EEGRC Poster: Characterizing Trade-off Decisions in Student Designers

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Molly Goldstein is a Ph.D. candidate in the School of Engineering Education at Purdue University, West Lafayette with a research focus on characterizing behaviors in student designers. She previously worked as an environmental engineer specializing in air quality influencing her focus in engineering design with environmental concerns. She earned her B.S. in General Engineering (Systems Engineering & Design) and M.S. in Systems and Entrepreneurial Engineering from the University of Illinois in Urbana-Champaign.
Although design and decision-making are intertwined for practicing engineers, students from elementary school through college are not taught to think through uncertain situations in which information is limited or outcomes are not guaranteed. Trade-offs are a complex element of decisions, as the decision-maker weighs possible outcomes against their respective costs. Understanding how students characterize design tradeoffs would allow educators a better glimpse into students’ systems design thinking. Without such knowledge at the K-16 level, we cannot create suitable design activities for students to improve on their decision-making skills, inhibiting their effectiveness as future engineers.

**OBJECTIVES**

The purpose of this poster presentation is to provide a brief overview of my dissertation work to date on an NSF-funded research project, Collaborative Research: Large-Scale Research on Engineering Design Based on Big Learner Data Logged by a CAD tool. In particular, I will briefly summarize my pilot work that guided my research.

**PARTICIPANTS**

<table>
<thead>
<tr>
<th># Students</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>463</td>
<td>7th Grade</td>
</tr>
<tr>
<td>152</td>
<td>8th Grade</td>
</tr>
<tr>
<td>140</td>
<td>Mixed High School</td>
</tr>
<tr>
<td>23</td>
<td>Mixed High School</td>
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</tbody>
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**PILOT STUDY**

Profiles of student designers
- High school students (n=107)
- 4 design features: construction, analysis, simulation & reflection
  - Cumulative count of all actions across design project
  - Hierarchical agglomerative clustering resulted in 5 groups
- I collected data from over 700 middle and high school students as they designed energy-efficient buildings in a CAD platform, Energy3D.
- Fine-grained data information of student actions, experimentation results, electronic notes (i.e. reflections), and design artifacts are collected through automatic, unobtrusive logging as students design.
- Per student, this log data sums 4,000 to 6,000 actions that are used to reconstruct her design process.
- A mixed methods approach will be used to investigate designer student trade-off behavior using process data, artifact trade-off value, and student reflections.

**METHODS**

- Cumulative count of all actions across design project
- Hierarchical agglomerative clustering resulted in 5 groups

**CONCEPTIONS OF DESIGN**

(adapted from Adams & Fralick, 2010)

Of the design activities below, which 5 would you consider as the MOST important in terms of producing a high quality design? For one of the selected terms, explain why.

- Analyzing data
- Brainstorming
- Building
- Communicating
- Conducting Tests
- Evaluating
- Identifying constraints
- Iterating
- Making decisions
- Making trade-offs
- Modeling
- Planning
- Prototyping
- Refactoring
- Setting goals
- Sketching
- Using Creativity

**CONTACT INFORMATION**

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