PIXELS: Comparing classroom-based and field-based learning to investigate students' concepts of pixels and sense of scale

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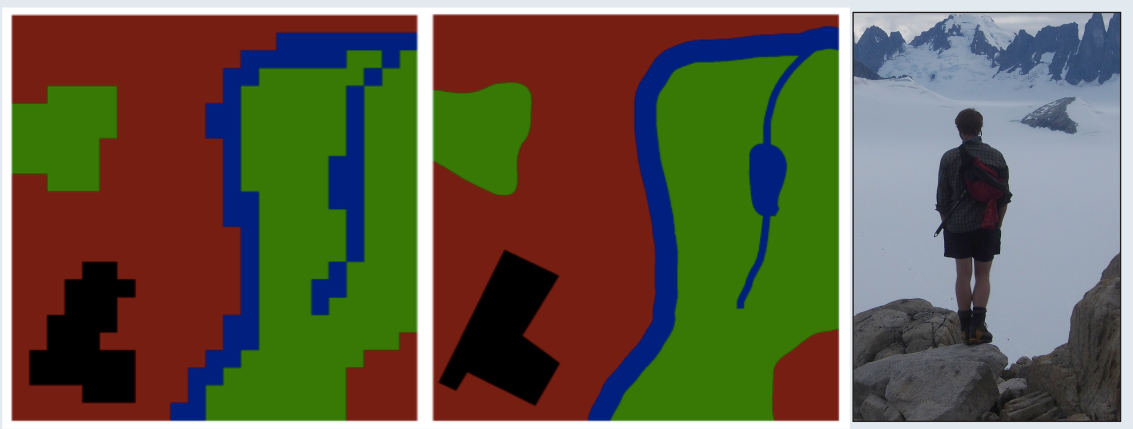
Why Pixels?

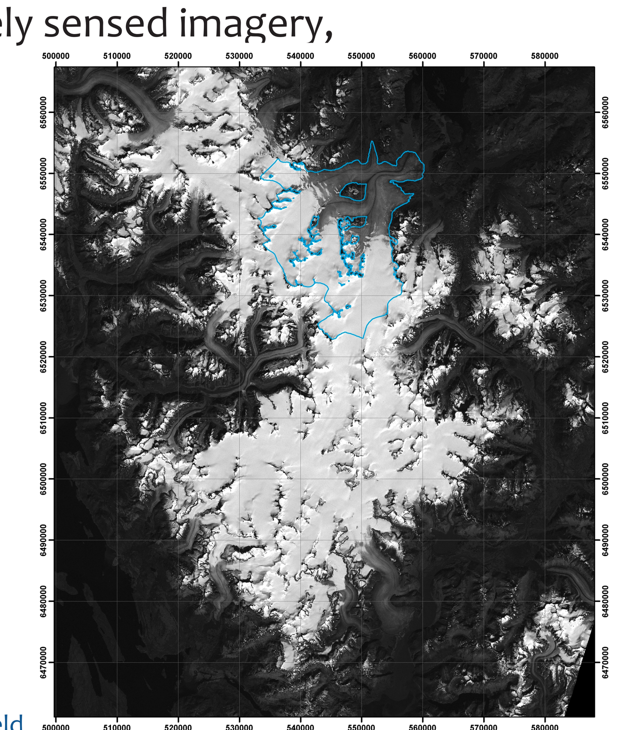
- Spatial thinking is critical to success in the geosciences (fieldwork, visualizing subsurface structures, finding rotation axes in minterals, etc.).
- Scale is also an important concept (see work by K. Cheek, R. Trend, and others).
- Sense of scale is how individuals quantify physical space.
- Sense of scale develops through kinesthetic experience.



Project Goals

1) Explore how a field-based and GIS-based activities may impact students' ideas about remotely sensed imagery, i.e., definition of a pixel, pixel changes depending on the sensor used, and variability within a pixel.

2) Explore how sense of scale may interact with students' ideas about remotely sensed imagery.



