

# Alchemy

**A solution to a pedagogical customization problem**

**Russ Algar, Jane Maxwell, *et al.***

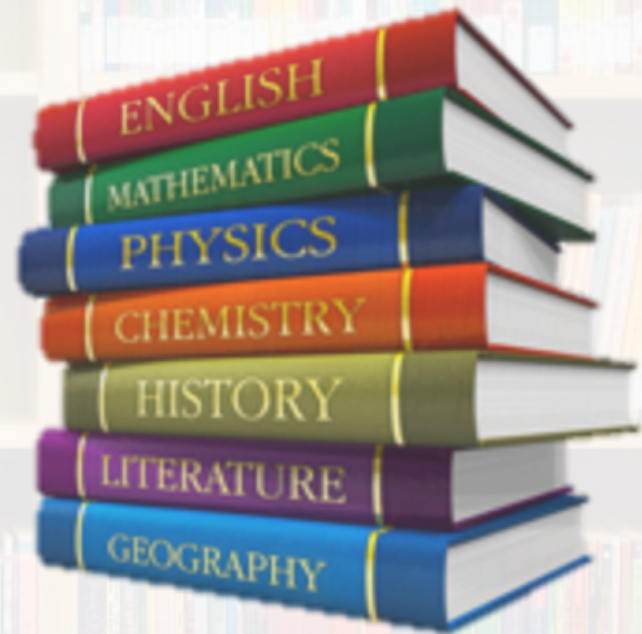
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## A Custom Resource is Needed

### Textbook Model

- ✗ Concepts appear disconnected
- ✗ Pattern recognition, plug & chug
- ✗ Misconception: only one answer
- ✗ No feedback
- ✗ Much of content is unused





## A Better, More Flexible Fit

Molds to our syllabus/  
course content.

Questions that reflect our  
course tests and exams.

