# Foreword

This volume owes its existence to the work of Robert Badger, Professor of Geology at SUNY Potsdam. As he describes in his introduction, after reading several deficient books on the art of teaching, Dr. Badger decided that his colleagues ought to be given a chance to write about what works—and what doesn't work—in college teaching. He knew from numerous conversations that faculty at SUNY Potsdam have thought long and deeply about how they teach, and he suspected that they might have as much to say about teaching as the experts. I think you will find that this volume demonstrates the accuracy of his surmise.

In the booklet that summarizes its policies on reappointment, promotion, and tenure, SUNY Potsdam declares that it "will consider effective teaching as the most important variable" in such deliberations. Members of our faculty actually follow this in their evaluations of their colleagues. It is taken for granted here that teaching is far and away our most important responsibility. And faculties teach a lot, with a teaching load of twelve hours each semester. It's not just that you have to like teaching to stay here very long. If you are to thrive here, teaching must engage you—you must be seriously interested in teaching well, in improving your pedagogy, in learning from mistakes. The people who wrote these essays are thus engaged: devoted to teaching as their primary responsibility, never quite satisfied with their efforts, endlessly fascinated by the ever-changing challenges that the classroom, laboratory, and studio present.

Another feature of SUNY Potsdam faculty that encourages discussions of pedagogy is their passion for interdisciplinary work. Each semester's offerings contain many learning communities of two to five courses with common enrollment, focused on a common theme. First-year students are unable to escape one or more Freshman Interest Groups, which are course clusters specifically designed to help beginning college students investigate an area of study. These cooperative

teaching activities put faculty of different disciplines in close contact with one another and compel discussions about how to present material so that it will be of most use to the interdisciplinary dialogue. The chapters in this book manifest the comprehensive view of the teaching enterprise that emerges from this kind of shared endeavor.

Our School of Education and Professional Studies has as a primary goal that its graduates shall be "reflective practitioners" as they practice the teaching profession. I think this is a worthy goal for teachers at all levels. May we learn to be reflective as we practice our craft, and may we turn that reflection to good effect in our conduct of our classes and laboratories and studios. The chapters in this book are evidence of pedagogic reflection by teachers at this college. We present them in the hope that they may be helpful, even inspirational, to all scholars who care deeply about their teaching, wherever they may be.

Galen K. Pletcher
Dean of Arts and Sciences
Professor of Philosophy

# Preface

## *Behind the Making of this Book*

The day that I conceived of this project, my environmental geology students and I met at a local cemetery to study the effects of acid rain on the different types of tombstones. As the students arrived, I handed out their assignments, carefully spelled out. Most students took the sheet of paper and began to read. One student, however, accepted the directions, thanked me, stuffed them into his backpack, then looked up and asked, in complete innocence, "What are we supposed to do here?"

The day before, my students in structural geology had an assignment due. This project involved the use of a microscope and, once I got them started, they needed no further instruction. We had started in class on Tuesday, but, when time ran out, I asked them to finish on their own and hand in the assignment at the beginning of Thursday's class. I emphasized *beginning* of class, Thursday *morning*, as the class meets again for a lab on Thursday afternoon. Some students had been less than diligent in meeting deadlines, so I looked several right in the eye and queried their listening capabilities. "Ryan, Thursday morning?" "Friday afternoon," he joked, "no problem." Turning to another student, "James? Thursday morning?" He nodded. "Michael?" "That soon?" was his reply. "Yes, Thursday, *morning*," was my emphatic response. Thursday morning rolled around, and only eight of the twelve had the assignment completed. Surprisingly, Ryan's was finished, but James skipped class, two others that I hadn't looked right in the eye were still incomplete, and Michael said, "Oh, I thought you meant Thursday afternoon for lab."

I'm sure something equally inane happened the day before, and several times the previous week, and the week before, and the week before that. Every contributor to this volume encounters the same frus-

trations, and I am certain that everyone reading these words can relate. Many days I leave school shaking my head, wondering what am I doing here, why am I teaching these . . . these . . . (several words come to mind).