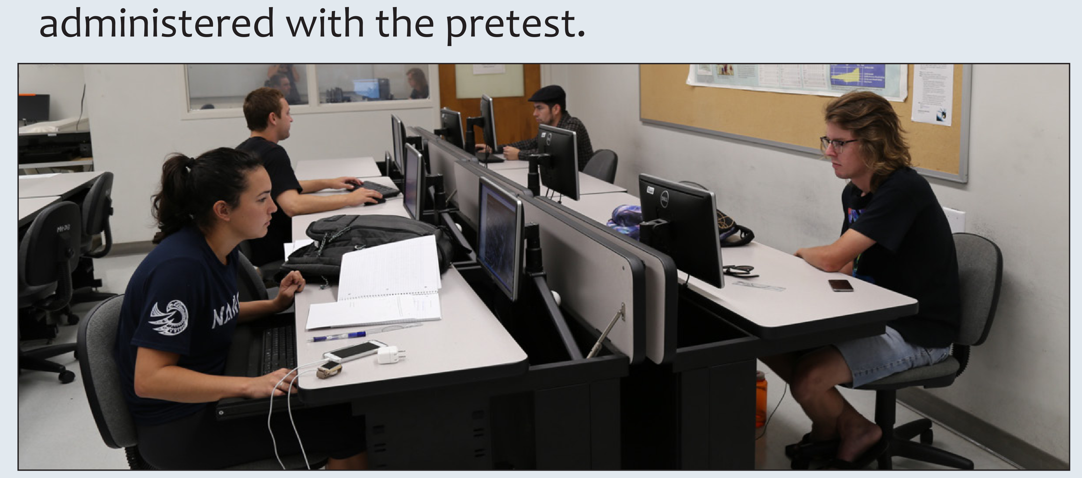
Landsat image of the Juneau Icefield

The Activities

- In the field, students skied the perimeter of several pixel types on rock & snow, taking reflectance measurements at regular intervals:
  - WorldView (1 m x 1 m)
  - Landsat (30 m x 30 m)
  - MODIS (500 m x 500 m)
- In the classroom, students investigated the same dataset using a GIS environment.

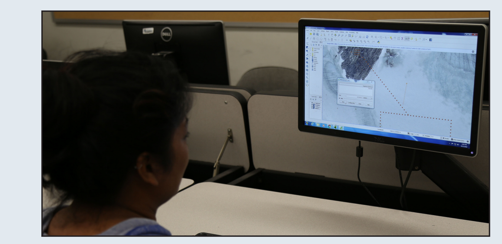
Data Sources

- A Pixel-concepts pretest was open-ended and was administered after lecture but prior to field activity.
- A Pixel-concepts posttest included the same items, as well as 3 additional items, demographics, and was administered immediately after field activity.
- We used a scoring rubric (3, 2, 1, 0) to grade responses.
- Two independent scorers, resolved for final use.
- In addition, a proven Scale of Objects questionnaire (Tretter et al. 2006) gave students 26 items that ranged in size from nanometers to billions of meters. This was administered with the pretest.



Field Participants

- Gender: 7 Male, 10 Female
- Age (mean and range): 21.8 (19-29 years)
- Ethnicity: 11 Caucasian, 1 American Indian, 1 Asian, 1 Mixed, 1 Other
- SAT/ACT Score (mean): SAT ~2100 / ACT ~29
- Year in school: 2 Sophomores, 2 Juniors, 6 Seniors, 3 BA/BS, 2 Graduate
- Major/program: 4 Geol., 4 Earth/Envi., 2 Geog., 5 STEM, 2 non-STEM
- Highest Math: Calculus & higher
- Prior Remote Sensing Course: 11 with some experience, 3 substantial

