Learning Outcomes in live versus online GIS lectures

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Outline

1. Background
2. Testing three theories of learning
3. Methods
4. Results
5. Discussion/Future work
6. Conclusion

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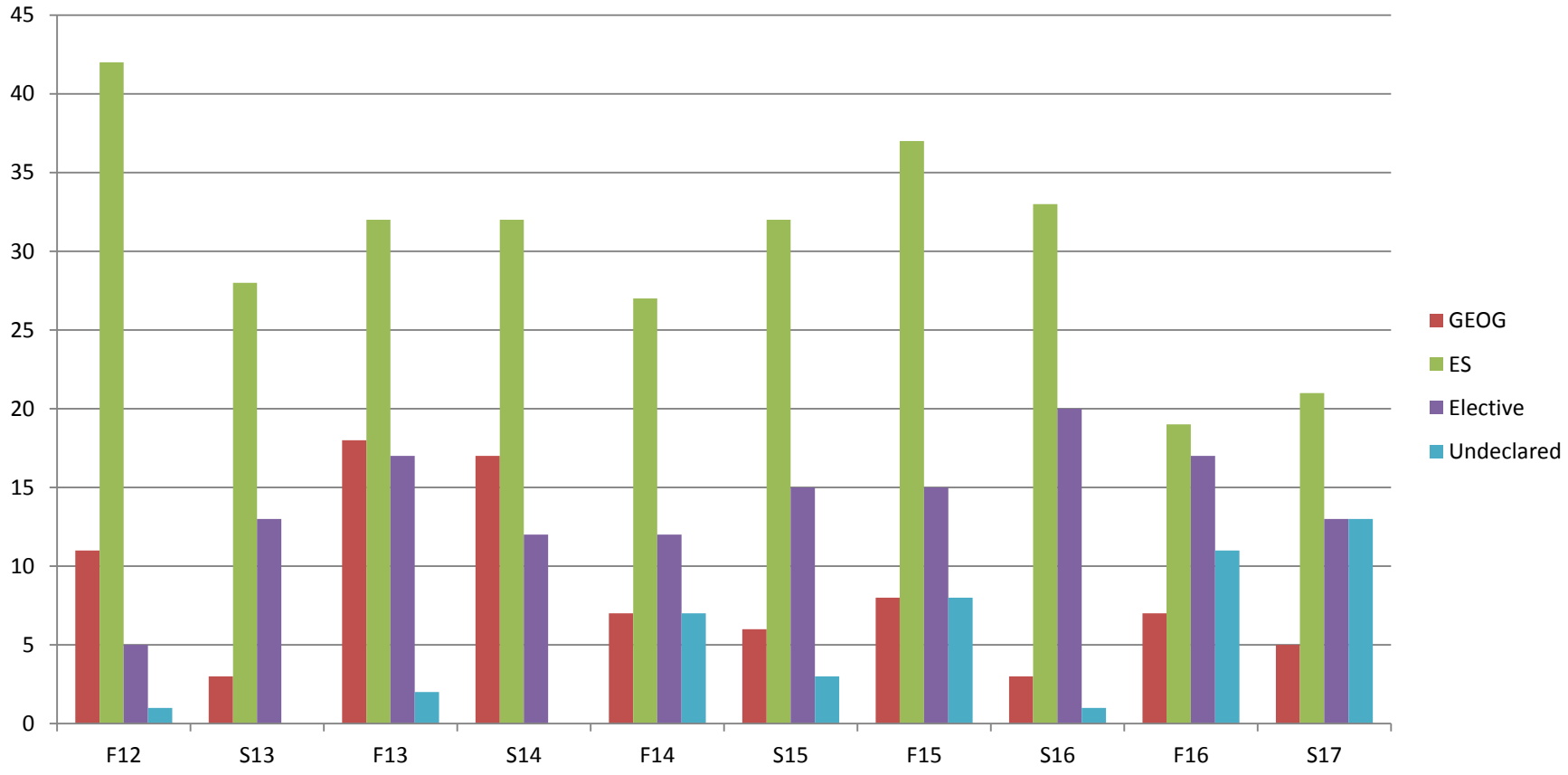
Background

"'You get it or you don't'"

I took the class as an elective and it was my favorite class of the semester. However, the class falls into the "you get it or you don't" category. Luckily, I seemed to get it and I was suprised, given the class' reputation how quickly I finished most of the work. I do know several of my classmates were not as fortunate however, so be realistic with your own ability/desire before you register. I never

Most of my students lack geographic expertise.