A few years ago, I had a class at the Blue Mountain Lake Museum, an outdoor museum deep in the Adirondacks. The museum consists of over two dozen display buildings, each devoted to some aspect of life in the early days of civilization in the mountains—logging, mining, recreation, art, transportation, the great camps, and so on. At one point, a student reported that four other students had scaled the fence and left the compound. Hmmm. This wasn't a prison; it has a front entranceway and an exit—why scale the fence? When she told me which four, I was sure they had jumped ship to smoke a joint, and when I went to investigate, I found them climbing back in. "Why do I have to deal with this crap," I remembered thinking at the time. My role is not as prison guard, camp counselor, or even babysitter. I am supposed to be teaching college students, motivating them to learn, piquing their intellectual excitement. Three of those students dropped or flunked out of school before the end of the year. The fourth became an honors student and presidential scholar. When he graduated three years later, he sent me a card and a note thanking me for being a mentor and role model, saying, "You are part of who I am today."

Last year a graduating senior presented me with a small rock sample consisting of a clump of clear to milky quartz embedded with several dark green, inch-long bladed crystals of the mineral arfvedsonite. We had briefly encountered this mineral during laboratory in a senior-level geology class. One of the goals of the course is for students to make connections between what they see microscopically and megascopically in a rock hand sample. Arfvedsonite is quite rare, and our department's mineral collection, though very good, did not include a sample. So when the student spotted a sample at a gem and mineral show, he bought it, and at the end of the year presented it to me with a note thanking me for an excellent course.

Not long ago I received the following email from a recent graduate:

> Dr. Badger,
> I want to thank you and the rest of the geology staff for having an excellent geology program. The quality of the program and the teaching methods used were top-notch. . . . I have recently accepted a position with Scientific Laboratories Inc. as a polarized light microscopist. . . . I don't think I would have landed this position if it weren't for Optics and Mineralogy. Once again, thank you for a great education.

These students provide the impetus for why I teach: the ones who jump the fence, but come back; the ones who make connections; the ones who get motivated and somehow make us feel that we were part of that motivation. Was it something I did? Something I said? How did I connect to one student, but not to another in the same class? Why was my colleague in anthropology successful at motivating a particular student while I was not? What did she do that worked? To that end, I hope that this book will contain some ideas that others can use or adapt to their own teaching situations to help students learn, to motivate them, or to help some of them back over the fence.

Our last provost started an informal book discussion series, which our current provost recognized as a good idea and continued.* It involved reading one book each semester, purely voluntary. We read, or (perhaps emulating our students) skim through, then meet on a Friday afternoon with a few bottles of wine. Usually we begin with a panel discussion, followed by a general discussion. The books always focus on education methods, reform, philosophy, or some such topic, and are the provost's gentle and subtle (yet effective) way of encouraging us to keep looking for new ways to teach, for new ideas to bring to the classroom. Each semester's panel consists of a group of faculty selected by the provost from diverse fields in our institution. For one semester the panel consisted of members of the psychology, education, and communication departments. For another, a sociologist teamed with a geologist, historian, and musician; another panel consisted of a physicist with an anthropologist, photographer, and English professor. Generally, we have no big egos (little ones, perhaps); we have mutual respect for our colleagues' disciplines and are wholly supportive of one another in our teaching endeavors. So these interdisciplinary panels work well, particularly if the wine is flowing freely.

Although there have been one or two mildly heated arguments, and perhaps a few blood pressures raised, no blood has been shed, no noses broken, and as far as I know, no egos bruised. We have read some thought-provoking books: *Consilience* by Edward O. Wilson; *How Nature Works* by Per Bak; *Punished by Rewards* by Alfie Kohn; *Rethinking Liberal Education*, edited by Farnham and Yarmolinsky. These have led to good discussions, and most of us have come away with something tangible and a feeling that the afternoon was time well spent.