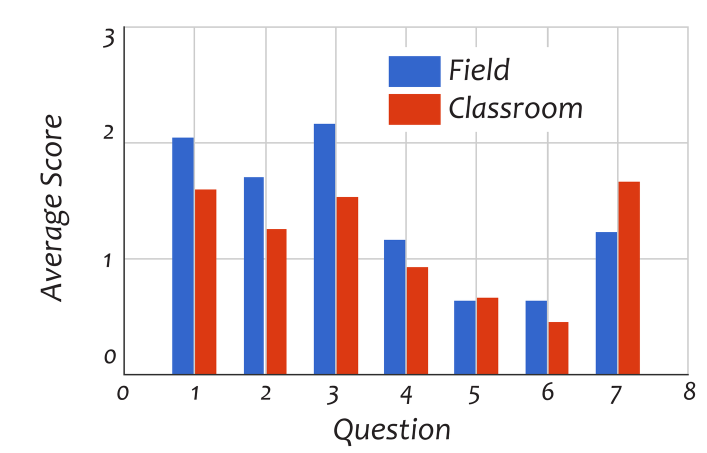


Classroom Participants

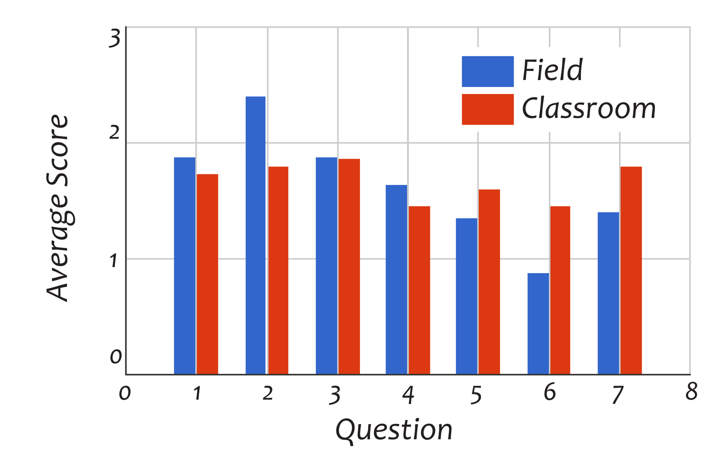
- Gender: 7 Male, 8 Female
- Age (mean and range): 26.6 (21-45 years)
- Ethnicity: 11 Caucasian, 3 Hispanic/Latinx, 1 Other
- SAT/ACT Score (mean): SAT ~1650
- All students were late-stage undergraduate or graduate students
- Major/program: 8 Earth Science, 7 Geology
- Highest Math: Calculus & pre-calculus
- Prior Remote Sensing Course: 10 with some experience, 3 substantial

