

# Problem Roulette: Studying Introductory Physics in the Cloud



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## What is Problem Roulette?

Problem Roulette (PR) is a cloud-based web service built atop U-M ITS and Google cyberinfrastructure. Upon entering the site, a student chooses the course number and selects an exam to study for (one of three midterms, a final, or all combined).

This selection then figuratively "spins the roulette" to randomly access one of typically hundreds of past, multiple-choice problems in that course/exam. The back-end server, which contains a database of problem URLs – each problem is published as an individual Google doc – as well as the correct answer for each, delivers the problem to the student's browser along with options to choose an A-E answer or spin again to select another problem.

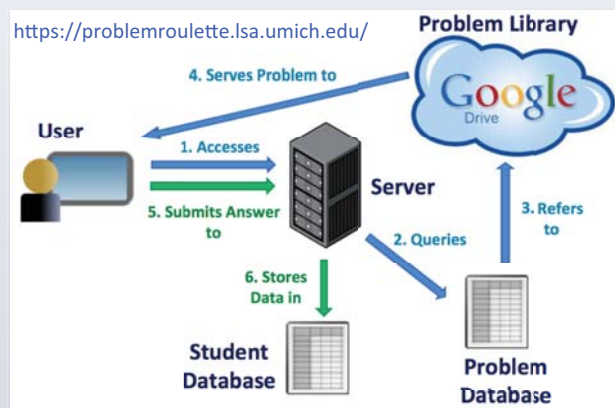


Figure 1: Flow diagram showing the interactions between system elements.

## Screenshots



Figure 2: A random problem from Physics 140 is served to the student, who can choose to answer, Give Up, or Skip. The problem URL is also available for future reference.

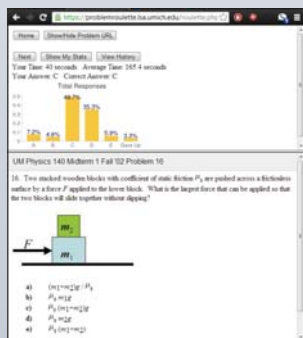


Figure 3: The student receives feedback: i) their answer of C is correct; ii) fewer than half of students got this problem correct; iii) she/he answered quickly.

## Usage in Fall 2012

Use of PR is optional to students enrolled in the introductory Science and Engineering (Phys 140/240) and Life Science (Phys 135/235) sequences. All courses have their three midterm examinations and final exams on the same dates.

A total of **954 students** completed **60,771 problems** Fall 2012.



Figure 4: Daily counts of visitors and pageviews to the PR site during the fall term. The four prominent peaks correspond to the four exam dates of the semester.

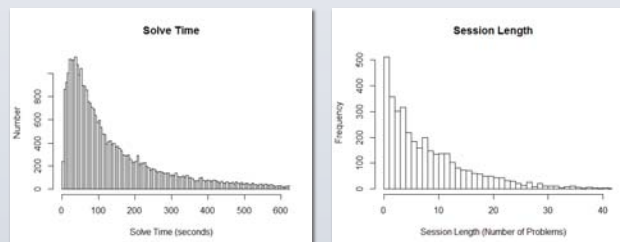


Figure 5: The distribution of problem solving times (left) has a median value of 98 seconds and a substantial tail extending to more than 10 minutes. Each login leads to a session, and the right panel shows the distribution of the number of problems attempted during a session. Most sessions involve only a few problems, but the median value is six, and in one session a student attempted nearly 120 problems! Sessions timeout after 1 hour of inactivity.

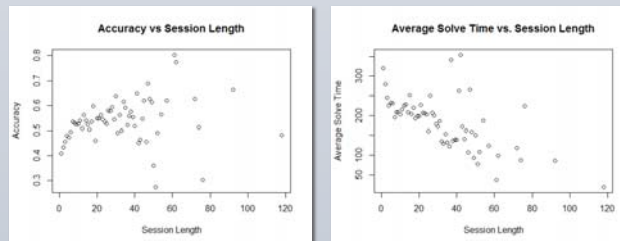


Figure 6: Analysis of sessions indicates that the fraction of correct responses increases with session length up to ~10 problems (left). The average solution time (in seconds) decreases with session length (right). These patterns may simply reflect the fact that better students tend to work longer sessions. The noise increases above ~20 problems/session because of poor number statistics.

## Impact

We have analyzed the impact of regular use of PR in Physics 240. The median number of problems attempted by all users during the term, 60, is used to classify students into heavy and light user populations. Beginning of term GPA is used as a parameter to account for the expected selection bias that better students will tend to work more problems.

We find that heavy users outperform light and non-users consistently on exams, typically by 7.5%, equivalent to 1.5 additional questions correct on a 20 question exam. Their **raw grade point enhancement is 0.38**. This improvement partly reflects the fact that regular users tend to simply be better students in general. But after adjusting for incoming term GPA (using Monte Carlo resampling of the light and non-user populations), we still find **an overall improvement of 0.22 grade points**.

## Grade point enhancement (4.0 scale)

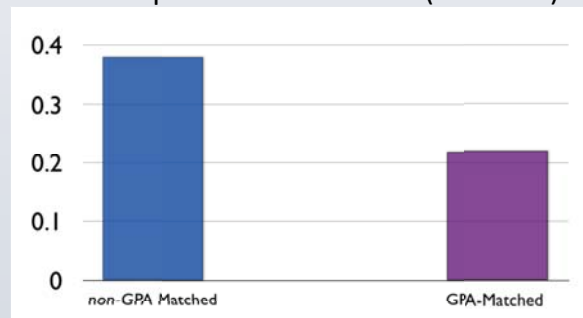


Figure 7: Grade point enhancement experienced by students who worked 60 or more problems in Physics 240 (roughly 1 problem per weekday of term). The raw enhancement at left is biased by selection, corrected at right.

## How Could Problem Roulette be Implemented for a Different Class?

Using existing database infrastructure and PHP code soon to be published under a GPL license, Problem Roulette could be adapted to work with any class that uses choose-from-a-list response exams. Problems would need to be converted to individually published Google docs, with their URLs and answer keys listed in an SQL database. Anyone interested in more information should please contact the PR team at:

[problemroulette@umich.edu](mailto:problemroulette@umich.edu)

## Acknowledgements

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