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*I should note that Provost Peter Brouwer, who initiated the series, has returned to our academic ranks and contributed chapter 5.

However, we have been less than enamored with a couple of books. One was branded as pure psychobabble by a science faculty member, whose comments were preceded by a sociologist who admitted to being thoroughly embarrassed to find the author of such diatribe was also a sociologist. Most of us rather enjoyed lambasting it, and came away feeling that, too, was a worthwhile endeavor.

Another book prompted a member of our Politics Department to write a three page document that he read to the audience, expressing his anger and indignation toward a writer who to him seemed like a spoiled, whining brat. We almost unanimously concurred. The author droned on and on, complaining about her students, who were from some of the finest Division I colleges in the country. As our discussion wound down, the moderator asked if there was anyone who had not yet spoken who would like to get in a word. That was my cue. I strolled to the front of the room, delivered my own editorial comment that far too many trees had been sacrificed to print such drivel, and voiced the opinion that we could do better.

The attendant faculty group represented most of the seventeen departments in our school of Arts and Sciences, plus members from our School of Education and the Crane School of Music. Indeed, before me was a fine cross section of the university faculty, and, just by their presence, all were interested in teaching and learning. Many, I knew, did interesting things in their classrooms from which we all could learn. "John, you teach a really unique course in politics. Can you write about it? Kim, I know you do wonderful things in Drama to motivate your students. Caroline, I've been in your art classes and seen how you can get the artistically challenged to draw. David, students rave about your Philosophy classes; you must do something right."

I received several nods, and mumbles of approval. I continued rambling, "Our students aren't born with a silver spoon in their mouths and sent off to the elite colleges of the country. We're not Division I; we're Division III." At which point I heard a "Hear, Hear" from a politics professor in the front row. Many of our students are the first generation of their family to attend college. Their parents are farmers, truck drivers, mechanics, construction workers. Some students have no parental support to attend college, and 80 percent receive financial aid. But if our van breaks down while on a class field trip, they don't pull out their AAA card and cell phone; they pop the hood open and try to figure out what's wrong. If a piece of lab equipment breaks down and a replacement part is available, they will retrieve their toolbox and do the job themselves, instead of complaining that the equipment is broken. These are generally really good kids but, for most of them, education

has been neither a top personal nor a family priority, and therein lies our challenge.

We're starting with pretty raw material. For those who really are freshmen, just out of high school, they are also freshmen in life. Their only travel out of state may have been a family vacation when they were in grade school, or trips to visit a relative in a nearby state. Work experience has been on the family farm, at a fast food restaurant, at a meatpacking plant, or doing odd jobs around the community. A fair number are older students. Some failed miserably when they first attended college at age eighteen, but now, five or ten years later, are ready to try again, this time better prepared psychologically. Some were in the military. Some have small children, and when the local schools are closed for a snow day, our classrooms sometimes resemble daycare centers. This is the typical clientele for many state schools—good kids, fine people, but often ill-prepared for immersion into academia.

So I put forth the challenge to my fellow faculty: Let's write about our own experiences, our many perspectives for the same target group of students. This is not the norm for this type of book. More commonly, contributors to edited collections of educational works are from a wide range of institutions with disparate student populations. Many are universities with extensive graduate programs. Often the authors are administrators, education specialists, and researchers. Our goal was different. As members of the faculty of the same college, the State University of New York College at Potsdam, we have the same pool of students. Our intent was to show how professors of psychology, biology, teacher education, and all the others approach this group from within our respective disciplines.

Several faculty accepted the challenge immediately and enthusiastically. I did a little arm-twisting and others slowly came on board, until we eventually had twenty who gave me a definite "maybe." Of these, finished chapters were received from fifteen, representing thirteen different disciplines of study: art, biology, computer science, education, geology, history, math, modern languages, philosophy, physics, politics, psychology, and sociology. These fifteen chapters offer ideas and philosophies that we have found successful. The basic theme is to try whatever works. Nothing works for all students; nearly everything works for at least a few. Our goal is to maximize our efforts. To that end, all of these stories and ideas are really not discipline specific. A concept that works in physics perhaps can be modified to work in philosophy; a teaching method used in history may be transferable to math.

