Chemistry as a Second Language

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INTRODUCTION

Everyone knows that when learning a foreign language you can memorize all the vocabulary you want, you can drill your grammar forever, but you don't really learn the language until you start speaking it. The best language teachers are those who force you to speak. Of course, you are embarrassed at first, because every word out of your mouth is wrong, but soon you begin to speak the language and, lo and behold, converse in it.

It occurred to me last year that chemistry is much the same—to become fluent in chemistry, you must speak it. But nearly all study strategies revolve around solving problems as the end goal. I decided that I wanted to try an experiment where solving the problems was only the first step, and *communicating* them was the ultimate goal. What follows is the structure I set up to do this and the first results I have obtained.

THE PLAN

I decided to organize the class into groups of eight or so, each group associated with a peer team leader, along the lines of the Peer-Led Team Learning approach of Kampmeier *et al.*[1] But the PLTL

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approach involves group problem solving. At the group meeting, new problems appear and the group must work together to solve them. I felt that my students had plenty of problems to work with and did not need new ones—in addition to the problems in the book, I have five years worth of previous exams readily available for them. I decided that the group sessions would be devoted not so much toward *solving* the problems but on determining a strategy to *present* them to the rest of the class. The idea was that the students (at least some of them) would have already done the problems by the time the group met. Group time would be spent rehearsing how to explain to others how the problem should be done, i.e., not just what the answer is but the thought process by which one arrives at it.

Logistically, I planned to spend two of my three-a-week class days operating in presentation mode. I would solicit from the class a problem they wanted help with. Then I would use a random name generator to choose a group. That group would send up their expert on the chosen problem and explain it to the class. Afterwards I would lead a discussion of the solution presented, pointing out any wrong parts and especially common mistakes brought up by the presentation. Then the class would grade the presentation (we use CPS remotes for this) and the *whole group* would get the grade earned by the presenter. This spreading of credit was supposed to give incentive to the group to make sure that each member was well-prepared for their problems.

WRINKLES

Well, it didn't turn out quite like this. Acting on advice from last year's students, I decided not to require group work of all students. It would be voluntary. I know this flies in the face of everything we learn about how to do these things. I know that the students who need it most will be most likely not to participate. I know that the results will be subject to the charge that the better students chose to join groups. I know that having some students participating and some not prevents me from counting the grades in any meaningful way, therefore removing much of the incentive to take this seriously.

Nevertheless, this is what I did. I hired enough peer leaders for about half the class. They each selected times and places for their groups to meet, and I told the class that the first eight people to arrive at each spot was the group, and they were stuck with that group for the entire semester.

LOGISTICS

In fact, some groups filled up rapidly, with a waiting list, while others got almost no takers. My first-semester freshmen told me that 10-12 at night was too late for them! Since I had no hold over students, some abandoned their groups, and others filled in. So my static groups became somewhat flexible. Further, within each group, some people took the charge seriously and others did not, arriving without having done, or even tried, the homework.

There were about 20 students who wanted to join groups who were not accommodated in the established ones, so they formed groups of their own. To my surprise, they asked to be called on just like the official groups. I was very pleased by this development, because it gives me a chance to determine whether any positive results I see are related to the group work or the peer team leader.

As it turned out, I had eight official groups, comprising 64 students, and three self-led groups totaling 21 students, out of a total of 134 students in the class. Thus, 63% of the original students were in groups.

RESULTS

On each exam, students in groups, on average, did better than students not in groups by about a whole letter grade. As you will see below, this does not apply to the final grade, because each student is allowed to drop their individual lowest exam score. This compresses the grades.

By the end of the course, 40 of the students had dropped. Of those, 10 (25%) were students who started in groups, and the rest (75%) had not. Two of the ten group members who dropped had not really attended their groups seriously, so it is probably more accurate to say the 8/40 (20%) of the drops were group participants.

Of the 94 students who passed, the grade distribution was as follows:

	Whole Class	Groups	No Groups
As	37%	45%	16%
Bs	32	28	44
Cs	23	22	28
Ds	7	6	12
Average	78	80	74

Perhaps most telling is a look at the fates of the students who started in groups vs. those who did not:

Students who started	in groups	not in groups
As	38%	8%
Bs	23	21
Cs	19	13
Ds	5	6
Drops	15	53

Was the leader necessary? This turned out to be a tough question to answer. On average, the leaderless groups did slightly *better* than the groups with leaders. However, these statistics are dominated by one leaderless group that was mostly students from the same high school who had taken organic chemistry before and did very well in this course. If you subtract out their scores, the unled groups did worse than the led groups, but better than the group-less students.

So is this effect real, or are we simply looking at a group of students who would have done better anyway? We don't know for sure, but we do have two sets of statistics we gather on entering students, one related to their math SAT scores and class ranks, which produces a prediction of how they will do in the course, and the second based on a quickie screening test they take the first week, which also leads to a prediction. Neither prediction works very well, but both lead to a division of the class into those who are likely to succeed and those who are not, and each method is about 70-80% successful in its prediction. According to both sets of numbers, students in groups were statistically indistinguishable from those not in groups. Therefore I conclude that this approach to group work is an effective means of studying chemistry.

Another, more serious question is, does the benefit accrue from the rehearsal for presentation aspect of the group work, or is it simply a function of extra time spent studying? This one I have no means of answering, so I leave it up to the readers to draw their own conclusions.

Note: At Juniata we teach organic chemistry to incoming freshmen, so the data I have presented are from an organic class. However, I do not believe that this approach is limited to the type of material we are studying.

NOTES

[1] J. A. Kampmeier, P. Varma-Nelson, and D. K. Wedegaertner, *Peer-Led Team Learning: Organic Chemistry* (Upper Saddle River, NJ: Prentice Hall, Inc., 2001).