Ignatian Values in a Chemistry Curriculum

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Introduction

The field of chemistry, like all sciences, is rapidly changing on many levels. New research is being published at an exponentially increasing rate, and the content of the textbooks changes so rapidly that there are significant changes each time a new edition comes out every couple of years. The labor market for chemists is also undergoing drastic changes. Some skills that did not exist a decade ago are now in high demand, while other major industries, such as the photographic film industry, have all but disappeared. All of this flux puts uncertainty into chemistry education.

Ignatian Pedogogy

The Ignatian approach to education provides excellent insight into resolving many of the pressing issues facing science educators today. The first key element to consider is context. A number of very important questions must be answered to understand the context of a chemistry education, including: "Who are the students?" , "Why are they learning chemistry?" , "How will learning chemistry lead them to meaningful lives of leadership and service?". Carefully consideration of these questions regarding my students has allowed me to continually re-evaluate the content and pedagogical strategies employed in my classes.

My students come from diverse backgrounds and are studying chemistry for a wide range of reasons. Some of them are studying specifically to become professional chemists, while a much larger percentage of them are interested in a field that is closely related to chemistry, such as medicine or pharmacy. There are other students that are planning careers outside of the sciences

entirely but are taking chemistry as a requirement or simply because of curiosity. Many of the students will never need to employ hands-on laboratory skills, while other students may work in a laboratory for their entire careers. The percentage of students in each of these categories varies depending on the nature of the course.

The second component of Ignatian pedagogy that I see as critical component of science education is experience. Much of the content of a chemistry course can be very abstract and may not be reinforced by observations made in everyday life. As a consequence, it is often difficult for students to understand how the different models, equations, and symbols that they learn about can be applied to explaining natural phenomena and solving real problems. While the acquisition of knowledge is important, there is much more to learning science than facts and concepts. As I outlined to my students this spring, as a direct result of the reflection stimulated by this Ignatian Mentoring Program, a combination of *knowing* and *doing* is required to be successful in chemistry. In some cases the experiential aspect of doing chemistry is reflected in a physical laboratory experiment, while in other cases it can be achieved through calculations or thought experiments.

The sheer volume of information that is expected to be learned in many science courses, especially introductory level courses, leads many students to see chemistry as a long list of items to memorize. The Ignatian pedagogical model recognizes that an essential element of true learning is reflection. By reflecting on the acquired knowledge, the student is able to connect concepts and ideas, and to ask questions that stimulate further acquisition of knowledge and reflection. There are many parallels between the Ignatian concept of reflection and the current academic buzzword critical thinking. It can often be difficult to integrate reflection into a chemistry class. Many students are only comfortable learning through rote memorization, and they find ways to avoid thinking by simply increasing the amount of material committed to memory. I continue to devise strategies that encourage

reflection by exposing the limitations of rote memorization and by connecting the material to concepts that students have experienced in other disciplines.

The Ignatian concept that action is a critical component of learning is readily apparent in chemistry, and is consistent with my belief that research is an important vehicle of pedagogy. My PhD advisor once told me that any knowledge that is obtained through research that is not published or disseminated in some way is wasted. What good is a critical insight or selection of data if it is buried in a laboratory notebook somewhere and it is not used for the good of society? This sentiment encourages me to incorporate new discovery into my research efforts, and to put powerful tools that can answer real questions in the hands of students whenever possible. To this end, I have increased the role of independent research in my instrumental methods class, Chem 341. As the capstone requirement of this course, students are required to address a public health problem by developing an analytical method that can be used to detect a specific contaminant. While the analytes of interest are all very well studied and the student research is not breaking new ground, the method development experience illustrates how the application of chemical principles and techniques that students learned in their lower level coursework can be applied to address real issues. Student projects have included such diverse topics as heavy metals in drinking water, artificial sweeteners in soda, and lead in soil.

Perhaps the hardest aspect of Ignatian pedagogy for me to grasp is evaluation. I feel that it is my duty as an academic is to evaluate students on their mastery of my particular discipline, yet I would also like to recognize that chemistry does not exist in a vacuum and the ability to relate chemistry to the rest of society is a critical component of being a leader and having a successful balanced career of service. After reflecting on this dilemma, I have come to the conclusion that the most important component of what I teach in a chemistry class is how to learn chemistry. By doing assignments, taking tests, writing lab reports, and using laboratory techniques, students are forced to exercise the mental agility associated with being a scientist. Although the content itself has value, the most critical tools that

the student develops in a chemistry course are the resourcefulness and discipline required to master the course objectives.

Conclusion

As I read various resources that explain the Ignatian approach to education, I was surprised and encouraged that I was able to recognize and appreciate many of the principles in my own Jesuit education. I have recognized that these principles are relevant both as a teacher and as a learner, and that reflecting on them can make me better at both. Perhaps the most important point that this program has reinforced in my consciousness is that teaching and learning cannot be addressed using a "one size fits all" approach. Learning is a nuanced process, so teaching strategies to encourage it must also be complex. The application of teaching techniques that are personalized to engage individual students in different ways are consistent with the teachings of Ignatius and with the mission of Xavier.