Results: Pixel Concepts

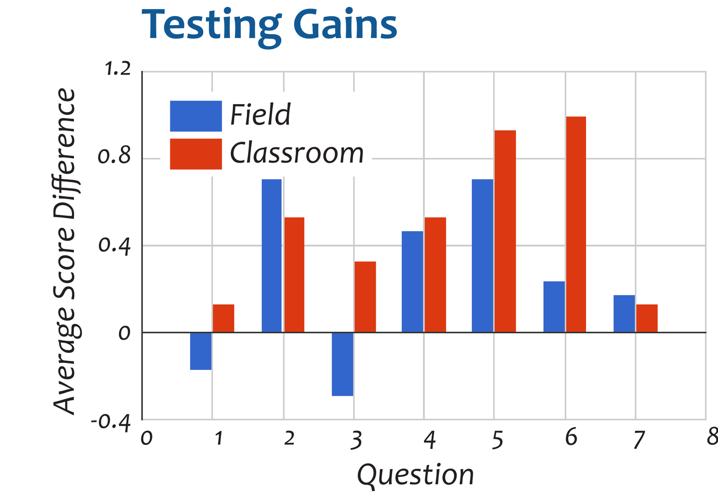
Pre-test



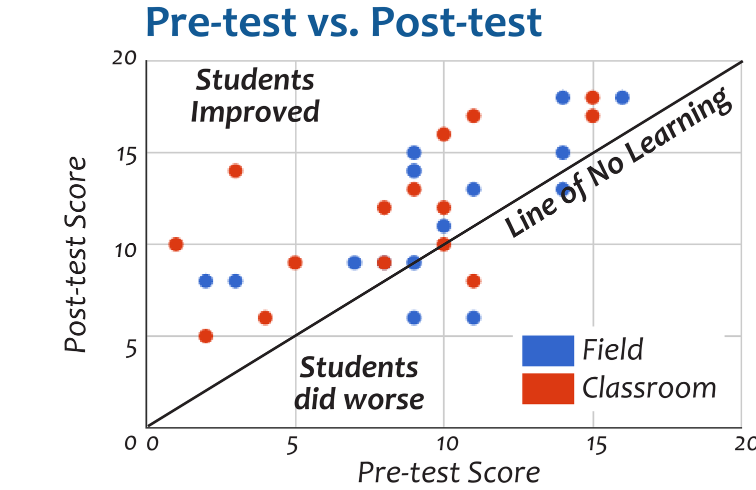
Post-test



Testing Gains



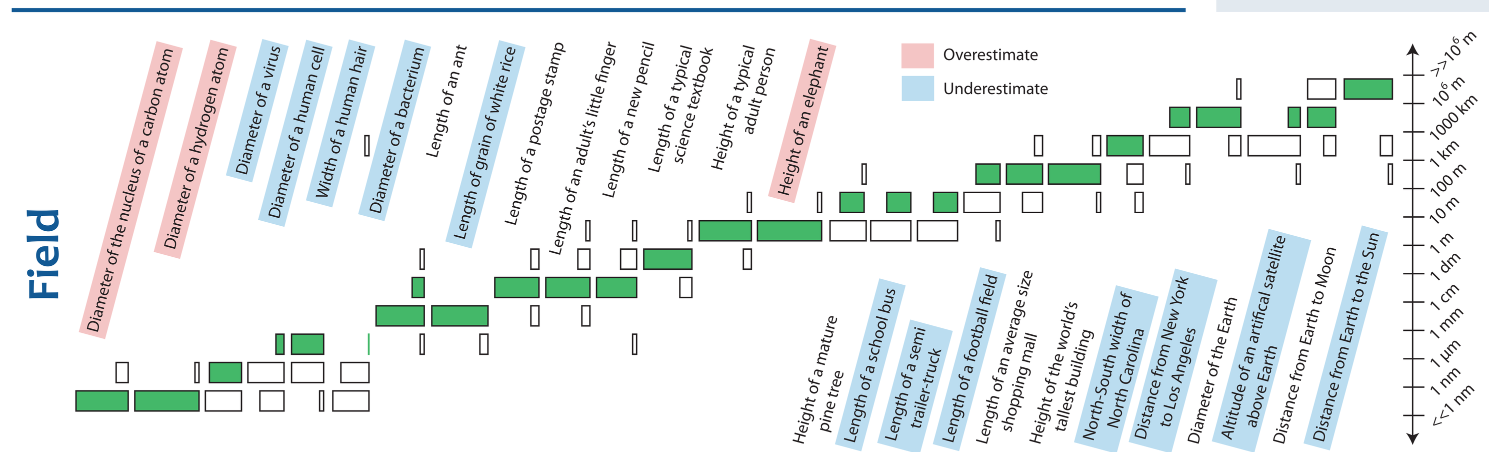
Pre-test vs. Post-test

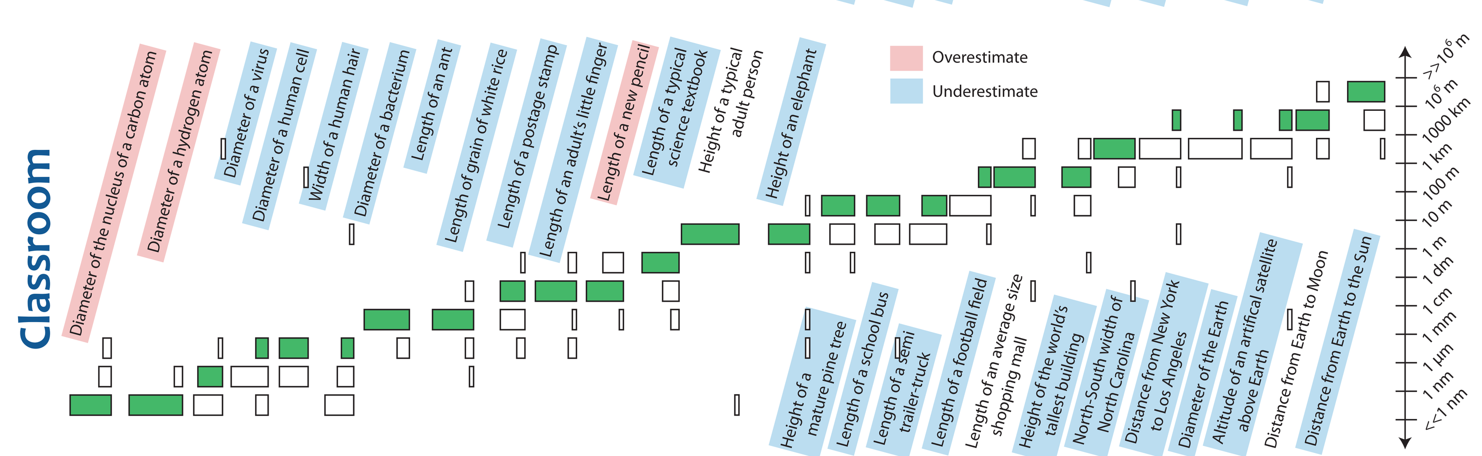


- There is no significant difference between the field and lab groups for pretest scores (independent samples t-test, p=.852).
- There is no significant difference between the field and lab groups for posttest scores (independent samples t-test, p=.294).
- However, the field group showed a significant difference between pre and posttest scores (paired samples t-test, p=.029) and the lab group also showed a significant difference between pre and posttest scores (paired samples t-test, p=.001).
- These statsitcisal tests showes that there are statistically significant learning gains as measured by our tests.
- We cannot say that there are any overall differences in learning between the two interventions, however there are notable differences in question performance between the field and classroom activities.

