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SAINT IGNATIUS ON TEACHING MATHEMATICS

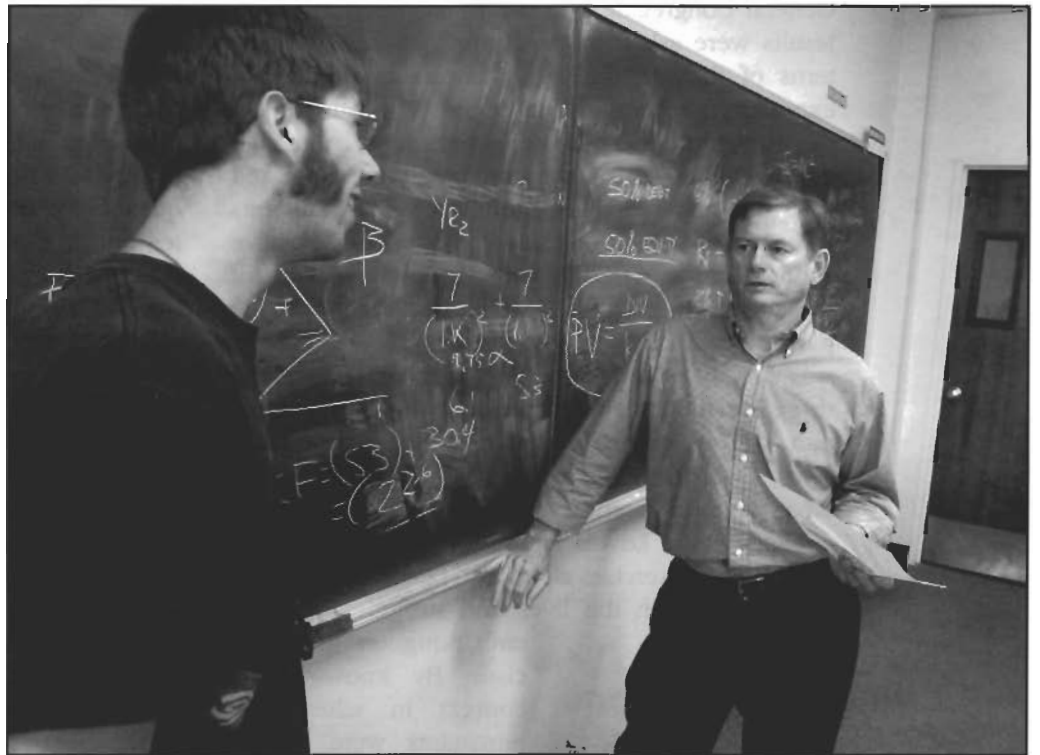
Making math human: first learn their names...

By Chris Petersen Black

Recently, Seattle University has been engaged in the process of creating a new mission statement to guide the university through the first ten years of the twenty-first century; what has been dubbed the “Decade of Distinction” in the University’s strategic plan. While the President of the University was grappling with the proper wording of this statement to convey the goals and values of the University, I was grappling with the issue of drawing the core ideas of the University’s mission into my classroom. At the undergraduate level, mathematics is a static discipline. It has no regard for the mission of the institution in which it is taught. This makes “teaching to the mission” in a mathematics department a real challenge. In recent years, there has been a significant shortage of Jesuits trained in mathematics. Although it appears that the Society of Jesus may not place a high priority on training Jesuit mathematicians, nevertheless nearly every American Jesuit college and university offers degrees in mathematics.

In practice, this means that the predominantly non-Jesuit faculty members of the various mathematics faculties are responsible for carrying Ignatian principles into the mathematics classroom. But, I was confused: How could I bring the university’s focus on social justice and education for values into a discipline as pure as mathematics?

