Describe 2%

Issue:
Many civil engineering students at UW-Madison specialize in an area other than water resources engineering and do not necessarily see CEE 311: Hydroscience as something that will be valuable to their future career. The urban hydrology topic in particular is perceived by many as challenging, not valuable, and in need of improvement.

Spring 2016 Student Attitudes (end-of-semester)

In which topic did you make the LEAST gains in understanding? Select three of 12.

1 in 4 students select Urban Hydrology

Which topics were the LEAST valuable to your future academic and professional career? Select three of 12.

1 in 5 students select Urban Hydrology

Which topic should we improve next year? Select one of 12.

Urban Hydrology is the **2nd most common choice**

Question:
To what extent do students develop **cognitive skills**, a **self-efficacy**, and **a perception of value** related to urban hydrology and water resources engineering when a structured design assignment is added to the curriculum?

Cognitive Skills

Students did especially well on assessments related to LO #5, designing stormwater management practices.
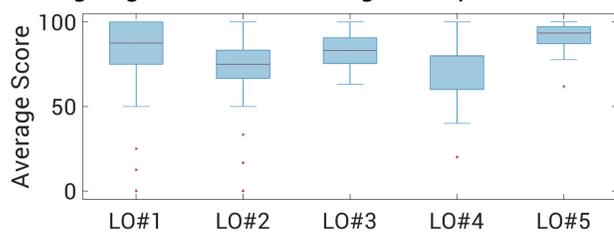
Grades on a design-based final exam question rose in Fall 2016 vs. Spring 2016, but so did overall course grades
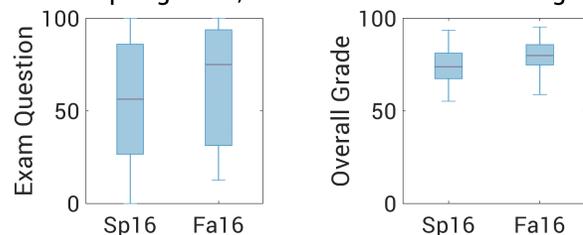
APPROACH

The structured design assignment associated with the Urban Hydrology topic provides a **real-world example** of stormwater detention basin design and **synthesizes previous course concepts**. A pre-developed spreadsheet structures the problem. The technical Unit Hydrograph concept is taught earlier in the semester, rather than the same time as Urban Hydrology. This approach was first implemented in Fall 2016.

Fall 2016	Milestone	Assessment	Learning Outcome
Week 1	Start of Class	Pre-Survey	6,7
Week 6	Unit Hydrographs *Lecture, Discussion*	Homework Set	3,4
Week 8	Midpoint of Class	Exam	3
Week 12	Urban Hydrology *Lecture*	Homework Set*	1,2,5
Week 15	End of Class	Post-Survey	6,7
Week 16	Finals Week	Exam	1,4,5

*Design homework

|	Learning Outcomes
1	*Identify* urban stormwater management features
2	*Describe* the hydrologic effects of urbanization
3	*Calculate* unit hydrographs, use them to calculate flood hydrographs
4	*Qualitatively predict* how a unit hydrograph would change if watershed characteristics change
5	*Design* stormwater management practices
6	Students perceive *value* to their future academic and professional career in mastering the above cognitive skills
7	Students have *self-efficacy* regarding the above cognitive skills

RESULTS

Self-Efficacy

How would you rank the gains in understanding you made in Urban Hydrology relative to all 12 topics?
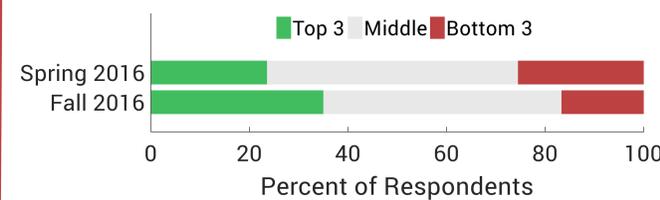

How confident are you that you understand water resources engineering?
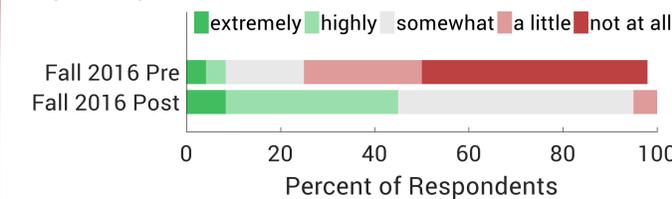

Student **self-efficacy related to designing stormwater management practices increased** in Fall 2016 (with intervention) vs. Spring 2016 (without intervention), but there were mixed changes in confidence in other areas.

