The Potsdam Miracle: Lessons in Revolutionizing Undergraduate Mathematics

Rafe Kinsey

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A few days ago, while browsing in the library, I stumbled across something pretty remarkable. John Poland, writing in 1987 about this “Modern Fairy Tale”, describes the scene:

Far away from the hustle and bustle, tucked away in a rural corner of North America lies a phenomenally successful undergraduate mathematics program. Don’t imagine some tiny private institute devoting its funds and attention to mathematics. Just picture a typical, publicly-funded, Arts and Science undergraduate institute of about 5000 students, with separate Departments of Mathematics and Computer Science. But while the total number of undergraduates has remained relatively fixed over the past 15 years, the number of mathematics majors here has doubled and doubled again, and again to over 400 now in third and fourth year. They don’t offer a special curriculum: no mathematics for computer science, no visits by industry to applied mathematics seminars. This institution is seemingly unaware of the success of its mathematics department and there are no special favours granted. [...] It is just a standard, traditional pure mathematics department.

Nevertheless, more than half the freshman class elect calculus, because of the reputation of the mathematics department carried back to local high schools by satisfied mathematics students. And of the less than 1000 Bachelor degrees awarded, now almost 200 of these 1000 (20%) are in mathematics. In case you are unaware, 1% of Bachelor degrees granted in North America are in mathematics.

1I feel an obligation, lest any administrators or librarians read this, to note the importance of serendipitous library browsing. I wouldn’t have discovered this if I wasn’t browsing the physical stacks, opening up books that caught my eye. I’m not saying this as a Luddite; I happily acknowledge that technology has done so many wonderful things for libraries and research. But there are many situations where the system in place works far better than new technologies. To get rid of the physical book—at least until both the technology and the digital infrastructure for managing information vastly improves—is to extirpate the library. (Even after that, it would still be an aesthetic and moral disaster—why can’t we preserve libraries the way we preserve museums? But that’s, alas, a far harder argument to win, so we must argue on the battlefield of reason, having lost the war for the soul.) More thoughts on libraries to come in future entries, I’m sure. If there’s anyone reading with influence over the libraries at either Michigan or Stanford, I have some {passionately and eloquently argued, rant-y} (depending on your perspective) emails about grievous wrongs at both libraries, which I’d be glad to forward.
Indeed, by the late 1980s, small Potsdam College, a former teachers college with no history of success in mathematics for most of its history, was producing more undergraduate math majors than anywhere in the country bar two of the UCs. It did this despite a student body with no particular interest in or aptitude for math. And it did this in a way that overcame the serious problem of underrepresentation of women in math; more than half of the math majors—and half of those who went on to get Ph.D.s—were women.

How did it do this? The answer has to do with the wisdom, courage, love, energy, and dedication of one remarkable man, Clarence F. Stephens. I spent Sunday evening reading about Stephens and his work, which needs to be shared more widely, so I thought I’d take the time to write about his approach to math education.2

I won’t dwell at length on his biography,3 but I should begin by giving a basic outline. Clarence Stephens was born in the Jim Crow South and orphaned at an early age, but he overcame these barriers to pursue an education, ultimately becoming one of the first African Americans to earn a Ph.D. in math, at the University of Michigan. (His thesis was in PDE; I’m glad to join such an illustrious tradition!) As a young man, he became chair of the math department at Morgan State in Baltimore and quickly transformed the department. (Wikipedia suggests, not unreasonably, that it be called the “Morgan-Potsdam Miracle”.) Seeking a more rural lifestyle, he moved to SUNY Geneseo before being recruited to Potsdam in 1969, where he worked until his retirement in 1987.

The fundamental philosophy underlying the Potsdam program was Stephens’s belief that all college students who wanted to learn math were capable of doing so. The Potsdam Miracle flowed naturally out of this belief. The department’s pamphlet explains the basic approach:

The major program in mathematics is based on the premise that the study of pure mathematics can be undertaken successfully by a large number of students if they are provided with a supportive environment including: careful and considerate teaching by a well-trained and dedicated faculty, continual encouragement, successful (student) role models, enough success to develop self-esteem, enough time to develop intellectually, recognition of their achievement, and the belief that the study is a worthwhile endeavor.

What I’ll do here is discuss a few of these and other ingredients, first in the context of how they worked at Potsdam, and then how these ideas can be carried out beyond Potsdam, including in the elite research university. (In the back of my mind is the question of how these issues apply to the course I’m teaching in the fall; I’ll discuss this briefly in the conclusion.)