Do spatial abilities help students learn in an introductory GIS class?

Because they seem to more broadly in STEM

> "The reason spatial abilities matter early on is because they serve as a barrier; students who cannot think well spatially will have more trouble getting through the early, challenging courses that lead to dropout."

Uttal and Cohen (2012), "Spatial Thinking and STEM Education," *Psychology of Learning and Motivation* 57: 147-181.

Research Objectives/Questions

(1) Does the spatial ability that a student brings to a classroom correlate with their ability to learn geospatial concepts and applications?

(2) If it does, can we present instruction in ways to help even this playing field so that spatial abilities no longer serve as a barrier to learning?

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Testing three theories of learning

Theory #1

A good lecture delivered by a good teacher in person is better than a good lecture delivered online.

Ideal of a Small Liberal Arts College

Theory #2

Students with high spatial abilities are better able to learn from difficult presentations of instruction than students with low spatial abilities.

Uttal and Cohen (2012)

Theory #3

Students with high spatial abilities benefit from well-designed presentations of instruction in ways that students with low spatial abilities do not.

Mayer and Sims (1994)

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Methods

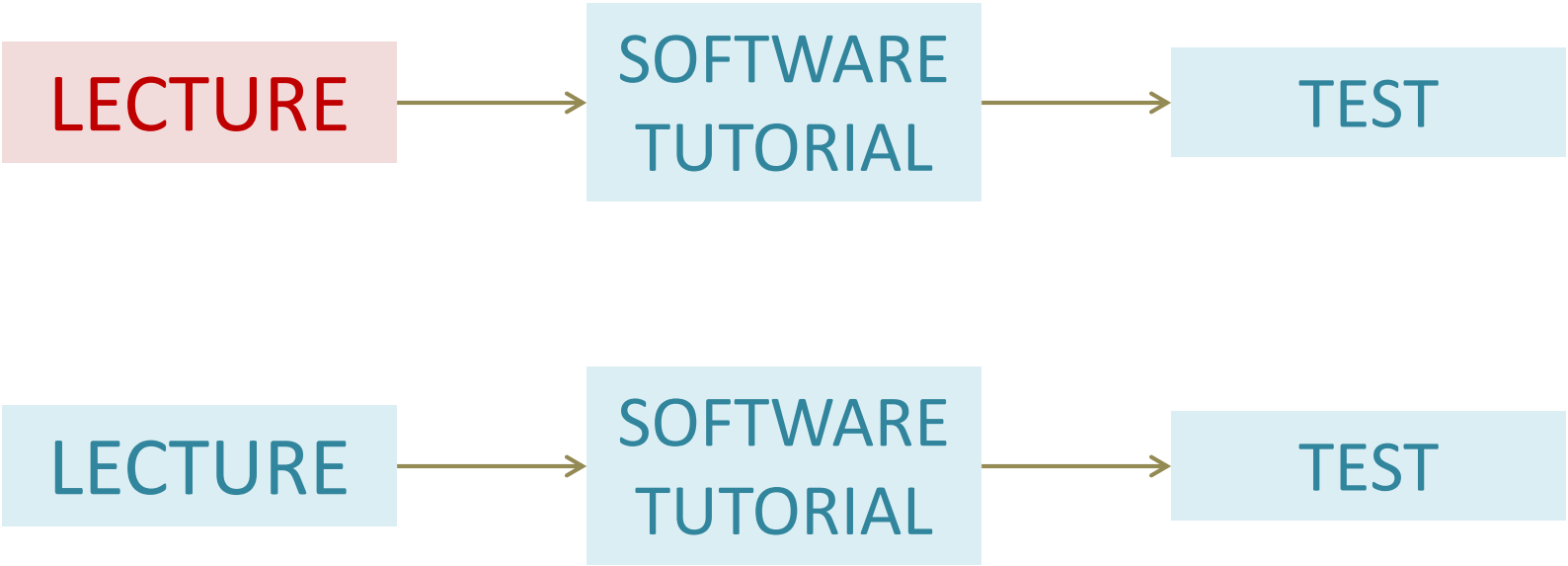
Worked example pedagogy

LECTURE → SOFTWARE TUTORIAL → TEST

Pre-training	Worked example	Assess learning
Introduce concepts	Implement concepts with software	Tests for transfer of knowledge