In our case, service learning, a concept well explained by sociology professor Heather Sullivan-Catlin in chapter 2, is relevant to any disci-

pline. In chapter 12, physics professor Larry Brehm suggests passing out office coupons that the student must redeem within a set time period by visiting the professor in his or her office. This idea can be used in any discipline to forge better student/teacher relationships. Professor Brehm also suggests not creating homework problems until after class ends, thereby allowing for the design of problems that pertain directly to what was done in class, and then sending the homework to students by email or Blackboard posting. Why didn't I think of this? Too many times in my teaching career I have designed a homework assignment, only to have to modify my directions when handing it out: "Only do problems one and two. You'll have to wait until next class to learn how to do three and four."

I hope you enjoy these chapters and perhaps come away with some useful new idea or concept. Some chapters are lighthearted, written in an informal style with ideas based on anecdotal evidence; others are written in a more formal research article mode. I set no prepublication format. Even if I had, my colleagues probably would have ignored me. If one style bothers you, or you find the subject matter not particularly relevant to your discipline, skip it and move on to the next. There is no direct connection between the chapters, and there is no rhyme or reason to their sequencing. I briefly struggled to impose some sequence that made sense. Finding none, I just pulled them out of my "Ed Book Final" folder in whatever order the computer had haphazardly arranged them. My only tweaking was to separate computer science from math, and to pair the two (art and geology) that referred to our Adirondack Studies Program.

My undergraduate mentor, Brew Baldwin at Middlebury College, had an office door plastered with cartoons and quotes. One of my favorites was labeled "The Gerber Model of Education: One way to feed strained food to a baby is to use a baby spoon and get 'the airplane to go into the hangar.' This is very neat and precise. The other way is to use a butter knife to move the food from one cheek to the other; in each pass, some food gets into the mouth." We don't want to spoon-feed our students, so I guess we are all using butter knives. These pages discuss our attempts to teach our students to lick their lips.

Robert Badger

# 1

# There Is No Such Thing as a Dumb Student, But How Can I Help Them Do Better?

*Joel Foisy*
Mathematics Department

I try to take an honest look at my own development as a teacher, and how my experience working with students at SUNY Potsdam has shaped that development. Starting with the premise that I want students to learn some mathematics, to improve their logical thinking and communication skills, and enjoy the process, I explore how this can best be achieved. Getting students to see ideas in a variety of ways, to reflect on concepts, to explain concepts to their peers orally and to me in writing is the best way to achieve this goal, though different classes and different students respond to a variety of techniques. In mathematics, students also need encouragement and motivation to stick with a technically and creatively demanding subject.

One of my all-time favorite lessons involves showing that the "dual" of a cube is an octahedron. To get the dual of a solid, you place a vertex in each face of the solid, and connect vertices of adjacent faces with an edge. Got it? To illustrate this, I brought in some tape and string. The cube in question was our classroom. One of our taller students volunteered to place a vertex in the center of each wall (tape the string down). As a result, we had a room-sized cube with a room-sized octahedron made out of string (the octahedron has six corners, twelve edges, and eight faces). On their way out of the classroom, students had

to be careful not to get caught in the web of this octahedron. During the next class my tall volunteer could not recall what the dual of the cube is. I felt discouraged. Wasn't this a great lesson plan? Then a few months later, at graduation, I ran into another student from this same course. She excitedly told me that she had used this same lesson in her elementary school student teaching, with great success. This experience has led to perhaps my biggest teaching lesson: what we do in the same class can be soon forgotten by one student, yet have a profound impact on another. To ensure that we reach the largest possible cross section of learners, we must use a variety of classroom approaches. We must somehow let students know their learning and development are important to us, we must motivate them to want to learn, and we must review important themes.

