

"Enhancing" General Chemistry for At-Risk Students

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Abstract

My statistical analysis of Union's admissions data over the last six years has shown that a student's score on the math portion of the ACT exam is a good predictor of the likelihood of their success in CHE 111 - General Chemistry at Union. Based on this analysis, a student with an ACT Math subscore of 25 or less could be considered at-risk for performing poorly in Union's CHE 111 course. Based on the results of my analysis I decided to form an "enhanced" section of the course in the fall 2017 semester and invite all students enrolled in CHE 111 who met the at-risk criteria to participate. The results of this effort are quite encouraging, and this approach will be repeated in fall 2018.

Background

It is common practice in the teaching of chemistry to try to attain a broad diversity of students within a given classroom. The theory is that when you have a mix of students with differing levels of experience and ability in class together all of the students benefit from the experience. Theoretically, the well-prepared students will help the less well-prepared students along, thereby benefiting both. What often happens in practice, however, is that the students who are less well-prepared can become intimidated by being in the class with students who are much better prepared, and frequently they avoid doing anything that will reveal their weakness to others. This means that, very often, the less well-prepared students are hesitant to ask questions, come to office hours, or even participate in discussions among students in the class. Obviously this tendency can be hugely detrimental to their learning, and even their ultimate success, in the course. This issue becomes especially pronounced when there is a very large difference in the preparedness of students within the course.

Union's CHE 111 course has no objective placement criteria in the catalog. This means that a student with an ACT Math score of 15 could be sitting next to a student with an ACT Math score of 36¹. While this is an extreme case, Union has had students at both ends of this range enrolled in CHE 111 over the six years that I have been collecting data. Unfortunately, a significant number of students who perform very poorly in CHE 111 end up leaving Union entirely. In an effort to help foster a less intimidating environment for at-risk students I proposed creating an "enhanced" section of CHE 111, and taught that section in fall 2017.

"Enhancing" General Chemistry – Throwing time at the problem

A major component of the "enhanced" section idea is to provide at-risk students with more time to work through the same material. This section of CHE 111 met 4 days per week (4 total hours per week) within the normal semester, as compared to 3 hours per week for a traditional section of CHE 111. The extra time was used for reviewing difficult concepts, spreading out challenging assignments over multiple class periods, and for working troublesome problems in class. The assignments, exams, and expectations were identical to those for the traditional sections, however. Additionally, students were very strongly encouraged to make extensive use of office hours, which they did to a degree I have never before seen in my teaching career. Students were enthusiastically welcomed into my office anytime I was in my office without regard to whether it was during scheduled office hours.

"Enhancing" General Chemistry – Preemptive and targeted remediation via ALEKS

Online homework systems are ubiquitous in the world of chemical education, and have been for many years. Most online homework platforms consist of large libraries of homework problems with some

¹ The ACT College Readiness Standard score for Math is 22. This means that a student with this score would have a 50% likelihood of receiving a grade of B in an average College Algebra course. A score below 19 would require compulsory remedial classes at any public 2 or 4-year institution in the state of Tennessee. A score of 36 is the highest possible score and demonstrates that the student has an extremely high level of mathematics mastery compared to an average high school graduate.

accompanying tutorial or explanatory material to help students along. Instructors select and assign

— problems from the library for students to work on outside of class in order to reinforce in-class learning.

ALEKS is a relatively new commercially available online homework system, but is a very different type of platform. Students begin using it by taking an assessment that creates a virtual map of their specific knowledge on a huge number of topics. It then uses an intelligent system of interdependencies to recognize when an individual student has the necessary prerequisite knowledge to learn a particular new topic...and when they don't. It will require them to gain any prerequisite knowledge they lack by working problems (complete with detailed tutorial content) before it gives them problems related to the more advanced topic. It is also topic-driven rather than problem-driven. This means that an instructor selects topics that the students need to learn rather than just assigning individual problems. Additionally, ALEKS requires that students demonstrate mastery of the assigned topics by correctly answering several problems in succession on the same topic. A student's learning is reassessed periodically throughout the semester and any topics they haven't retained they must re-learn before continuing on. These attributes make ALEKS the perfect companion to the "enhanced" section.