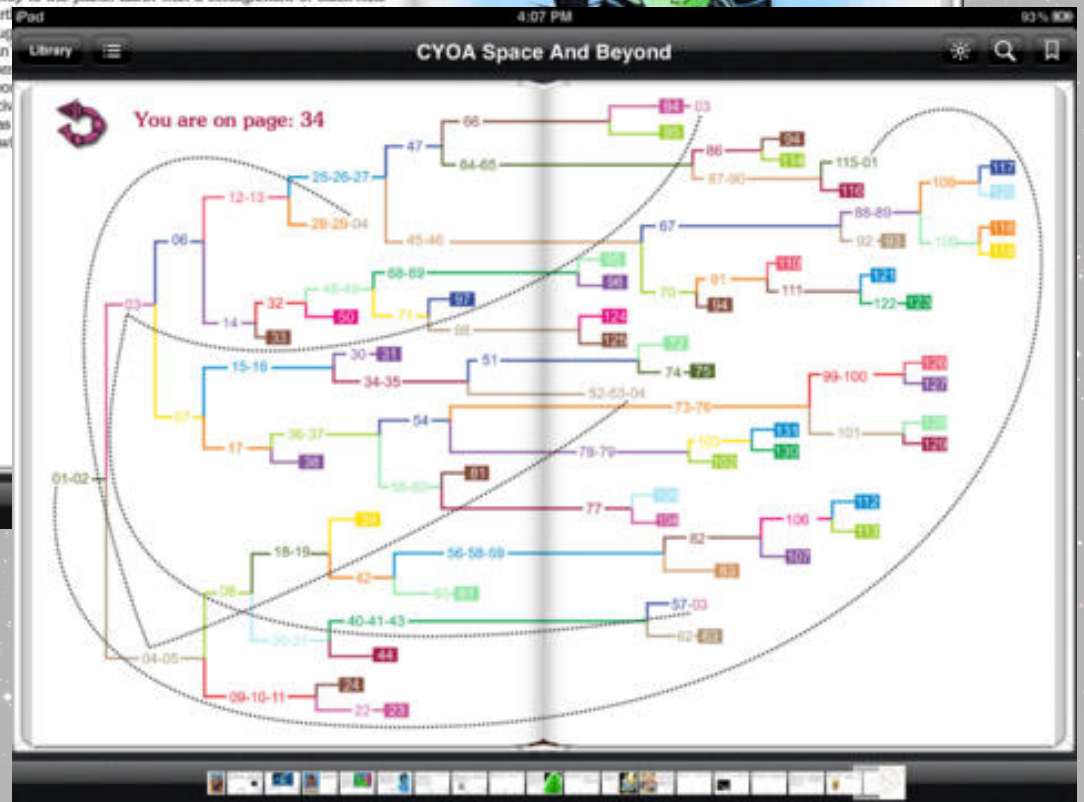
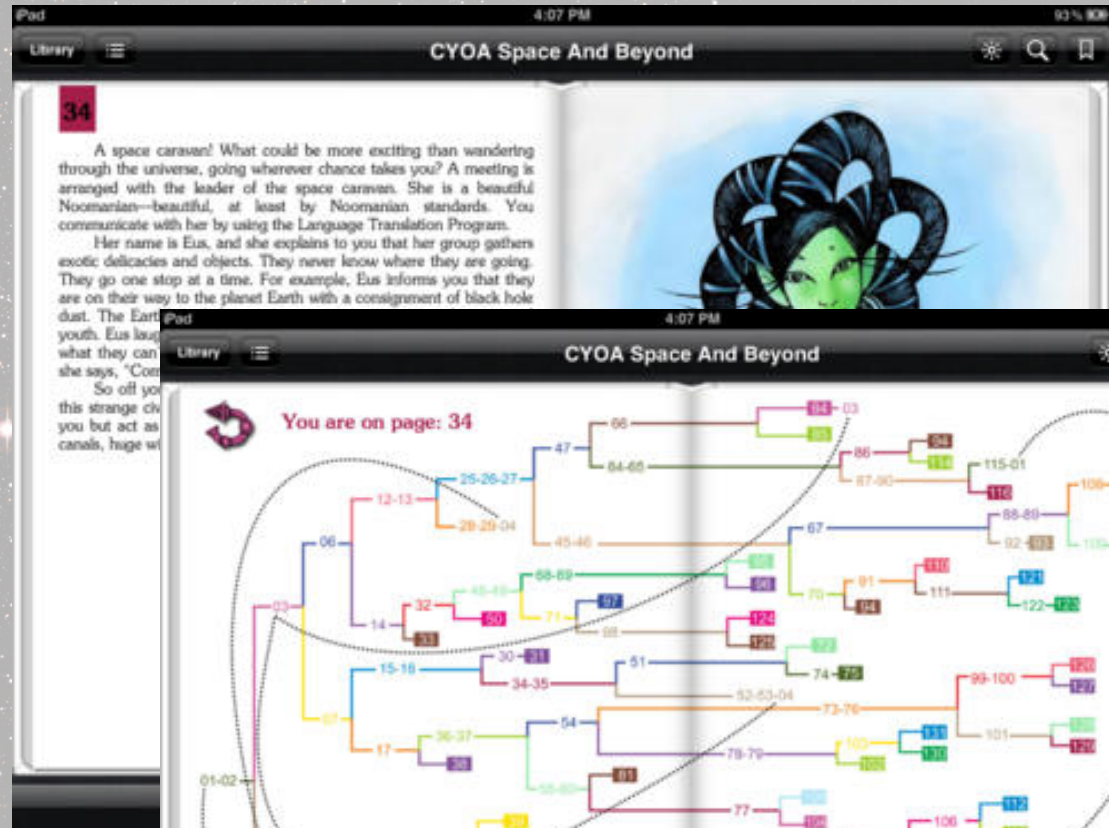
Addresses the  
difficulties of our  
students.

Conveniently and  
freely available to  
students.

Mimics our instructor  
feedback to students.



