

Training the Future Organic Chemistry Researcher

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The numbers of students in General Chemistry classrooms are at an all-time high at my institution and it appears as if this is the case across the country. The numbers are likewise up in my Organic Chemistry classrooms. But most of these people are not there because they want to be Organic Chemists. They are there because they need the class for professional school, or because the Biology department has told them to take the class, or they want to be biochemists. So how do I, as a teacher, get students to understand and, therefore, like Organic Chemistry? And how do I get them to want to become researchers? And ideally, organic chemistry researchers?

There are many pitfalls in getting the students engaged in the Organic Chemistry classroom. First I have to think about each student's attitude coming into the class. It is often perceived as the "weed out class", or a "requirement", or simply "the hardest class they will ever take". All of these attitudes do not help me reach the student and get him or her to love the material that I, as an instructor so dearly love. The next barrier that I know that I have is that my students think that the internet has all of the answers. This means that they have learned that the answer is always about content and not about understanding. This leads to the phrase I all too often hear from undergraduate organic chemistry students, "there is too much material to remember it all". Translation – "I cannot memorize all of this". Or maybe it is translated as "Why do I need to know all of this because it is all on Wikipedia", or "I'll Google it". The idea that the material can be memorized is the student's first mistake. I have seen many students with flash cards, like the ones that they used to memorize $7 \times 8 = 56$. This makes them think that each problem is unique, instead of looking for trends, similarities, and differences, which is one of the hallmarks of a good scientist. Thinking that all of the answers are on Wikipedia or that the student can simply Google the answer, devalues the entire educational process. I interpret this as the student is telling me that being in the classroom is a waste of time as they don't need to learn anything, especially Organic Chemistry.

How I had traditionally taught Organic Chemistry wasn't getting the students interested in become future researchers in the field either. The traditional textbook in Organic Chemistry doesn't seem to help today's students. Learning each functional group in the absence of other functional groups does not allow for the true complexity of the subject and feeds the idea that it can be memorized. Additionally, the traditional labs are more like cooking (i. e. following a recipe) than research and do not let the students truly connect to the topics in the way that they became attracted to science.

So how does one get the students excited about Organic Chemistry?

I have tried to do this, with more success, by changing how I teach the class and the lab. I haven't made the class easier, but I have restructured the course. I now introduce all of the functional groups early on and then approach the basic mechanisms (E1, E2, SN1, SN2, and additions) using examples from all of these types of molecules. My students would say that this is challenging, but they feel like they have learned more about how chemistry works. I have also changed my labs into mini-projects (a few weeks in length), which more reflect research. These labs also do not have definitive answers as there is the possibility for a wider variety of results than just one. There are certainly

advantages that I have on a logistical level that allows for this type of lab experience. I have smaller class sizes and a dedicated lab space. But I did have to change the way I graded. I could no longer grade on percent yields or purity of the product as those were more fluid within the experiment structure. What I could do was get the students to think about overcoming the difficulties that research possesses and to think like a researcher. I created poster sessions and invited the rest of the campus. This gave the students the feel of being a real scientist and reporting their work to the rest of the campus.

By no means is this a perfect system. I have seen a large increase in my students applying to graduate schools because they want to continue as researchers, but many of them still choose other fields other than Organic Chemistry.

What I do know is that with the change in technology, and the way that students gain information through that technology, I will need to continue to adjust how I teach Organic Chemistry if I want to train future researchers of Organic Chemistry.

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