# Development and Usage of an Online Homework System in a Chemical Engineering Curriculum

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BACKGROUND

- We have developed an online, open-source system to administer course materials[1-4]:
  - Homework assignments,
  - Lab safety training quizzes,
  - Course surveys,
  - Simulated laboratory experiments.
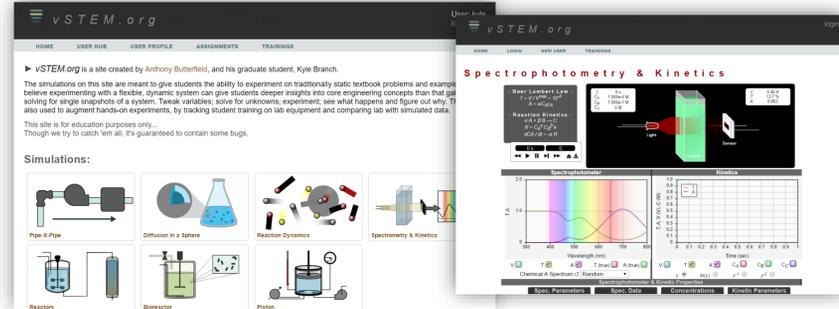
HOMEWORK SYSTEM

- Variables in the homework assignments have randomized values and units to reduce cheating.
- Homework assignments are automatically graded and allow students multiple attempts.
  - This helps reduce the grading commitment on instructors and allow students to correct misunderstandings as early as possible.
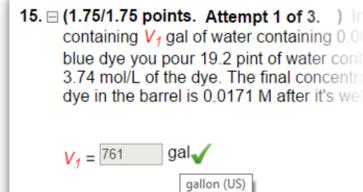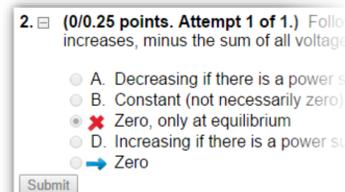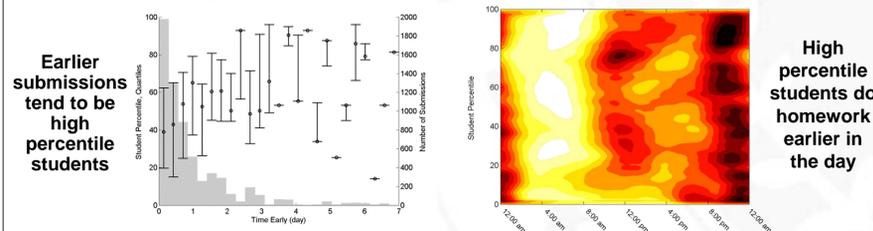
GAMIFICATION

- Students are able to obtain "experience" and "level-up" on the website:
  - Completing homework assignments,
  - Solving for unknowns on the simulations,
  - Completing lab equipment training quizzes.
- Students can obtain awards on the website by performing exceptional relative to their peers.
- Preliminary results have shown that students enjoy the awards and some solve unassigned homework problems in order to gain as much "experience" as possible.

EDUCATIONAL DATA MINING

- We have added real-time educational data mining functionality to provide both instructors and students with student usage statistics.
  - Students see, on average, how students in the past have performed and how much time it took them to complete homework problems.
  - Instructors see when students submit their assignments and how well they are performing.
- We have found many pedagogical insights from analyzing the simulations usage data.

Earlier submissions tend to be high percentile students

High percentile students do homework earlier in the day

STUDENT ANALYSIS

- Performed multiple regression methods to students' unbiased* final grades and used cross-validation to determine their accuracy:
  - Number of correct and incorrect attempts,
  - Total time and active time spent,
  - Primary internet browser,
  - Percentage of attempts on campus,
  - Student gender.
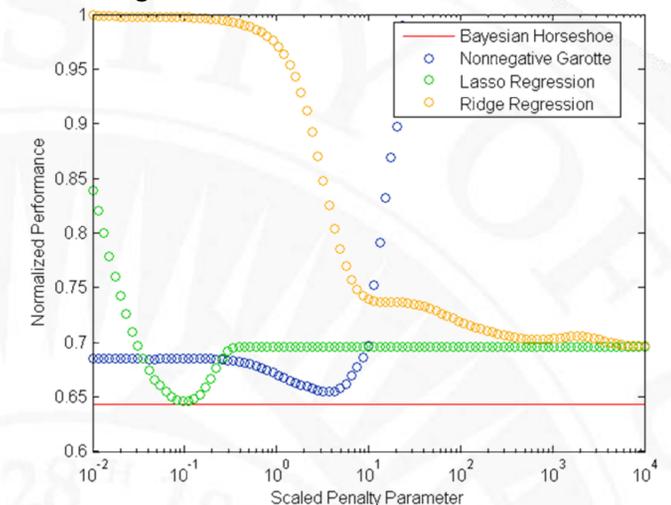
- Found that completing the homework is the largest predictor of their final grade.
- Women performed better than men. (P=0.031)

FUTURE WORK

- Augment homework system to provide students with hints and tailored feedback.
- Add automated interventions to the simulations.
- Provide user and instructor tutorials.
- Develop a homework generator interface.

1. **Branch, K.**, A. Butterfield, "Implementation and Usage of an Online Environment in a Chemical Engineering Curriculum," ASEE Annu Conf Expo. in press, 2016.
2. **Branch, K.**, A. Butterfield, "Analysis of Student Interactions with Browser-Based Interactive Simulations," Computers in Education Journal, 2016.
3. Butterfield, A., **K. Branch**, E. Trujillo, "First-Year Hands-On Design Course: Implementation & Reception," Chemical Engineering Education, 49 (1), pp. 19-26, 2015.
4. Butterfield, A., **K. Branch**, "Results & Lessons Learned from a Chemical Engineering Freshman Design Laboratory," 2015 ASEE Annu Conf Expo. doi:10.18260/p.24674, 2015.

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