## Context For Success: Showing Students You Care About Their Learning

My father taught mathematics at SUNY Potsdam (it was called Potsdam State in those days) while I was growing up. By nearly all accounts, he was an amazingly successful teacher. From what I can remember about his dinner table conversations concerning work, one consistent theme emerged. He loved talking about students—where they were from, what they were going into, how he had taught so-and-so's parents, how they had done well, and so on. Recently, a graduate from the late sixties came to campus to give a talk. My father could recall the names of more of the alumnus's friends than the alum could. Although learning mathematics was the basis of his interactions with students, and my father did like the subject he taught, he clearly cared about his students much more than the mathematics itself.

I have appreciated the supportive environment I have had since joining the faculty at Potsdam; my department has shown confidence in me, which has helped me grow professionally. Similarly, teachers need to show confidence in our students, so that they may grow academically and as people. When students are struggling with math problems, we need to listen to their approach (and possibly encourage them to develop an approach, even if that approach is not directly leading them to a correct answer), then help guide them toward their own understanding of the material, getting in the way as little as possible.

In college, I became a mathematics major partly because the only courses I got A's in were math courses, partly because there were many excellent professors in the math department, and partly because the

math department at my school offered a free meal to any student who declared a major in mathematics. I cannot underestimate the importance of that meal. As a student, it was so nice to have a department make a gesture of appreciation (economics and political science made no such gesture—they had enough majors already and did not need to recruit). As a teacher, I take away from this experience one key concept: students love food. For the past two springs, I have held a dinner at my house for math majors. About twenty-five students show up every year, along with a good number of faculty, and it has been a great time. My department also recognizes outstanding students by inducting them into an honor society and offering summer research opportunities. Showing respect and kindness can go a long way in motivating students.

## How Testing and Assessment Can Help Students

I also believe that it is important to be tough. I can summarize my philosophy: keep standards high, but be flexible. At SUNY Potsdam, some of our students are not confident and resilient enough to accept the challenge of a bluntly demanding teacher. When I was a first year student, I remember getting a terrible grade on a certain assignment. This only prompted me to work even harder (and I was already putting forth a substantial effort). I talked about this sort of policy—grading hard on the first paper—with my colleague Blair Madore. He responded that such a policy may work well at a highly selective school where the students are more eager to be challenged, but he was not sure how successful it would be at Potsdam. He suggested grading gently at first and then gradually easing into a more demanding fashion. This keeps the students engaged without demeaning them, and is ultimately demanding. In practice, I must admit that I have found it difficult to make the transition into stricter grading.

It has been the philosophy of the mathematics department that helping students understand concepts in depth is more important for student intellectual development than "covering" a lot of material. Helping them learn how to think logically and develop intellectually is paramount. To keep the students engaged, we need to offer tasks that are challenging, but ones they can do. This means giving them challenging tests, but not so difficult that they are thrown into a panic or feel demeaned. Writing a good test requires walking a fine line. If you consider that there are usually about thirty students in the class, this makes constructing a good test even more difficult. Ideally, we as teachers

must strike a balance between creating a comfortable and welcoming environment in the classroom, while being cognizant of the reality that learning is difficult and that students sometimes need to be prodded to put forth the effort they need to master the subject material.

## Day-to-Day in the Classroom

I believe that lecturing can be an effective way to teach, especially if it is done in an interactive manner. I also believe, however, that following the same routine every day can make students feel too comfortable and unmotivated. I thus try to assign a nonlecture-focused project at least every couple of weeks, especially in calculus. Though there are an abundance of projects commercially available, very few appeal to me as appropriate; most are either too boring or too impossible. In particular, projects that have students work on real-world application problems can get quite messy. They are of limited direct benefit because, frankly, most students will not do applied mathematics for a living. In life after school, most students will need to be able to think logically to help a business or to write a computer program, and such logic can be best learned through the study of pure mathematics. In keeping with my department's philosophy, an ideal project does not make students feel overwhelmed, yet it stretches their thinking and forces them to work together to succeed.