How much confidence do you have in your ability to do each of the following? (see detailed learning outcomes above in 'Approach')
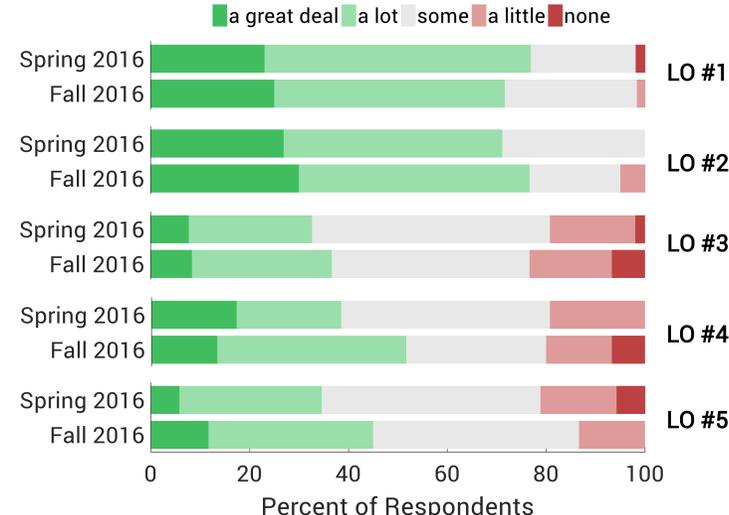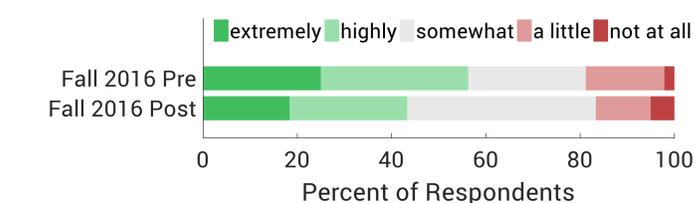

Perception of Value

How would you rank the value of the Urban Hydrology topic to your future professional career relative to all 12 topics?
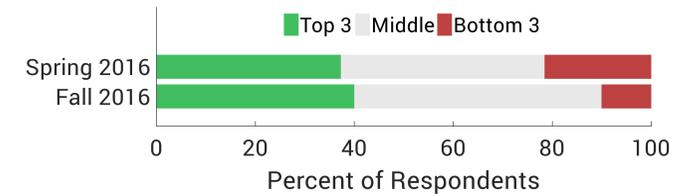
How confident are you that this class will be valuable to your future professional career?

The Urban Hydrology topic led to **more gains in understanding** and was perceived as **more valuable** to students in Fall 2016 (with intervention) vs. in Spring 2016 (without intervention)

Students overwhelmingly **gained confidence** that they understand water resources engineering, but their **perception of value declined** over the course of the Fall 2016 semester

RECOMMENDATIONS

Based on the results from this teaching-as-research project, I recommend that future courses:

1. **Retain the structured design homework**, since it seems to contribute substantially to student understanding and is perceived as valuable by students.
2. Make more **explicit connections to other civil engineering specialties** in assignments (including the design assignment) to engage those that will specialize in other areas
3. Provide **additional resources for excel assignments** (e.g., cheat sheets, video tutorials) so that technical obstacles do not prevent students from understanding the main objective of assignments.
4. **Reduce the weight given to exams** in the overall course grade, so that students are rewarded more for effort on time-consuming, "real-world" assignments.

ACKNOWLEDGEMENTS