Howarth (2015)

Compared presentation delivery of pre-training lecture



live

online

Fall 2016

THEME	TUES			THURS	
1 Intro to Flatland	13	Introductions	Lab 1	15	Distance Problems
2 Euclidean Space	20	Distance & Area	Lab 2	22	Attributes of terrain
3 Topographic Space	27	Terrain models	Lab 3	29	BEGIN IP1

Spring 2017

THEME	TUES			THURS	
1 Intro to Flatland	feb 14	Introductions	Lab 1: Planning	16	Distance Problems
2 Euclidean Space	21	Distance & Area	Lab 2: Biogeog	23	Attributes of terrain
3 Topographic Space	28	Terrain models	Lab 3: Mad River	mar 3	BEGIN IP1

Fall 2016

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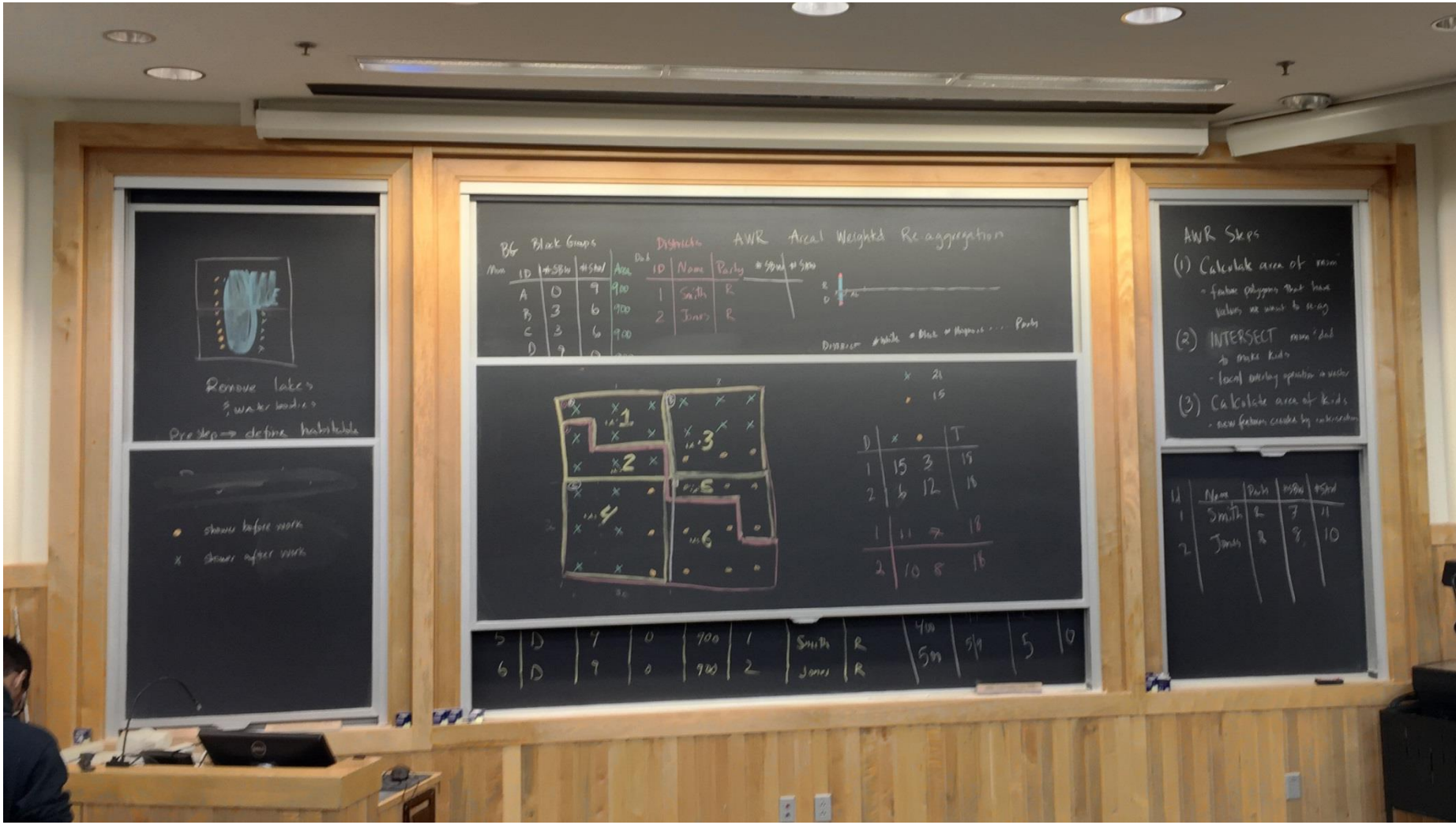
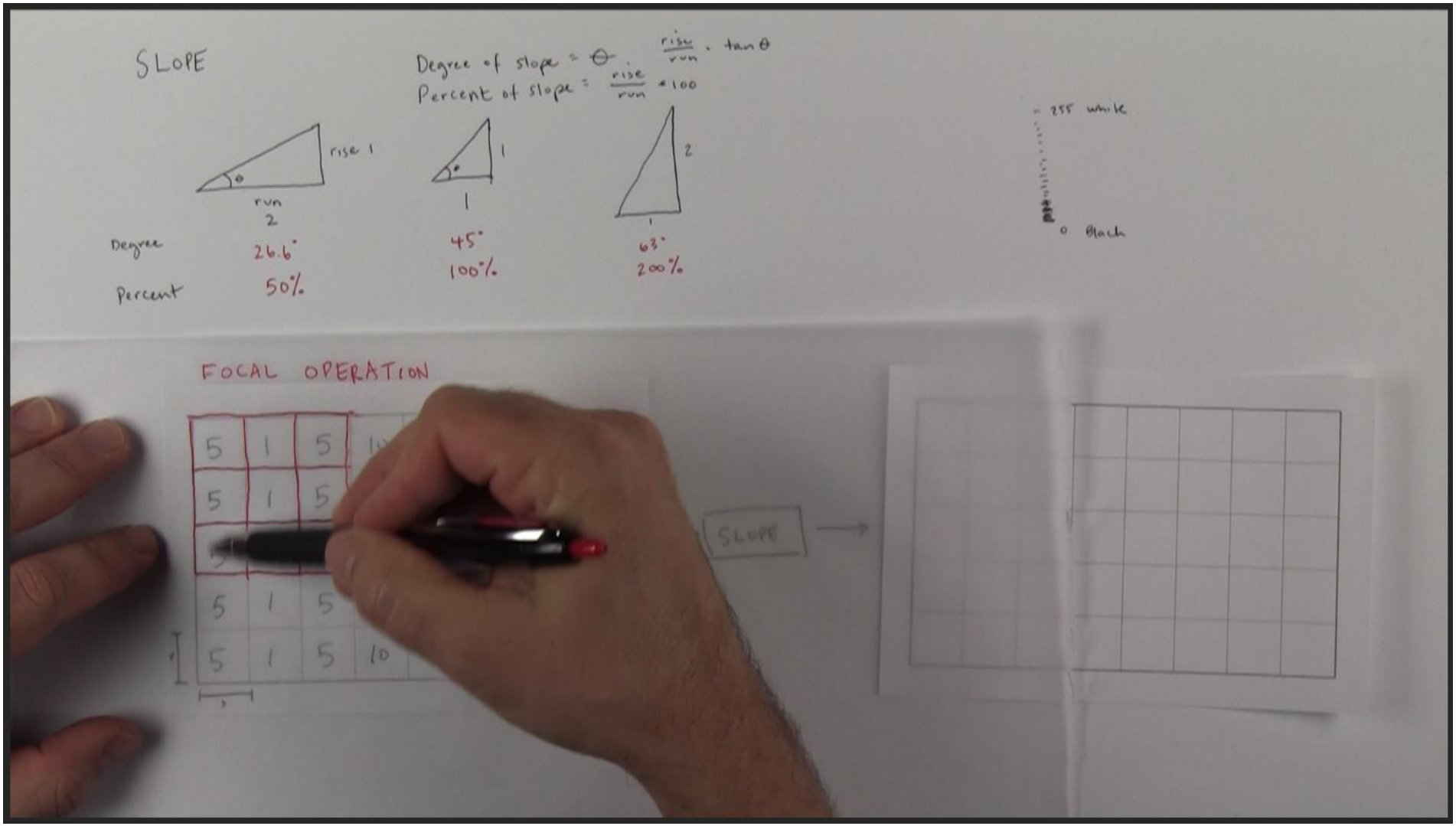
Spring 2017