Writing an appropriate level project is time consuming and requires creativity; however, there are a few that I like. Every differential equations book discusses Newton's Law of Cooling—a way to estimate how long a body has been cooling based on a couple of temperature readings at different times. A popular application of this is to figure out when a person died. I have had students work on a mock trial that uses Newton's Law of Cooling as the main evidence. A student is accused of murdering his or her professor from the previous semester. Students must then form defense, prosecution, and media teams. The students have to present mathematical arguments in court to either establish or throw in doubt the time of death. The last time I did this activity, George Kahn, our local audiovisual expert, filmed the mock trial. George was a great asset to the project. He provided pretrial music (Bach's Toccata and Fugue), and borrowed a graduation robe for me so that I could look like a proper judge. I invited some high-level administrators to the case, and instructed the students to take their job seriously. Most of the presentations went smoothly, although one student made a mathematical mistake that the provost

noticed. Of course, we discussed the student's mistake during the next class, and I'm sure that the experience of participating in the trial heightened the student's interest in understanding the mistake. This was an event I will never forget.

I should point out that as a result of the mock trial project, we ended up spending a couple of extra class days on Newton's Law of Cooling (and, to be honest, it is not the most difficult topic in the course). Thus, for reasons of time, I am only able to do one such project per semester. I believe that good projects can add a lot to the students' classroom experience, but these projects are difficult to find, and they are time consuming.

## Interacting with Students

My father has taught me that the preparation you do outside of class is not nearly as important as how you interact with students in the classroom. One of his primary vehicles for interaction was using 3 x 5 index cards. Each card included an individual student's name and some information about the student. He used to shuffle the cards, fire questions to his class, and randomly call on students to answer them. This does keep students alert. He would lecture very little, perhaps the last fifteen minutes of class. More than one alumnus has told me that my father could sniff out whether they had done their homework, and that he could make them want to complete their homework for the next class. I have heard from his colleagues that students would not like my father's courses for the first half of the semester or so, but were won over by the end. He was tough on them, but at the same time obviously cared about them and their learning of the subject.

I have used the random card technique with some success. On the end-of-semester evaluations, many students have said that it keeps them on their toes, and very few have complained about feeling put out by having to speak out in class. By calling on everyone, students tend to feel more comfortable speaking up when it is their turn. I did have one faculty observer say that he believed such a random calling system was bound to make some introverted students feel uncomfortable. In retrospect, there was always a student or two in every class whom I would not call on even if their card came up (or, more precisely, I would only call on them once). I still use 3 x 5 cards, but have also tried other techniques, like having students explain a concept to their neighbor (and thus the shy ones need not speak out in front of the entire class). Generally, this technique is effective, but it does not

always work perfectly. Sometimes the class is reduced to silence. When this happens, I momentarily leave the room and instruct the students to talk to each other; this usually works. Or I tell them that if the silence continues, I will call on one of them to explain what is going on to the rest of the class. Another technique is simply to have students write down their explanation to a given question.

When a student asks a question, I often do not answer it directly myself; instead I give the rest of the students in the class the chance to answer. That way the students feel ownership of the course. I also try not to repeat what a student says verbatim, although I may try to paraphrase what they say. This allows the students to feel they have a voice in the class. It is not always best for our students to give an immediate answer to their question. Usually, they need time to figure things out for themselves. On the flip side, sometimes we can be too evasive in answering their questions, creating excessive frustration and loss of confidence on their part. Finding a balance is not easy, and depends on the particular student in question.

I enjoy having students work on homework problems at the board. Doing so gives me immediate feedback as to how they are progressing and forces a good portion of the students to explain their work and assume an active role in the classroom. Having said this, sending students to the board can create difficulties because they always take up more time working on problems than I anticipate. Consequently, I currently do not send students to the board more frequently than once a week.

