**ChE** teaching tips

This one-page column will present practical teaching tips in sufficient detail that ChE educators can adopt the tip. The focus should be on the teaching method, not content. With no tables or figures the column should be approximately 450 words. If graphics are included, the length needs to be reduced. Tips that are too long will be edited to fit on one page. Please submit a Word file to Phil Wankat <wankat@ecn.purdue.edu>, subject: CEE Teaching Tip.

# TWO MINUTES OF REFLECTION IMPROVES TEACHING

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A laboratory notebook has great utility in recording procedures, measurements, calculations, and ideas in real time, sometimes in a very methodical way and other times as a stream of consciousness. With the development of any experimental technique, a standard operating procedure is written and refined. Analogously, a university classroom is like a laboratory and teaching is sometimes very structured and other times improvisational, and the key result is learning, which is measured on exams and quizzes in most engineering classes. Historically, a professor's standard operating procedures are his/her lecture notes. These notes are generally static and commonly show their age (wrinkled edges, yellowing paper, coffee stains, etc.). Also like laboratory measurements, good teaching practices are reproducible and backed by significant findings in the literature (*e.g.*,[1,2]).

From this literature, one practice that encourages student learning is reflection (*e.g.*, allowing students 1 to 2 minutes to think about the last concept or example[2]). Reflection encourages students to organize their thoughts and find ways to tie new material with their existing knowledge. Faculty also benefit from reflection.[3] I feel my courses have improved every semester by implementing a simple reflective exercise immediately after each class that I lead (even before checking messages).

Nominally, the reflective exercise takes 1 to 2 minutes and employs free writing to analyze the just-completed class session. Some of the major areas to address include:

- *Assessing what worked and what could be improved*
- *Logging how long each segment of the class* (e.g., *concept) took to cover*
- *Listing any pertinent questions that the students asked (or ones that I stumbled on answering)*
- *Gauging the energy level of class and potential reason* (e.g., *exam last night, just returned an exam)*
- *Recording ideas for adding/subtracting content* (e.g., *too easy, too far off topic)*
- *Generating ideas to start the next class period* (e.g., *finish or review a topic, clarify a concept)*
- *Cataloging ideas for future quiz or exam problems (and filing separately)*

The reflective statements are read over in preparation for teaching that specific course material the next time. Another benefit of this technique is improved organization, including not scrambling to squeeze in content before the homework is due or an exam or quiz.

While data on student learning based on reflective change will be difficult to collect, this type of attention to detail can improve the quantity and quality of material learned, the classroom learning environment, and instructor-class dynamic. Overall, the teaching "lab notebook" documents and organizes ideas, criticisms, and questions immediately following a classroom "experiment," and has led to improved organization and student learning of course concepts in the author's experience. Finally, the importance of reflection is not a new idea in education as reflective exercises date back to St. Ignatius Loyola and persevere as an integral part of Jesuit schools and universities for more than 450 years.

1. *How people learn: brain, mind, experience, and school*, National Academy Press, Washington, D.C. (2000)
2. Bruning, R.H., G.J. Schraw, and R.R. Ronning, *Cognitive psychology and instruction*, Merrill, Upper Saddle River, N.J (1999)
3. McAlpine, L., and C. Weston, "Reflection: Issues related to improving professors' teaching and students' learning," *Instructional Science*, **28**, 363 (2000) ❐

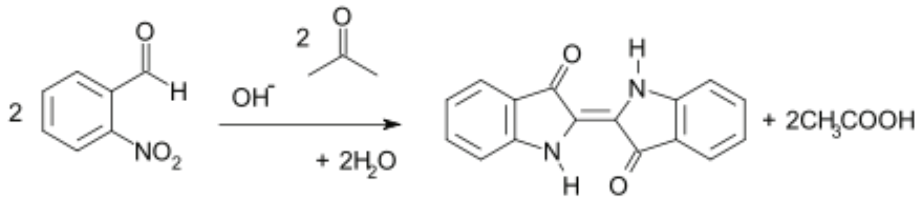
# Appendix A
## Procedure for Indigo Synthesis

continued from "Indigo," page 230.

Laboratory: Synthesis of Indigo

Adolf von Baeyer first synthesized indigo by this reaction in the 1880s.

**Reaction**:




o-nitrobenzaldehyde acetone indigo acetic acid

Reference for image: http://en.wikipedia.org/wiki/2-Nitrobenzaldehyde

**Procedure:**
Bring copies of the MSDS sheets for o-nitrobenzaldehyde, acetone, NaOH and acetic acid to lab. You must show them to me before beginning the experiment and correctly answer safety questions I will ask.

1. Take a weigh boat with a measured amount of o-nitrobenzaldehyde in it. Carefully transfer the o-nitrobenzaldehyde into the 50 ml plastic beaker. [Side note: Benzaldehyde is an artificial essential oil of almond!]
2. Using a graduated cylinder, measure 5 ml of acetone.
3. Add the 5 ml of acetone to the solid o-nitrobenzaldehyde and swirl it to dissolve.
4. Using a graduated cylinder, measure 5 ml of 1 M NaOH.
5. Slowly add the NaOH to the beaker. If you add it too quickly, the acetone will evaporate. Note what you observe as you add the NaOH.

6. Let the beaker set for 5 minutes to allow the reaction to go to completion.
7. Weigh a piece of filter paper.
8. Place the filter paper in the Buchner funnel. Set the funnel in a beaker, and pour a small amount of water in the funnel to help the paper adhere to the funnel.
9. Carefully pour the indigo solution onto the center of the filter paper. Rinse the beaker with a small amount of water to remove the last of the crystals. Note what you observe as the filtration begins.

10. Allow some time for the liquid to drip through the filter.
11. Clean your 50 ml beaker with glassware cleaner and water. Place it at your spot to dry.
12. When the filtration is done, carefully lift out the filter paper and set it near the back of your spot to dry overnight.
13. Pour the filtrate into the dye waste container, and clean your Buchner funnel and the large beaker.
14. On Monday, weigh the filter paper with indigo on it to estimate the yield.

**Memo** Due to WA: Final memo due:

Use the format as before to describe the experiment and your results.

Introduction: Provide background information about the synthesis. Include the mechanism (explained in Ullman's Encyclopedia) if you have taken organic chemistry. Add other information you consider useful or interesting.

Procedure: Summarize the procedure you followed (main steps only, not all the details). Use Visio to draw a process flow diagram.

Results and Conclusions: Prepare a table with the raw data (g benzaldehyde, g filter paper, g final product) and calculated results (g indigo, % yield). How well did you do? How could you improve your results or the process? What are sources of error? Consider an economic analysis (For small quantities: Benzaldehyde: 5 g costs $19.10; 100 g costs $24.00, 18 kg costs $242.50. Acetone: 1 L costs $23.50, NaOH: 100 ml costs $9.60; 2 L costs $30.50. Indigo: 25 g costs $28.30; 100 g costs $90.50. Bulk prices would be different.)