I should begin, though, by noting two things about what Potsdam did that aren’t unusual. First, the success at Potsdam wasn’t due to any unique teaching style; the Potsdam professors used a variety of methods. Second, the success wasn’t because of any unusual curricular choices. Potsdam offered a traditional curriculum: calculus, linear algebra, logic and set theory, modern algebra, etc.4

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2I’ve relied primarily on Dilip K. Datta’s 1993 book Math Education at Its Best: The Potsdam Model, which features extensive interviews of Stephens and others and quotations from Potsdam’s materials. All quotations and page numbers above, except where otherwise noted, are from this work, which seems to be the best resource available. If you can get a copy—it’s out of print but there are used copies on Amazon and it’s probably available in most university libraries—skim around to get the best parts. Particularly valuable is chapter 7, which is mostly in Stephens’s words. Other sources include Poland’s article, a citation for an award to Stephens by Robert Megginson, an article by Armond Spencer about Potsdam’s program, and a discussion in chapter 8 of Reuben Hersh’s Loving + Hating Mathematics. I wasn’t able to access this article in Math Horizons by Reuben Hersh about the program, nor the interview of Clarence Stephens by Gloria F. Gilmer and Scott W. Williams in the now-defunct publication UME Trends (March 1990, Volume 2, No. 1), from which much of the material in chapter 7 of Datta was apparently taken. If anyone has access to those, please do send them!3

3In addition to the sources mentioned in the previous footnote, see this biography from MAA and the biography on Scott Williams’s Mathematicians of the African Diaspora site.

4This stands in partial contrast to my ideas about pure math. I think that if we’re going to introduce pure math to students (which we should do), it’s best to do it in a completely completely unfamiliar domain: logic/set theory, discrete math, number theory, or algebra, rather than the pre-calculus and calculus they’re used to doing tedious calculations in. Then, later on, once students have developed mathematical maturity and an understanding of proof, they can learn analysis at a more sophisticated level. I’m not saying that you can’t just start with honors calculus, just that I think it’s much easier to make a sharp break from the material students have seen in high school. None of that is inconsistent with the philosophy of Potsdam’s program. Indeed, at some point in Datta’s book Stephens discusses a case where he introduces a student to modern algebra, since it has no prerequisites.
Believing in Students: High Expectations

Above all, the Potsdam model depended on the belief that all (or almost all) students were capable of doing college-level math. Note that this belief is partially self-fulfilling—if you believe in students, and if you create a supportive environment, they can indeed succeed.

One important aspect of this was a de-emphasis on placement tests or SAT scores, which seem to cut off the possibilities and deny students their potential. Stephens tells numerous stories (I’m imagining him doing so with an almost impish glee, though this might just be me projecting) of students with literally no high school math whom he tutored and advised to take, say, calculus courses—and instructed only to tell their professors of their non-existent backgrounds after the semester was over. Of course, that wouldn’t work without the right environment in those calculus classes, but it does say something important about human potential.

The lack of placement tests and the belief in the capability of all students in no way held back the most talented students. On the contrary, students who showed special aptitude were pushed to take more advanced courses (including graduate courses that Stephens initiated) and do independent work. Furthermore, the more advanced students were integrated into the education of the other students, tutoring students both formally and informally.

Nor did Potsdam succeed by lowering academic standards. Yes, professors were happy to adjust the pace of the course, and weren’t wedded to finishing a specific syllabus. But what matters in undergraduate math education is not content but rather developing that mystical quantity, mathematical maturity. The sense I got was that Potsdam instructors kept standards high where others fail by insisting that students really understand the material and master the methodology—i.e., proofs, abstraction—of pure math. What good, after all, is an algebra class that blazes through to get to the Sylow theorems when students don’t even understand normal subgroups, and are barely scraping along? To give a more elementary example, from my own experience: at Michigan, we cover a full calculus syllabus, and ensure that students can, say, calculate a Taylor series at the end of Calculus II, but many of those students still won’t understand the concept of what a counterexample is.

As I read this discussion, I was reminded of Claude Steele’s work on stereotype threats. Self-confidence plays a really crucial role in mathematical performance. My own experience (as a non-stigmatized half-Jewish-American white male raised in a highly educated family) bears this out; in spite of going to an excellent high school, I felt incredibly insecure when I shopped the competitive honors math course at Stanford, but I succeeded—and did better than those original honors students—when I took a path via more welcoming introductions to math. It’s no surprise that Stephens’s approach eliminated the gender disparity at Potsdam, and that earlier at the historically black Morgan State he mentored many of the first African Americans to receive Ph.D.s in math.

5 A notable exception to the “traditional” curriculum is the course on logic and set theory—especially the fact that students take this course very early. This course, I would argue, accomplishes the goal I listed above, of teaching students pure math in a unfamiliar domain.