Often while students are working on a project, I will interrupt their group work and talk at the blackboard for five minutes about a question that has come up for several groups. At these times, the students are primed to pay attention and digest what I say. Similarly, when I am "lecturing," I will frequently interrupt the class to have them work on a question (the lecture is interrupted by a project). In addition, I often stop the class and say that we will not progress until someone asks a question. An uncomfortable pause usually ensues, but then inevitably someone will speak up. I always try to circulate in the classroom, getting in the students' space. I believe this makes me seem more accessible, and it makes the class just a little more exciting (especially after I trip over a desk trying to walk between rows).

I do not believe that students have to reconstruct mathematics for them to understand it, although I would not rule this out as a good way to learn. I do believe that they have to internalize the material at hand; they must make it their own. To do so, they need to work on the material, and they need to be able to talk through the course content (which is a theme in *Thinking About Teaching and Learning* by Robert

Leamnson). Our interactions with students must force them to explain the material in class, ask questions, and motivate them to work on the material outside of class.

## Quick Activities

There is an abundance of quick activities and demonstrations one can do to make students more interested, and I am always on the lookout for such activities. Jokes are a classic way to get students to pay more attention. In third semester calculus, I always ask the students what results from crossing a dog with a cat. The answer, of course, is (dog)(cat)(sin theta)($n$). The next question is what results from crossing a dog with a goat. The answer is that you cannot cross a dog and a goat because the goat is a scalar. The students groan at these, but they appreciate the effort, and maybe, just maybe, it will help them remember the definition of the cross product of two vectors. (If anyone knows any good math jokes, please email me.)

When I discuss angles and angle measure in the beginning of calculus, I review it with the students by having them stand up and make the angles with their own arms. This does not take very long, and it is my hope that it helps some of the more kinesthetic students remember what an angle measuring pi radians looks like in standard position. I also get immediate visual feedback as to how well the students understand angles.

By definition, quick activities are quick; they are ad hoc. I try to use them whenever possible. Anything that breaks the routine and either gets the students' attention or forces them to think about the subject is useful.

## Cross-Curricular Connections

Cross-curricular connections are always effective, and do not necessarily require much effort. In calculus, connections to physics are easily made. When we discuss modeling the height of a dropping ball, we use a CBL (calculus based laboratory) system that will plot the height of an actual dropped ball over time. It does not take very long to drop the ball and it shows some practical minded students that the functions we are studying do relate to physical reality. In third-semester calculus, much of the end of the semester is difficult for students, particularly Green's theorem. I have taught this course often and only this past time did I make a conscious effort to point out that what we do is directly

related to physics and electrostatics. I must confess that I did not mention physics connections because I was not comfortable with the physics since I had never taken a college-level course in it. This past year, I asked one of my colleagues from the physics department for a spare physics book and quickly read it. At the end of the semester, students commented on their evaluation forms on how much they appreciated how the course related to physics.

I have had the privilege of teaching a math for liberal arts students course. In such a course, there are ample opportunities for discussing how math relates to other topics. I used the book *The Heart of Mathematics* by Burger and Starbird, which discusses many connections to art, music, and science. We did classic activities, like measure angles of triangles on a globe, construct Mobius strips, and then cut them up. We discussed the golden ratio and how composer Claude Debussy used it in his musical work "Prelude to the Afternoon of a Faun," and even listened to the piece in class for a couple of minutes. Several music majors in the class appreciated this activity, and it was simple and quick. When we studied fractals, I brought in my Oliver Schroer avant-garde CD of "fractal reels." His music was inspired by geometric fractals. I wish every mathematical topic had such great musical accompaniment. It is not always easy to make connections to other disciplines, but it is well worth the effort.

## Summary

My main goal is getting students to think for themselves, while learning the subject matter at hand. There is no one way to achieve this; any given class is really many different classes—one for each student involved. Even what we think are excellent classroom activities will not have a serious impact on all the students in the class. This is why I try to vary my technique, and also to respond to the individual class, and the individuals in the class, as much as possible. I hope that after a semester with me, students become more enthusiastic for the subject, remember some of the important themes of the course, and want to learn more.

## References

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