Ongoing & Future Work

- We are in the process of revising the Sense of Scale intrument to include more familiar items of better defined sizes and including US customary units.
- We will pull apart field vs. classroom gains on particular questions.
- We will investgate if Sense of Scale correlates with other spatial skills.
- **We are interested in conducting a larger-scale experiment. Do you want to get involved and conduct your own "field-" or computer-based trial of this pixel exerise? Please get in touch!**

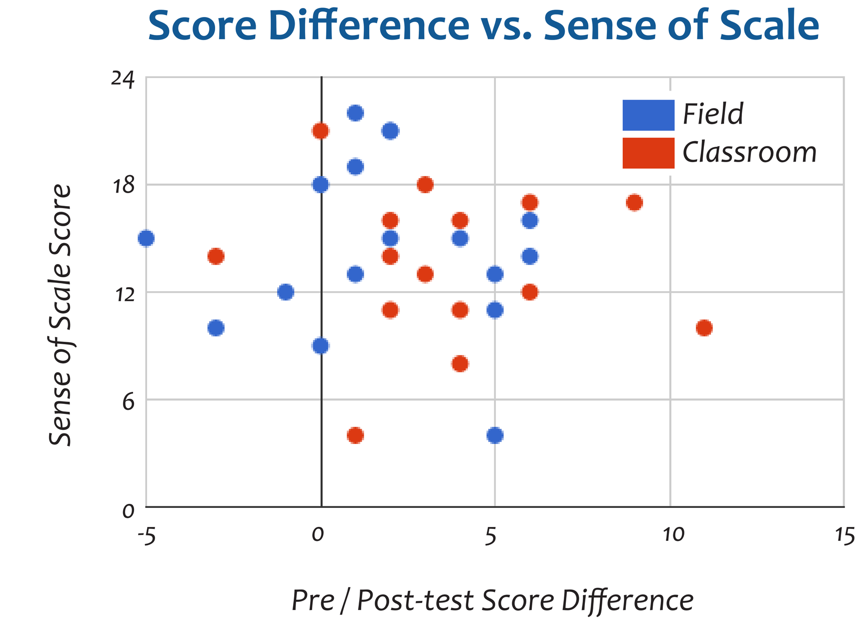




Results: Sense of Scale

- Results of the Scale of Objext Questionnaire for both field and classroom groups are on the left. Each bar represents the number of students that picked each scale range, with green being the correct range.
- No relationship has been found (thus far) between Sense of Scale and (gains in) pixel knowledge or demographic variables.
- This could be because no relationship exists, because our study population is too small, that our instruments are not valid for this population, or that our instruments are not sensitive enough to pick up any correlations.
- Most students seem to underestimate the size of objects. Uncertain if that is real, or related to the design of the instrument. Spatial skill generally correlates with intelligence. The field group's high test scores suggest that these students may already have high spatial ability.
- However, despite noteable differences in the students of the field and classroom groups, there is no significant difference between their Sense of Scale scores (independent samples t-test, p=.492).
- There is no correlation between Sense of Scale score and Pixel pretest score, posttest score, or gains (p>.05 for all using both Pearson's r and Spearman's rho). In other words, sense of scale does not correlate with knowledge of pixels, even after learning about pixels.

Score Difference vs. Sense of Scale

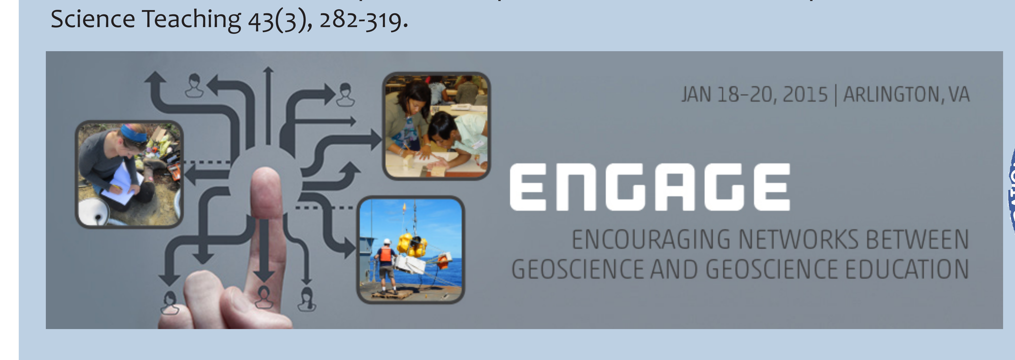


Acknowledgements

We would like to thank our participants for their time and engagement in the activity. We also thank the 2015 ENGAGE workshop, where the authors ended up together in a group and hatched this pilot study.

Finally, we thank the Juneau Icefield Research Program for hosting our work - you can find their booth in the Exhibition Hall.

Tretter, T. R., Jones, M. G., Andre, T., Negishi, A., & Minogue, J. (2006). Conceptual boundaries and distances: Students' and experts' concepts of the scale of scientific phenomena. Journal of Research in Science Teaching 43(3), 282-319.



http://tinyurl.com/engageworkshop