Intensive data at CREATE
Research approaches & future directions

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Understanding Engagement & Learning

• Engagement with educational materials can be:
  – Affective: motivation, enjoyment, frustration
  – Behavioral: overt activity and responses
  – Cognitive: mental effort, information processing, attention

• How can we capture all aspects of engagement during learning tasks?

• How can we measure them in an objective and reliable way?

• How can we relate behavioral/cognitive/affective states to specific learning outcomes?
## Intensive Data at CREATE

**Goal:**
To combine multiple streams of data to understand attention, effort, and excitement during learning.

**Data sources:**
- Self-reports
- Pretest/posttest comparisons
- Activity logs
  - Time-on-task
  - Number and timing of interactions
- Eye-tracking
  - Number and duration of fixations
  - Fixation transitions
  - Sequences of fixations over time
- Biometrics
  - Skin conductance
  - Heart rate
  - Respiration
  - EEG
  - Posture
Ongoing Work

Fixation time, gaze sequences, pre-/post-tests, and activity logs in chemistry simulations

Fixation time, pupil size, and behavior in an advanced theory of mind task

In each case, we make connections between larger classroom/lab-based studies (breadth) and smaller eye-tracking studies (depth), with each informing the other.
Future work: Measures of engagement

• Different measures can indicate different aspects of engagement

• Behavioral:
  – Activity logs: amount and type of action
  – Nonverbal “on-task” behavior (posture, direction of gaze)

• Cognitive:
  – Eye-tracking: focused & selective attention
  – Pupillometry: mental effort
  – EEG rhythms: states of attention, alertness
Approaches to data collection

Collecting multiple physiological measures at once using wireless receivers. Can be collected alongside activity logs, video recordings, screen captures.

Importing eye-tracking data and/or activity logs as “hits” on particular areas of interest.
Approaches to triangulating multiple measures

After synchronizing physiological measurements with eye-tracking and behavioral recordings, any channel can be used to demarcate events or segments of activity...

...or continuous measurements can be taken across channels at regular intervals.

Behavioral interactions used to segment eye-tracking and physiological recording

Measurements taken in regular 2 second windows
Approaches to Data Analysis

• Using behaviors or physiological responses to parse eye-tracking data
  – Where is attention directed at the moment of an interaction/event/response?
  – Where is attention during a segment of an activity, or throughout a physiological response?

• Using eye-tracking data to parse physiological data
  – What physiological responses occur when attention is directed at a particular object?

• Sequence analysis: Longer patterns of gaze and behavior over time
  – Do interactions predict a shift in attention or a change in physiological state?
  – Do physiological responses precede particular interactions, shifts in attention, overt emotional reactions?
Benefits and Challenges of “Intensive” Measures

| + | Measures are objective and continuous  
|   | Not under conscious control  
|   | Sensors are minimally invasive  
|   | Record aspects of engagement that are otherwise invisible (cognitive processing) |

| - | Lab-based studies, small samples  
|   | Presence of sensors can influence behavior  
|   | Data requires filtering, processing, averaging to be meaningful  
|   | Synchronizing multiple data streams with different equipment, sampling rates, timescales of responses |