My struggle to understand and implement the universi-



A Santa Clara professor discusses math with a student.

ty mission statement led me to enroll in the faculty seminar, “The Jesuit Imagination.” In this seminar, ten tenure-track faculty members in their early years of employment at Seattle University studied the early history of the Jesuit order, along with the rise, fall, and re-emergence of Jesuit educational institutions. We explored Jesuit philosophies of teaching, Jesuit teachings on the preferential option for the poor, and the implications of non-Jesuits teaching in Jesuit institutions, as well as a number of other related topics. As a non-

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Catholic, I found this seminar immensely helpful. After much reflection, I think I may have discovered how to teach mathematics in a way that fulfills the University's Jesuit mission while not compromising the course material and level of rigor.

The five principles we discussed of the Ignatian pedagogical paradigm are: context, experience, reflection, action, and evaluation. These principles were greatly inspired by the proceedings of the 33rd General Congregation of the Jesuit order, in which Jesuits were asked to transform their habitual patterns of thought through a constant interplay of experience, reflection and action. The purpose of this five-step educational paradigm is to counteract the inadequacies of the traditional lecture-based classroom experience and to challenge the students to become seekers of truth and agents of positive change in the world. I will discuss how each of these principles is addressed in my classroom in the paragraphs to follow. When I compiled this list, I was very surprised to see that, with one exception, these teaching methods were *already* an integral part of my classroom philosophy and practice. Thus, I was using Ignatian pedagogy before I knew what the term meant!

Ignatius of Loyola insisted that the directors of the Spiritual Exercises attempt to become as familiar as possible with the lives and struggles of those

embarking on the exercises. By knowing the context in which the retreatants were participating in the exercises, the directors could better guide the participant on the path to a life devoted to Christ. Similarly, I can better guide my students

to the less lofty goal of success in their mathematics courses by becoming familiar with the life-contexts in which they are taking my course.

The first small step is for me to learn the names of each student in the class, which I usually manage to do in the first week or two of the quarter. Next, I try to find out their majors and individual goals – why are they taking my course anyway, what do

they expect and what do they need to get from it? On the first day of class, I usually ask the students in each of my courses to fill out an information form. This provides me not only their standard contact information, but more important information as well, such as their majors, life goals, and any special circumstances that may affect their work.

The answers to this last question can provide me with great insight into the potential pitfalls a particular student may face during the quarter. Besides bringing to light the standard problem of juggling school and a part-time (or even full-time) job, I have also learned of family problems, threatening health problems, and looming births and deaths in the family. All of these issues can take their toll on the quality of work a student produces during the quarter, and it is my job to distinguish between failure due to circumstances and failure due to lack of trying. By taking the effort to know students as individuals, I am teaching them by example to care about the circumstances that affect others throughout their lives. As Ghandi said, "You must be the change you wish to see in the world."

Ignatius had a powerful imagination, and that is the key to his Spiritual Exercises. During the Exercises, he invited the retreatants to imagine the images before them so powerfully that they became part of the scene themselves; hence, they could see, touch, and smell the vivid scenes they had conjured. The purpose of this imagined experience is to heighten immediacy and intensify emotions. By experiencing the imagined scenes, the visions become more real. Similarly as well in the education process, learning needs to be more than purely cognitive. The emotional response to experience causes the material to be better internalized by the student.

But, for the majority of students, mathematics does not stir the emotions (at least not in a positive way). In many other disciplines, it is clear that the students could imagine experiences that cause emotional responses. One could argue that the traditional mathematics homework problems provide the "experience" that is so central to Ignatian pedagogy. However, I have found that the best method for using experience as a learning tool is to devote class time to working in groups on problems that are

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challenging but not out of reach for the average student. When a group works together to solve such a problem, the emotional responses of satisfaction and pride create a positive experience. In turn, this positive experience gives students confidence to try to solve problems on their own. This technique is particularly useful with those students I jokingly refer to as “math-phobic,” that is, students who have not had much success with mathematics in the past and who are thereby convinced that they “just can’t get it.” Devoting time during class to group work also advances the Ignatian principle that education supersedes distinctions of social class. Within a group, emphasis is directed towards working together in order to reach a common goal, rather than exploiting issues of class, race, or gender.