THEME	TUES		THURS
			ONLINE LECTURES
1 Intro to Flatland	feb 14 Introductions	Lab 1: Planning	16 Distance Problems
2 Euclidean Space	21 Distance & Area	Lab 2: Biogeog	23 Attributes of terrain
3 Topographic Space	28 Terrain models	Lab 3: Mad River	mar 3 BEGIN IP1

Live lectures Fall 2017



Online lectures Spring 2017



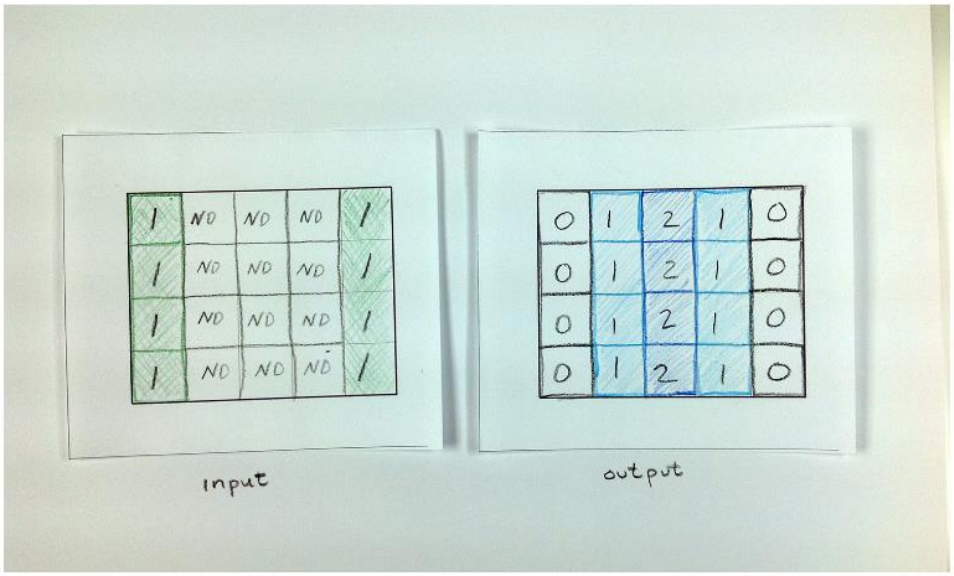
Evidence of learning outcomes

With simple diagrams

Question 2 1 pts

What **operation** could transform this input into this output?

Note: cell size = 1m.



