PEER-LED TEAM LEARNING EVALUATION

RESEARCH IDEAS FROM PORTLAND STATE UNIVERSITY

CARL WAMSER

The first part of this presentation illustrates assessment data we've been collecting at Portland State University (PSU), and the second part shows how we are using Peer- Led Team Learning (PLTL) to probe students' visualization skills.

Assessment of Student Success in Organic Chemistry - The Effect of PLTL Workshops

In terms of assessment, we look at three common characteristics: (1) success, (2) persistence, and (3) performance. For us, success is defined as a grade of "C-" or better, and the percentage success is measured as a fraction of the total class that starts. Persistence means completing all three terms successfully, where success is defined as before. This is a full-year course in Organic Chemistry, yet very few students take all three courses in the same year (fall-winter-spring). Performance refers to student grades for all those who complete the course and get a grade (including withdrawals and other administrative grades). We also have student scores on a standardized exam from the American Chemical Society (ACS), with student scores reported as percentile rankings relative to the nationwide group who took the same exam.

We have been doing PLTL at PSU for four years now. We accommodate approximately 30% to 40% of the students in workshops for both General and Organic Chemistry. Workshops are optional. We feel it is important to take students who really want to do it. This affects our decision to make workshops optional, but the decision is partly influenced by resources as well. Over 1600 students have been served in workshops over the four years, including both General and Organic Chemistry. A summary of the data is presented in Table I.

Table I. Success, Persistence, and Performance with PLTL Workshops at Portland State University (Four years)

	Success	***Persistence***	***Performance***
	C- or higher (D or lower)	all 3 terms	course % ACS %-ile
Workshop	**83 %**		**71 %**
	(17 %)	**53 %**	**85 %-ile**
Non-workshop	**68 %**		**64 %**
	(32 %)	**28 %**	**80 %-ile**

Normalizing this group of students tends to be a problem. What defines the students who choose to do workshops -- are they the better students? Are they more motivated? We have examined their overall GPA to get an indication of the type of student they are, not just in chemistry. Students' overall GPA is typically higher that the GPA they obtain in Organic Chemistry. For example, the average student who did not select workshops had an overall GPA of 3.15, but a 2.50 in Organic Chemistry, a difference of 0.65. Students who selected workshops are indeed "better" students, but don't suffer as drastic a drop as do the overall group (overall GPA 3.29, course GPA 2.90, difference 0.39).

We have also been interested in the attitudes of the students towards workshops. We used a standard workshop survey (see the PLTL website for the survey form) to assess how they feel about the workshop. A majority (n=232) of the students pointed out these positive aspects of the workshops:

- interaction with the workshop leader;
- interaction with other students in the group;
- they like it enough to recommend it to other students;
- they are improving their grades as a result of workshop.

Overall, we see that the success rate, persistence and performance are all improved as a result of the PLTL workshops.

Assessment of Student Visualization Skills - PLTL Workshops as a Testbed for New Approaches

The second part of this presentation is about how PLTL has been used to assess students' skills in visual thinking. As a result of visiting a Gordon Research Conference about two and a half years ago, I collaborated with Neil Stillings, a well known and respected cognitive psychologist, from Hampshire College. The Gordon Conference offered $5,000 mini grants to collaborators who previously did not know each other and were from different dis- ciplines. The conference topic was 'Visualization in Science and Education.' Dr. Stillings had an interest in understanding how students approach three-dimensional information. Three-dimensional information is crucial for organic chemistry and is often the limiting factor for students' understanding.

Dr. Stillings and I turned our attention to stereo- chemistry because it involves the ability to manipulate three- dimensional objects mentally. There are known gender differences in terms of the ability to mentally manipulate images. Dr. Stillings was well aware of this and I reported to him that this was a source of difficulty for all kinds of students.

PLTL workshops provided us with the opportunity to try something different -- something outside of lecture mode. Workshop students were a "ready-made" group to experiment with. The basic stereochemistry issues in these courses include determining whether molecules have planes of symmetry and visualizing a three-dimensional model on paper. These kinds of visualization issues are well known to cognitive psychologists. In fact, the Shepherd-Metzler test is used in the SATs where students are given three-dimensional blocks with different orientations to identify those which are similar.

We compared students in organic chemistry (since they already have a background in stereochemistry) to see how the students visualized three-dimensional images. In the first year, we used the Shepherd-Metzler test for the organic chemistry students and administered it three times in the year -- at the beginning of the year, in the middle (after learning stereochemistry), and at the end. The test is susceptible to practice and students generally do better each time with the biggest increase noticed between the first and second times. Students on average did perform better, and we are still sorting out whether the magnitude of the improvement is consistent with a practice effect with the exam or because of their experiences with stereochemistry.

The differences with respect to gender were also examined. It is known that males generally are better with three-dimensional visualization than females. This was confirmed in the results. The difference in scores between workshop and non-workshop students were quite similar with the non-workshop females improving a bit more.

We repeated the experiment the following year using a more sophisticated test. The MMRT (Molecular Mental Rotation Test) was used to assess the students' ability to visualize three-dimensional organic molecules rather than blocks. This test provided similar results -- again we saw that students do better after learning stereochemistry and that males performed better than females. Understanding the reasons for these differences and how to address them is a very important question. It has always been a source of concern in cognitive psychology circles. We would also like to pursue this question and then decide what means of intervention exist. The PLTL workshop is perfect for this.

Dr. Stillings observed workshop groups working on three-dimensional models and noted the following:

- students normally start out deeply confused;
- physical models are important -- some students prefer visual means of learning while others favor kinesthetic (hands-on) methods;
- the MMRT is very difficult, but there are different strategies for doing this test. There are at least three different approaches:
    - by visualizing one molecule turning until it matches another;
    - a piecewise rotation -- by breaking up a complex molecule into simpler pieces and mentally moving them around to see if the two molecules are the same;
    - to apply an algorithm (rather than visualization) to determine whether a molecule is an "R" or "S" configuration.

The results from the MMRT have led to several follow-up questions, particularly with regards to learning styles and how the students approach three-dimensional visualization problems. Obviously there is the need for further research and we intend to implement new instructional interventions based on students' characteristics. This year we will look at demographic information such as age,

race, gender, and ethnicity to see if there are any correlations among these variables in order for us to better address the problem of three-dimensional mental modeling.

Carl Wamser
Portland State University

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