# Inspiration: CYOA Books





## Design Criteria for our Custom Resource

### Student Use

- Online resource
- Point-and-click through decision trees with text graphics
- Enroll in a class
- Complete assignments for grades and for extra practice

### Instructor Use

- Online resource
- Point-and-click construction of decision trees with text and graphics
- Add co-instructors and organize decision trees by class
- Assign practice assignments and graded assignments with due dates
- Record and view student results

## Resource Development

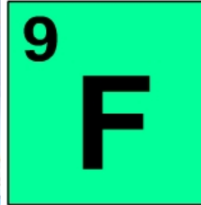
### CPSC 319 Software Engineering Project

- Third-year computer science course
- Students formed into teams that functioned as a mock software company
- Developed a project from start to finish
- Competition between different teams

*We served as clients and chose a winning software product.*



Alchemy 



GLACIER





## Decision Node (Student)

CHEM 211 288 2016

### Mixture of strong and weak acid

$$[\text{H}_3\text{O}^+]^2 - 0.010[\text{H}_3\text{O}^+] - 1.8 \times 10^{-5}(0.10) = 0$$

$$[\text{H}_3\text{O}^+] = 0.0102 \text{ M}$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$\text{pH} = 1.99$$



### Solving the Simplified Equation

The calculated pH is 1.99. If we had assumed the acetic acid had no effect on the pH with hydrochloric acid present, the calculated pH would have been 2.00. Thus, such an assumption would have been acceptable. When would this assumption become less likely to be valid?

(A) Lower initial concentration of hydrochloric acid

(B) Mixed with a weak acid with a smaller  $K_a$  value than acetic acid

(C) Mixed with a weak acid with a larger  $K_a$  value than acetic acid

(D) Both A and B

(E) Both A and C

# Tree Builder (Instructor)

## Mixture of strong and weak acid

11

+ New Node

× REMOVE

$$\begin{aligned} \text{pH} &= -\log[\text{H}_3\text{O}^+] \\ &= -\log(0.010) \\ &= 2.00 \end{aligned}$$



Node Type:  Regular  Goal  Failure

Requires Justification:

12

Continue

×

+ Add Choice

Title

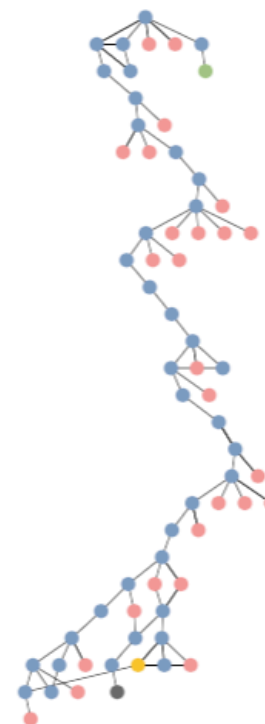
pH of 0.010 M Hydrochloric Acid

Body

The pH of 0.010 M HCl (aq) is calculated as shown, yielding a result of pH 2.

This result can be also be obtained from a systematic equations approach. Although unnecessary for strong acids, a systematic equations approach will prove useful later, so we'll apply it to HCl (aq) first.

Scenario Tree



×

Delete



# Class Results (Instructor)

— Courses

— CHEM 211 288 2016

Equilibrium review (Test 1, Q4)

UV-visible worksheet

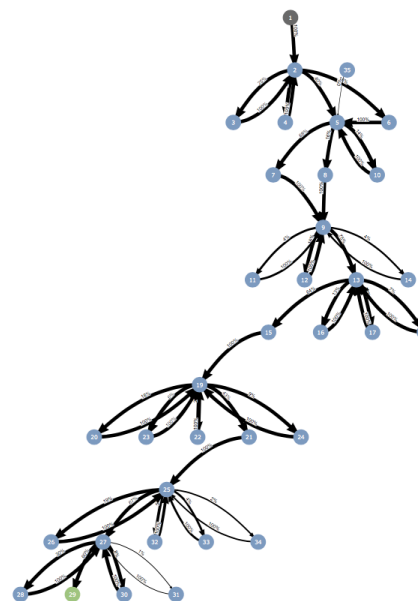
Calibration plot and statistics

Equilibrium review (Test 1, Q4)