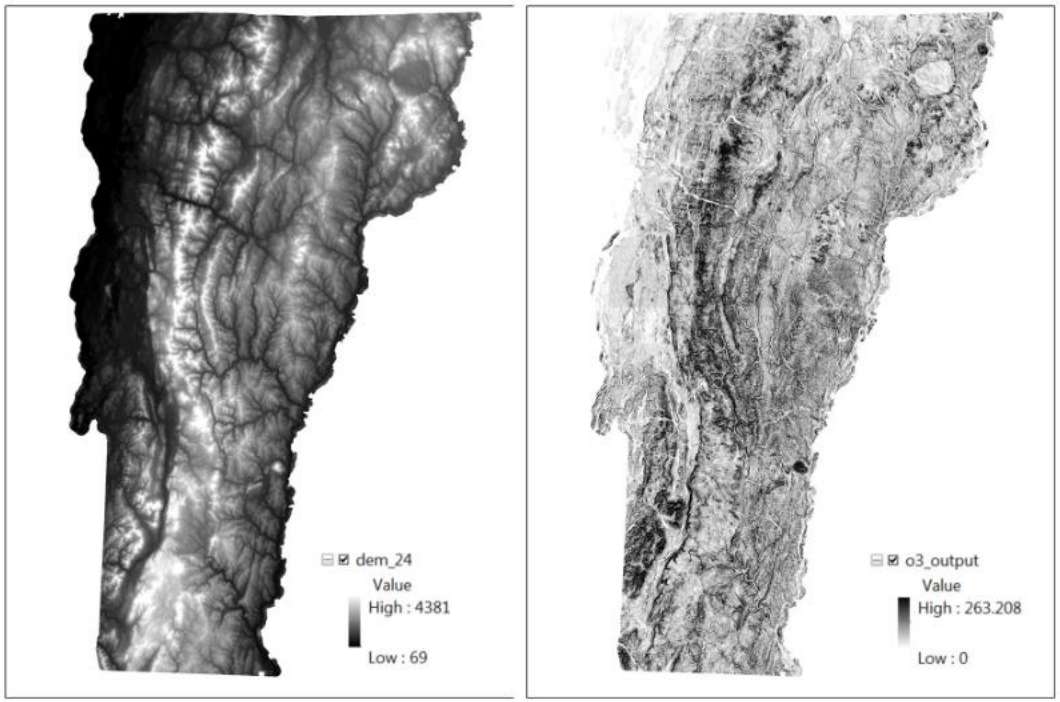
- [ ] RECLASSIFY
- [ ] REGION GROUP
- [ ] AREA
- [ ] EUCLIDEAN DISTANCE

Evidence of learning outcomes

With pictures of real data

Question 4 1 pts

What operation and parameters would create this output (right) from this input (left)?



- HILLSHADE, altitude 30
- HILLSHADE, altitude 60
- SLOPE, degrees
- SLOPE, percent slope

Spatial ability pre-tests

Paper
Folding

Surface
Development

Ekstrom et al (1976)

Higher and lower ability groups

Combined scores from two tests

Calculated median

Higher spatial ability

Median

Lower spatial ability

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Results

Subject pools

Table 1. Number of subjects for GIS and SA tests by treatment

Treatment	GIS Tests	SA Tests
Live	54	54
Online	52	48

Testing theory #1

Is a good lecture presented by a good teacher in person better than a lecture presented online?

No, not necessarily

Table 2. Descriptive statistics, t statistics, and Cohen's d for GIS quizzes

Week	Treatment	Min	Max	Mean	St Dev	T statistics	Cohen's d
2	Live	2.25	10	6.5	1.88	T(104)=-4.09, P=0.0001*	0.8
	Online	4.5	10	7.93	1.70		
3	Live	2	10	6.38	1.70	T(104)=-3.58, P=0.0005*	0.7
	Online	5	10	7.48	1.45		
Combined	Live	3.5	10	6.44	1.34	T(104)=-4.89, p=0.000004*	0.95
	Online	5	9.75	7.7	1.32		

Testing theory #2

Do high spatial abilities help students learn from difficult presentations?

Yes, they appear to be related.

Table 3. Correlation coefficients and significance levels between GIS and SA scores

Treatment	Paper Folding	Surface Development	Combined SA score
Live	R=0.34 (P=0.01)*	R=0.36 (P=0.007)*	R=0.39 (P=0.003)*

Table 4. Descriptive statistics of GIS scores and t statistics for higher and lower spatial abilities

Treatment	Group	Min	Max	Mean	St Dev	T statistics
Live	Higher	4.13	10	6.99	1.2	T(52)=-3.26,
	Lower	3.5	8.5	5.89	1.26	p=0.002*

Testing theory #3

Do high spatial abilities enable students to learn from good presentations in ways that low spatial abilities do not?

No. In this study, online presentations leveled the field.

Table 4. Descriptive statistics of GIS scores and t statistics for higher and lower spatial abilities

Treatment	Group	Min	Max	Mean	St Dev	T statistics
Live	Higher	4.13	10	6.99	1.2	T(52)=-3.26,
	Lower	3.5	8.5	5.89	1.26	p=0.002*
Online	Higher	6	9.75	7.76	1.16	T(46)=-0.71,
	Lower	5	9.5	7.48	1.53	p=0.48

Testing theory #3

The effect was greater for lower ability students.

