# Online Laboratory Tutorials: Design, Implementation and Impact

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## Introduction

Web-based teaching and learning resources offer many advantages, including ease of access and the possibility of incorporating animation. While online homeworks, quizzes and lessons are widely available in the field of Chemistry,[1] laboratory tutorials are less common.[2] In an effort to improve student preparation in the undergraduate Organic Chemistry Laboratory, an online tutorial on the topic of Distillation was created. The 30-minute tutorial contains a lesson on the theory of distillation, as well as various demonstrations using a distillation apparatus. The tutorial has proven to be effective in improving student learning and increasing student confidence.

## About CHM 317L

CHM 317L is the first quarter of year-long Organic Chemistry Laboratory sequence. The CHM 317L Laboratory Exercises focus on techniques:

| | |
|---|---|
| melting point | TLC |
| extraction | **distillation** |
| recrystallization | IR spectroscopy |

**Recurring problem: unprepared students**

## Project Goals

Create an **online prelab tutorial** on distillation

- ✓ Use time outside of class for student learning
- ✓ Audio, video, and animations make the topic more interesting and engaging
- ✓ Thoroughly explore both theory and practice

Help CHM 317L students to:

- ✓ Come to lab prepared
- ✓ Get the most out of the lab exercise
- ✓ Remember something in CHM 318L…and beyond!

**IMPROVE STUDENT LEARNING!**

## Research Plan

**Collect Pre-tutorial Data**

- •Seven sections of CHM 317L (W07, F07)
- •Administer prelab quiz & survey
- •Observe students during lab period

**Incorporate Online Distillation Tutorial**

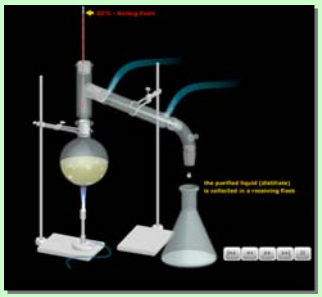
**Collect Post-tutorial Data**

- •Five sections of CHM 317L (Sp07, W08)
- •Administer prelab quiz & survey
- •Observe students during lab period

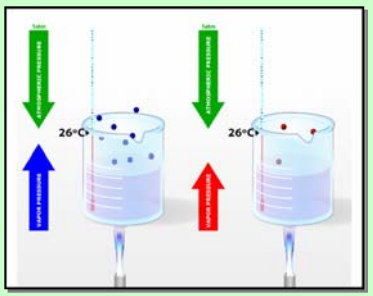
## Creating the Online Tutorial

The Distillation Tutorial was developed in Adobe Presenter (a.k.a., Breeze, Connect). The tutorial can be viewed with any Internet browser, using Flash Player 8 (free download is available from Adobe). Presenter is a PC-only application that operates as a Plug-In within Microsoft PowerPoint. The software enables the addition of Flash animations, video, and narration, and converts the modified PowerPoint presentation into a web-based presentation.

**http://connect.csupomona.edu/distillation**



Audio commentary guides the viewer through a detailed, animated overview of the distillation process. A series of text passages highlight notable features.



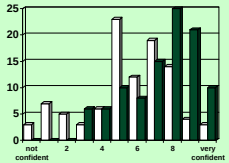

Flash animations were developed to illustrate the theory of distillation, vapor pressure and boiling points.


With the videotaped lab demonstrations, viewers can become familiar with apparatus, including ground-glass glassware and various heat sources. Videos include demonstrations of setting up and dismantling both simple and fractional distillation apparatuses, with an emphasis on safety and how to avoid common mistakes.

## Results: Prelab Survey

Confidence in Running Distillation Experiment

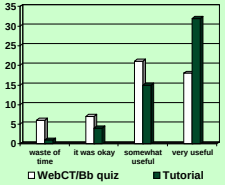
(1 = not confident; 10 = very confident)




Mean = 5.5 ☐ **Pre-tutorial** ■ **Post-tutorial** Mean = 7.3

Students who watched the online tutorial reported a higher level of self-confidence (in both theory and experiment).

Usefulness of Online Materials

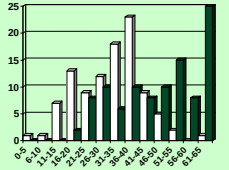



Students found the online tutorial even more useful than the regularly offered online pre-lab quizzes.

## Results: Prelab Quiz

Overall Quiz Score

Percent of Students at each Score (Max. Score = 65 points)

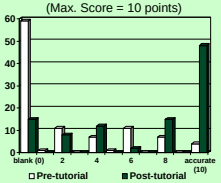



**n=147** ☐ **Pre-tutorial** ■ **Post-tutorial** **n=52**

Students who watched the online tutorial scored higher on an in-class diagnostic quiz (tested both theory, experiment).

Apparatus Sketch

Percent of Students at each Score (Max. Score = 10 points)




The majority of students who had watched the tutorial were able to draw/sketch a simple distillation apparatus. Without the tutorial, the majority of the sketches were simply blank.

## Conclusion

The online tutorial significantly improved the students' pre-lab preparation. The students' quiz scores also improved, both in the area of distillation theory and in the knowledge of experimental details. The consistent increase in the students' level of self-confidence is especially noteworthy. Students who come to lab better prepared and more confident are more likely to have a better learning experience.

## References

(1) Belford, Robert E.; Hanson, Robert M. *J. Chem. Educ.* **2006** *83* 1592.

(2) Herman, Carolyn; Casiday, Rachel E.; Deppe, Roberta K.; Gilbertson, Michelle; Spees, William M.; Holten, Dewey; Frey, Regina F. *J. Chem. Educ.* **2005** *82* 1871. Koehler, Brian P.; Orvis, Jessica N. *J. Chem. Educ.* **2003** *80* 606.

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