Three weeks prior to the beginning of the semester students in the "enhanced" section were told that they needed to complete their initial ALEKS assessment, as well as a limited set of remedial-level topics, prior to arriving on campus. These topics consisted of very basic math skills including basic algebra, working with fractions and percentages, etc. Any of these topics that students already knew, as demonstrated in their initial assessment, they automatically got credit for. This allowed them to focus their time on any areas of deficiency they might have. In addition to the remedial aspect of this approach, I think the fact that the students are confronted at the very beginning of the semester with their need for extensive review helped them to understand the seriousness of the effort ahead of them. The terms "remediation" and "remedial" were not used, however, in any communication with the students.

"Enhancing" General Chemistry – Creating a team

Concentrating at-risk students into a section together might seem counter-productive, but I think it was actually a critically important component of this effort. The dynamics in the classroom were crucial. From the very beginning of the semester I clearly communicated to the students that all of our data suggested that this was probably going to be a very difficult course for them, but that I had created this particular section because I wanted to help them as much as I possibly could. That information, coupled with the fact that every student in the section knew that every other student in the section was also at-risk, created a powerful team dynamic. Students seemed to view me as an ally rather than an adversary, and they seemed to be much more willing to admit, to me and to the other students, when they were confused or struggling. I think the lack of stronger students in the section was extremely important in creating this dynamic.

In addition to the extra time in class and office hours mentioned previously I held impromptu group study sessions in the Logos on a number of evenings throughout the semester. These sessions were impromptu, frankly, because they were a spur-of-the-moment idea and I really didn't have any idea how much interest there would be. As it turns out, there was tremendous interest. Attendance at each of these sessions was more than 80% of the class. While these sessions were undoubtedly helpful educationally, they may have been just as important in terms of reinforcing to the students that I was willing to go out of my way to help.

Innovation

The concept of an "enhanced" section is extremely unorthodox in the field of chemical education. A very small number of institutions have tried something similar in mathematics classes, but the application to chemistry classes is extremely rare. In fact, I know of only one other institution that has tried something similar in chemistry. To my knowledge that work has neither been published nor presented publicly. As mentioned previously, this strategy is exactly the opposite of what most institutions try to achieve in terms

of the distribution of students in the chemistry classroom. When I presented this work in two different Chemical Education symposia at the recent National Meeting of the American Chemical Society attendees seemed to be simultaneously fascinated and horrified at the prospect of deliberately teaching an entire section full of students who were predicted to perform very poorly. I am gratified to say that there was a great deal of interest in this work within the symposia and several institutions are now considering implementing a similar program.

Results

From a statistical standpoint it is difficult to rigorously substantiate comparison claims between groups of students due to the limited number of students involved in the “enhanced” and traditional sections. All of the indicators, however, point in a very positive direction. The DFW rate² was 10 percentage points lower in the enhanced section than for a comparable³ group of students in traditional sections. Of the 17 students who started the semester in the enhanced section only two did not attend classes in the spring semester at Union. One of these stopped attending the enhanced section after only 6 weeks of the semester, and the other earned a C in the course but elected to transfer schools to be closer to home. So, retention of these at-risk students was excellent, and considerably better than what would be expected based on historical data. Lastly, the students in the enhanced section had a higher average score on the standardized final exam than the comparable group of students in traditional sections.

² The DFW rate is commonly used as a measure of student success. It is the total percentage of students who earned a D, an F, or withdrew from the course. In this case, a withdrawal has been defined as dropping the course and receiving a Drop designation on their transcript.

³ The comparable group consisted of 21 students who were eligible to participate in the enhanced section but elected not to. This is the best comparison group available, but equating the two groups is a bit suspect given that this comparison group actually had a higher average ACT Math score than the enhanced group by 1.6 points. This makes the results for the enhanced section even more encouraging.