Table 5. Change in mean for higher and lower spatial abilities and effect size

	Higher	Lower
Live Mean	6.99	5.89
Online Mean	7.76	7.48
Change in Mean	+0.77	+1.59
Cohen's D	0.66	1.13

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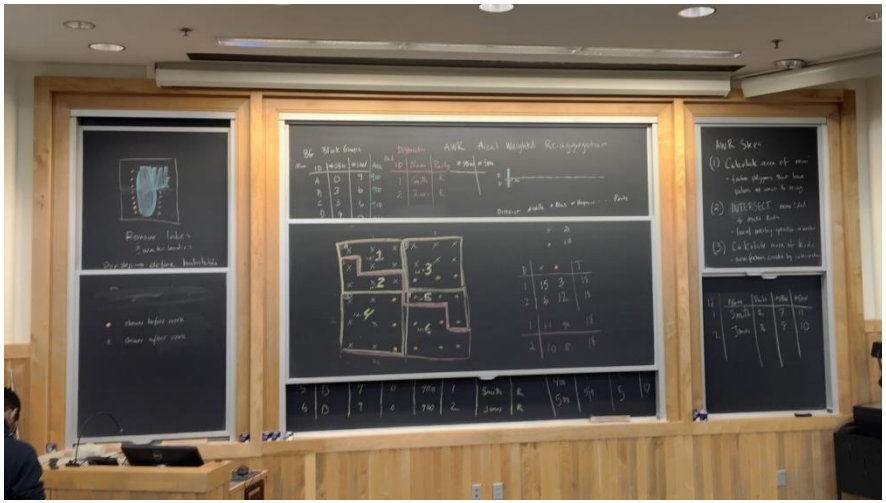
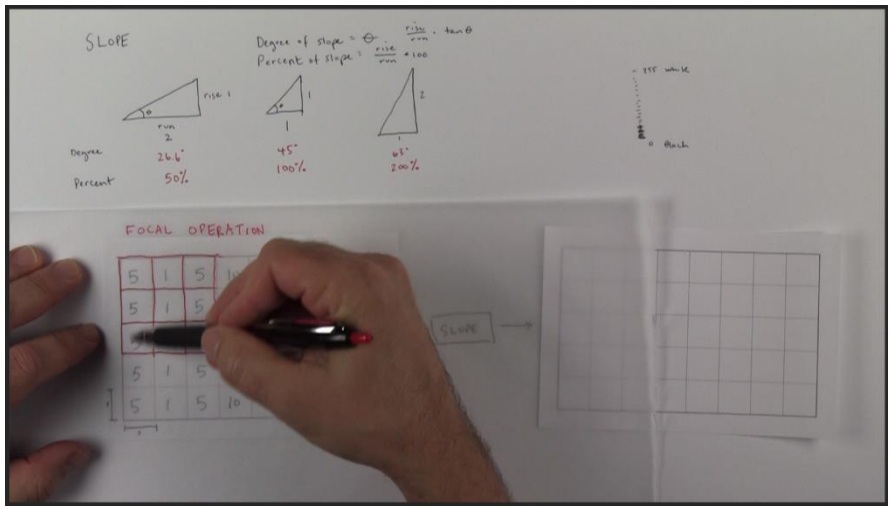
Discussion/Future Work

