

Abstract

We explore the in-house development and use of a web-based laboratory management system. With a large student body (~3000 per year) our traditional approach of teaching assistant (TA) grading of student reports was prone to error and inconsistencies. Instead, the online platform does the heavy lifting of dealing with student data. It performs systematic grading, allows personalized feedback, incorporates auto-graded prelabs and is fully customizable to the institution's needs. The system also allows easy identification of laboratory issues and is a powerful resource for identifying student strengths and misconceptions associated with lab methods and theory.

WVU laboratory details

The chemistry department has 8 freshman laboratory rooms each capable of holding up to 24 students. Each room is overseen by a TA allowing a maximum of 192 students (8 TAs) to take the lab at a given time. Before the implementation of the online system, student lab reports were collected by the TAs and graded by TAs. The reports were mainly graded based on reported data, calculations, accuracy and in some cases identification of unknowns. Various prelab approaches were tried but all generally led to a significant increase in workload for the TAs.

Goals/Motivation

Our traditional grading rubric was numerically focused on input data and subsequent calculations. As such, it was clear that it could easily be implemented using a programming language. We also found that grading mistakes were common and feedback provided by TAs was difficult to structure. Ideally, therefore a developed system would:

- automate as much of the grading as possible, allowing better targeting of resources to more specialized grading tasks
- be systematic, providing consistency for all students and removing grading errors
- provide a level of personal feedback

Various off-the-shelf packages were explored but none provided the necessary functionality.

Implementation

- The system was developed mainly using PYTHON and the DJANGO web framework.
- The site presentation is minimalist allowing clean navigation
- Students login to the site and input observations/findings
- The site implements "dependent grading" i.e.. when a later entry by a student depends on earlier (or combination of) entry (s) (see figure 1) this is accounted for.
- Structured feedback can be developed to highlight different aspects of the data entry/calculations (see figure 1)
- The grading rubric is desk specific allowing the distribution of different unknowns/tasks to different desks
- Automated generation and grading of prelabs
- The project is modular in structure allowing a new lab to be developed (using a set of basic PYTHON commands) and then added to the existing course structure

Lab Name: Quantitative analysis of KCl/KClO₃

Completing the lab: **65/65**
 (1) mass empty crucible and lid: **21.755 g**
 (2) mass crucible +lid and mixture before heating: **23.055 g**
 (3) mass crucible +lid and content after heating: **22.890 g**
 (4) total mass KCl and KClO₃ in mixture: **1.3 g** **calc 5/5, sig fig err (use 4 sfigs) 0/5**
 (5) mass oxygen evolved: **0.165 g** **calc 5/5**
 (6) mass KClO₃ in mixture: **0.419 g** **calc 5/5, sig figs 5/5**
 % KClO₃ in mixture: **32** **calc 5/5**
accuracy of %chlorate 5/5

Figure 1: Student input data for quant. analysis lab (light green font). Generated feedback based on student input (red font). This demonstrates dependent grading. For example, the input value (4) depends on previous values (1) and (2)

Other feature/benefits

- Simplifies attendance records for TAs and instructors
- Operational issues with labs can be easily identified (e.g. a problem with a buffer solution)
- Regrading of labs can be automated
- Easy presentation of any aspect of student data (see figure 3)
- Rapidly identify issues with laboratory procedures and/or grading schema

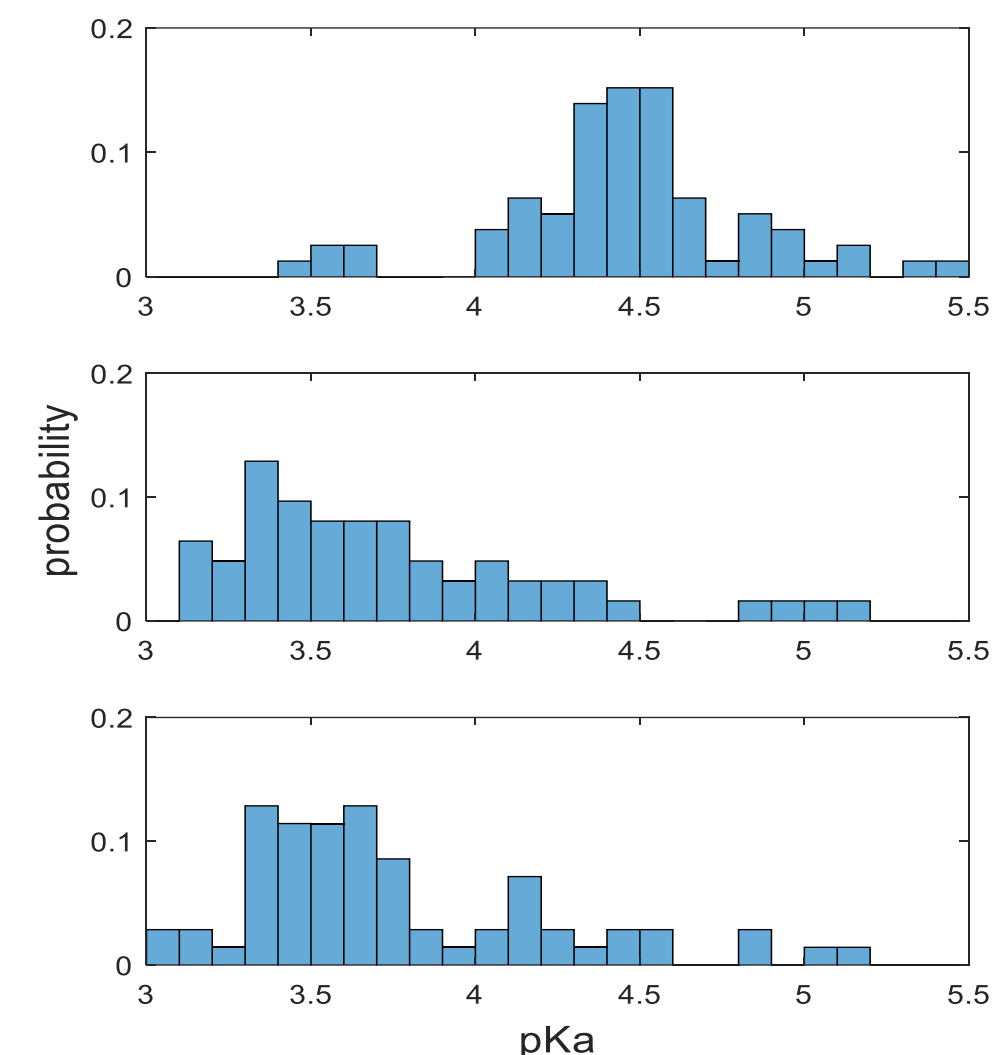


Figure 3: Student estimates of the pKa of three different unknown weak acids

A solution waiting for a problem

While our lab management system has been an invaluable resource in terms of managing student data, a secondary outcome awaits. Since the system is fully customizable, there is the potential for such a system to be powerful tool in research studies. A lab can be synergistically designed along with student data input/feedback. Any aspect of this data can then be simply accessed. I encourage readers to dream ahead on this point.