Another term for Ignatian pedagogy is “reflexive education,” which emphasizes the importance of reflection in the learning process. However, this is the only one of the five principles that I have not instinctively included in my courses. The most common method for incorporating reflection into courses is probably journaling, an exercise which I have

deliberately avoided based on my own prior experience as an undergraduate student. I attended a small liberal arts college and one of my mathematics professors instructed us to keep a journal of our thoughts, ideas and inspirations throughout an introductory course in linear algebra. This course is often the first in the mathematics curriculum in which some of the major ideas of mathematics are presented, many of which are very hard to grasp. I loved the material of the course, but looking back, I do not believe that the process of keeping a mathematical journal truly stimulated Ignatian reflection.

So, this leaves me searching for a way to encourage student reflection in my mathematics courses without using a journal. In looking for another method to encourage the students to really reflect on their work, I have decided to institute a

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Wheeling Jesuit University students.

policy in which the students are required to review their graded exams, get help on what went wrong and re-submit their corrections. Too often I have the feeling that when students receive graded exams, they look at the grade and then hastily stuff the paper away in a notebook or folder, where it will never again see the light of day. I have often assigned exam corrections as a method of obtaining extra credit (when the exam average was lower than I expected), but I envision this as a different process. I intend to give back the exams graded but not corrected, to only mark problems "right" or "wrong," and to have the students submit, not just their corrections to the exam, but an explanation of where their original work went wrong. In this way, students re-visit and correct their mistakes *themselves*, instead of learning to rely on me to tell them how to approach the problem by providing solutions or corrections. Additionally, it is up to each individual student to determine if he or she has made only a minor error or a major gaffe. Only after they have submitted their corrections will I completely grade the exam and assign a score.

In Ignatian pedagogy, action is the external manifestation of internal development. The goal of Ignatian pedagogy is to inspire students to act with the purpose of creating and protecting justice in the world. How can this possibly apply to the solitary and abstract endeavor of mathematics? Few students will leave a mathematics class feeling inspired to **change the world**. However, success in mathematics courses can provide students with the ability to **think more** clearly, **creatively**, and logically. Consequently, mathematics leaves my students better prepared to **provide strong**, valid arguments to support **their cause when they do** get inspired to go out and **change the world**.

Hence, **the manner in which we** interpret action in **the case of mathematics is different from how we** would assess a course in the humanities or social sciences. **The action that we want to develop through Ignatian pedagogy is the process** of clear and level-headed thinking. In mathematics, this action is measured through the demonstrated mastery of course materials that occurs during an exam. I have often thought of my position as analogous to that of a coach: **I can show the students how to do mathematics; I can drill them until they can't see straight, but it is up to them to perform once the starting gun is fired.** **The process of studying the course material, discern-**

ing what the important concepts are, and synthesizing the material, each help spur the internal growth that is demonstrated in the test-taking period. In this way, the individual exam-taking environment of the traditional mathematics classroom has a fundamental place in Ignatian pedagogy.

It is necessary to periodically measure the academic progress of students throughout the course. To accomplish this task, I use the standard performance-based measurements of homework, exam, and quiz scores. This type of measurement is included in evaluation, the fifth principle of Ignatian pedagogy, but it is not a good enough measure by itself. Ignatian educators are not only concerned with a student's academic progress, but also with the development of the whole person. Thus, there needs to be a way to measure the mathematical growth of the students. This is where the reflexive process of having students review their exams and explain their mistakes can serve a dual purpose. The awareness of the type of error the student has made and the level of severity of that error gives the evaluator a glimpse into the intellectual development of that student. As a result, there needs to be some flexibility in the final grading system in order to allow for recognition of the internal growth of each individual student, as well as mastery of the course material.

The opening line of the mission statement of Seattle University is as follows: "Seattle University is dedicated to educating the whole person, to professional formation, and to empowering leaders for a just and humane world." By using Ignatian pedagogy to further these goals, we as faculty need to remember that education often happens in a widening spiral, not merely a straight line. We must repeat these **five** steps cyclically throughout our courses. Intentionally, we want our students to internalize **the** cyclic process of education so that, when they graduate from Seattle University, they take with them the ability to apply these steps in their own lives, to keep learning, and to continually be inspired to change the world.