The apples to oranges problem



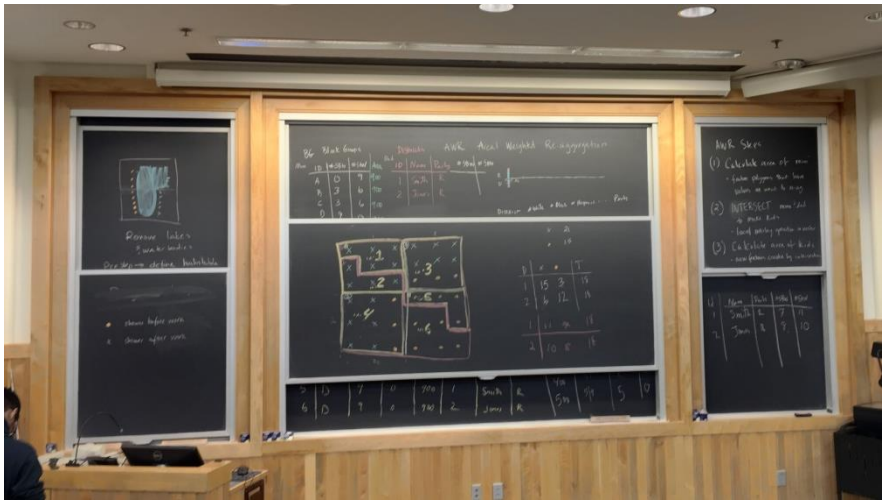


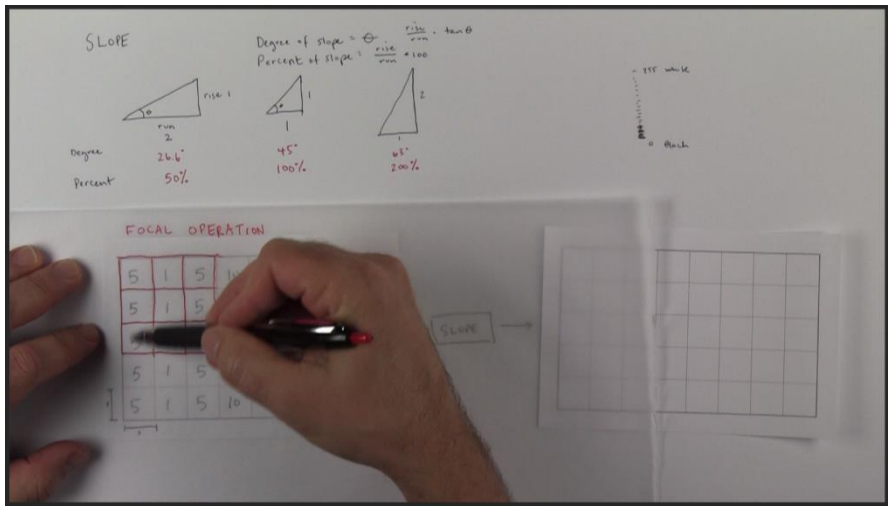
Same content: list of GIS operations and concepts

Different modes: live versus online

Different methods: strategies for presenting concepts with words & pictures (Mayer, 2010, *Multimedia Learning*)

Different methods of interaction





Live

Instructor controls pace

Public action to repeat

Public question →

Immediate ask

Online

Learner controls pace

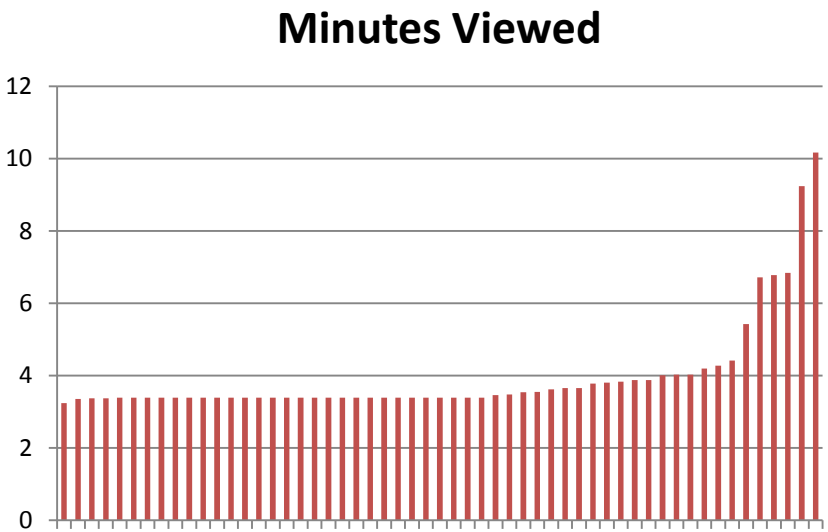
Private action to repeat

Private question →

Delayed ask

Next step in analysis

Is repeat viewing related to spatial ability?



Statistics from Panopto video hosting service

- Unfortunately, may be limited to amount of video time watched rather than amount of time watching videos.

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Conclusion

Main Findings

(1) Online presentations can have better learning outcomes than live presentations, even in a small classroom setting.

(2) Spatial abilities do seem to help novices learn geospatial concepts from difficult presentations of instruction.

(3) Improving presentations of instruction do seem to help level learning outcomes across different spatial abilities.

Acknowledgements

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