Assessing the Potential of Biometric Sensors to Measure Engagement and Learning in the Classroom

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Research Question

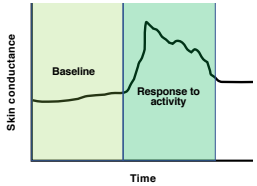
Which teaching strategies increase student engagement in climate science?

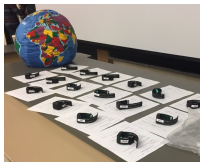
Background

- "Engagement" is herein defined as the **interest, motivation, effort** that students have or show towards learning (Sinatra et al., 2015)
- Increased classroom engagement leads to increased learning - Qualitative analysis shows active learning is engaging (Freeman et al., 2014).
- Here, we **quantify** engagement in a controlled and a classroom setting.

How do we quantify engagement?

Skin conductivity is a biometric proxy for engagement!

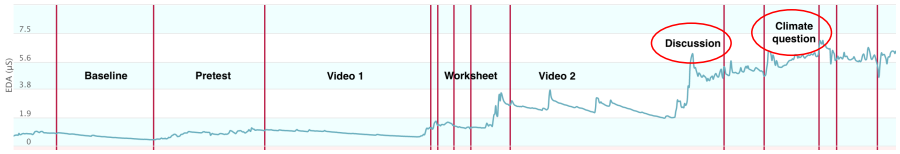




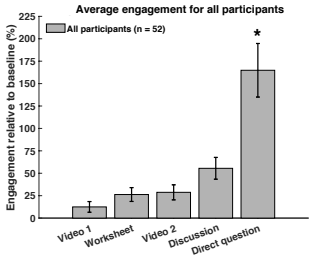
Compare personal baseline with activity skin conductance to get activity engagement

$$\text{Activity engagement (\%)} = \frac{(\textit{activity skin conductance}) - (\textit{baseline skin conductance})}{\textit{baseline skin conductance}} * 100\%$$

Morrison et al. (2019) showed dialog most engaging in a controlled setting…



Example of a student's raw skin conductance data in a controlled setting (Morrison et al., 2019).



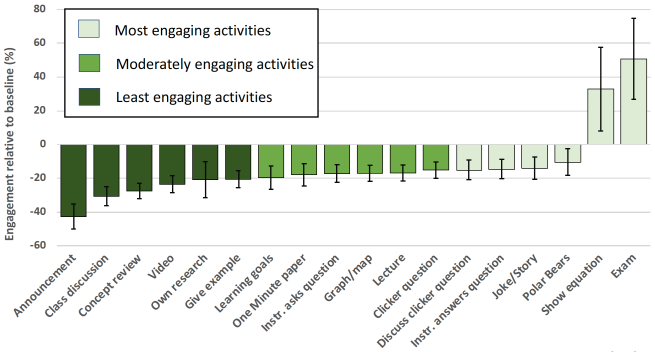
(left) Average engagement response to different learning activities in a controlled setting. Overall students were statistically most engaged while answering a direct question (starred, $p < 0.05$; Morrison et al., 2019).

Why? Students reported interest in dialogue activities, but also felt 'nervous' about giving incorrect answers in front of peers

…but is dialogue most engaging in a real class?

IRP analysis shows exams, equations, small group dialog engaging in classroom environment

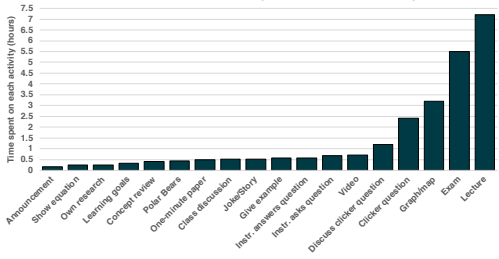
- Intro climate science class with 200+ students (ATOC1060 in Duane Physics classroom, picture below)
- Same **17 students** wore hand sensors in each class. Observers recorded student behavior in each class. Engagement from hand sensor calculated with periods of **"distracted"** behavior (e.g., cell phone) removed. Students also self-reported engagement.



Most engaging activities: exams, equations, clicker questions, jokes/stories, polar bears

Least engaging activities: announcements, whole class discussion, concept review

How much class time is spent on each activity?



Take home messages

- Perceived (peer discussion, equations) or actual (exams) high stakes activities increase engagement
- Small group discussion is highly engaging in controlled and classroom settings
- Polar bears are also engaging!

Our python code for hand sensors is available on github…

SCAN ME

References: A.L. Morrison, S.R. Rozak, A.U. Gold, and J.E. Kay (2019). Quantifying student engagement in learning about climate change using galvanic hand sensors in a controlled educational setting. *Climatic Change*. DOI: 10.1007/s10584-019-02576-6; s. Freeman, S.L. *et al.* (2014). Active learning increases student performance in science, engineering, and mathematics. *PNAS* 111(23):8410-8415; G.M. Sinatra et al. (2015). The challenges of defining and measuring subject engagement in science. *Educ Psychol* 50(1):1-13. **Funding:** Kay NSF CAREER Award (AGS 1554659) and 2019 CIRES IRP. IRP funded analysis of classroom data including open source code development (https://github.com/armo1216)