Summary

By Student

## Class Decision Overview (Wider edges are more traveled)



### Average No. Failures

0 / 100

### Completion Status

Completed 92 Expired 48

## Implementation in CHEM 211

### Course

- CHEM 211: Introduction to Chemical Analysis
- ~150 students

### Delivered Content

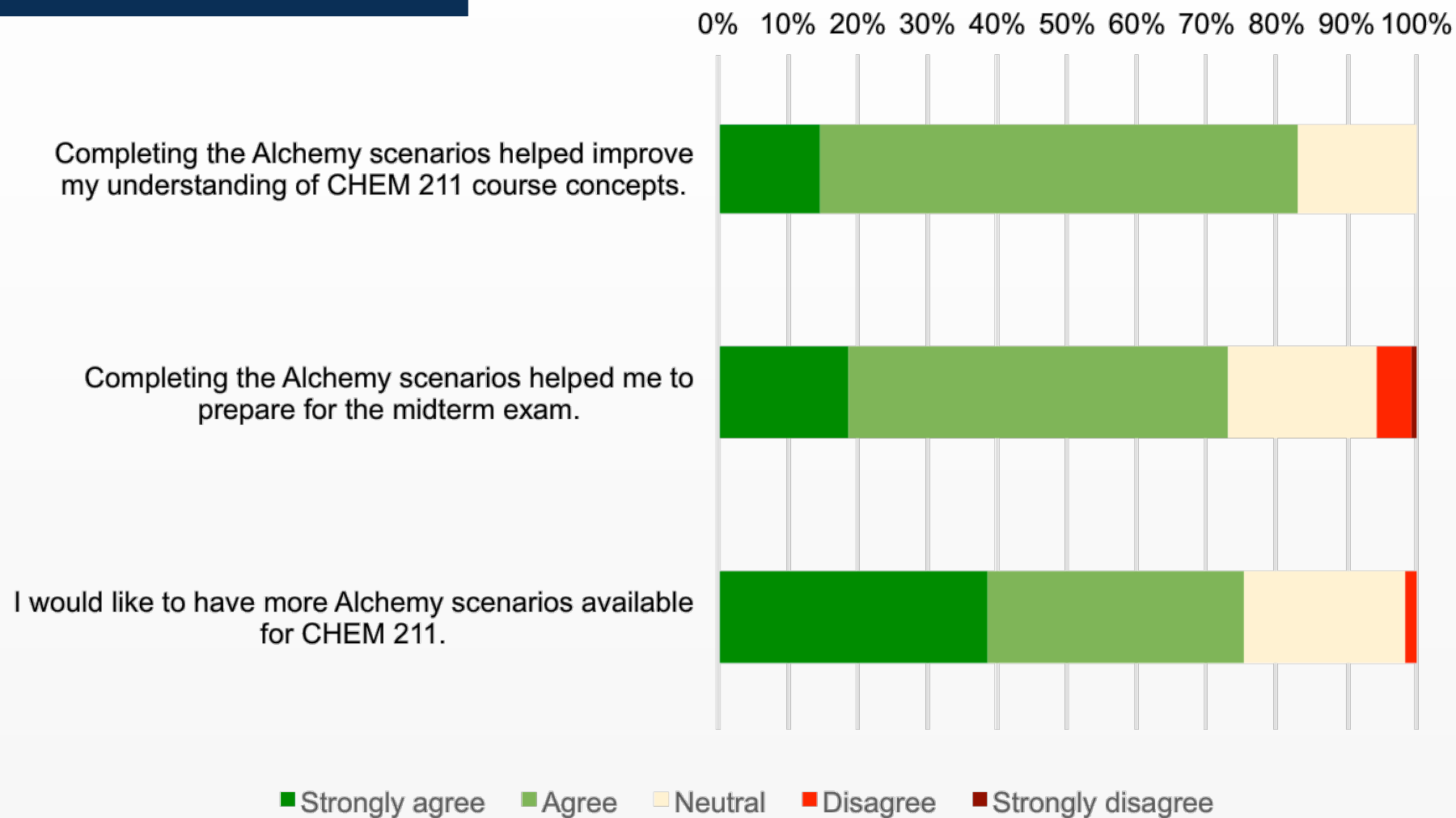
- *De novo* scenarios
- Interactive answer key to a difficult test question
- Interactive homework worksheet

### Student Participation

- Participation mark earned (up to 2% of course grade)
- 73% of class earned non-zero participation mark
- 84% of non-zero grades were a full participation mark



## Student Feedback



#1 student comment: More content in Alchemy!

# Prospectus



- Software upgrades
- Extensive content development
- Full integration into CHEM 211
- Pilot in other courses