6 Datta cites a student doing independent reading in Royden’s Real Analysis, a serious graduate text.

7 A worthwhile quote from Stephens about this: “Excessive concern for academic standards may be observed in faculty members who believe that a high level of achievement by most members of the class implies a lowering of academic standards. Such concern may also reflect a general lack of faith in the intellectual potential of students in their classes.” (Datta, p. 80)

8 There are really two things going on here. One is the question of students getting by without fully understanding basic concepts; that’s what I was talking about in my algebra example. Even more fundamental is students who get by without understanding the conceptual framework of mathematical thinking; that’s what I was getting at in my calculus example.

8 Steele outlined this issue in the August 1999 Atlantic article I linked above, which he later expanded into the book Whistling Vivaldi. The Atlantic article, which I think I’ll assign to my students, is more than enough to get the fundamental ideas; the book didn’t seem to add that much more in terms of content. (And yet, it was valuable for me to read the book, even if it seemed to be saying the same thing. Why? There’s something important about letting an idea simmer in one’s mind. I didn’t get any new content during the evening I spent reading the book that I hadn’t gotten in the fifteen minutes it took me to read the article. But those hours provided me with a lot of time to let these ideas sink in, and this was crucial. This is an interesting phenomenon which can occur in literature, as well.)
Teaching Humanely

Concomitant with believing in students was creating a comfortable, supportive environment. As I read about Stephens and the other Potsdam professors’ teaching, I was struck by the sense of love and kindness they had. “Never put students down—ever” was a key motto in their department, and this is so true. Math is hard, and it’s something where so many of us have deep insecurities. The only way to fight this is by being loving and caring—by being human.9

A telling anecdote:

Clarence Stephens is known to have been a very gentle and kind person and he was able to infuse a spirit of gentleness and kindness... One of the older members of the department tells the story of a conversation he had with a student of [Stephens]. He asked the student, “You have studied with this man before. He makes no demands on you. You know you will get a good grade in this course. What causes you to work so hard in this course? What causes you to work so hard in his course?” The student’s reply was, “Oh, Professor Stephens will feel so bad if I didn’t. You see, he is such a kind person that he will be terribly disappointed if I do not do my best in his course.” (p. 59)

Independence: Being able to read, think, and prove on your own

What’s the most important skill developed in a math major? It certainly isn’t any specific content knowledge; math majors aren’t special simply because we have access to the fundamental theorem of algebra. Instead, it’s because math teaches us how to think and to learn on our own. Potsdam put this independence at the center of their program. From early on, there’s an emphasis on being able to read math effectively, to question and understand the proofs in the book. From an interview with Stephens:

Early in my teaching career and many years before I joined the mathematics faculty at SUNY, I concluded that the best way I could help students to write correct proofs was to teach them to read mathematics textbooks with understanding; perhaps one of the best things a teacher can do for students. This task is not easy, but requires time, patience and encouragement of students. I observed that proofs are written in textbooks and teachers explain proofs in their lectures. However, both students and teachers are often disappointed with the proofs given by students of theorems when they have not seen a proof of the theorems before. I conjectured that most students accept proofs given in textbooks and by teachers in their lectures on authority (they memorize the proofs) and not on understanding. Hence, these students have difficulty giving proofs on their own. (p. 70)

I love this approach. I’m dismayed by the hand-holding that’s endemic, say, in undergraduate education at Michigan. Each time I teach calculus, I emphasize the importance of learning to read the book, to teach things themselves. But students push back against this—and it becomes easier for us teachers just to give in, to prepare handouts and bite-sized lessons for students rather than empowering them to think on their own.10 Certainly, learning this independence is crucial for grad school, much more than any specific content.11

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9 And the professors were human, too, in sharing their own lives with the students. This is something I think about a lot in teaching, and in mentoring younger grad student instructors. There are many different teaching strategies, but I think the human connection is crucial, so letting your students get to know you is important. (It goes without saying that there are some boundaries to maintain.)

10 A favorite anecdote from Michigan math department lore: One pre-calculus instructor was really behind on the course schedule, so he told students that they were going to have to learn a certain section on their own. Read the book carefully and do the exercises, he told them; they could come to him with questions. On the midterm, his class did about average—except on the problem about the section he didn’t have time to cover in class. On that section, the students scored far above average.

11 As he helped the Potsdam professors adopt this new program, Stephens ran a reading course with some of the professors, many of whom hadn’t finished their Ph.D.s, emphasizing how to read math. Datta reports that these professors, after finally learning how to read math, returned to their Ph.D. programs and finished their coursework and Ph.D.s with far more success than they’d had in their first spell in grad school.
Teachers

Stephens quotes John Egsgard’s model of a good math teacher (apologies for the gendered language of the original): “A good mathematics teacher is one who uses his knowledge of mathematics, as well as his love and respect for his students, to lead them to an enjoyment of the study of mathematics.” The teachers at Potsdam were incredibly dedicated, devoting long hours to their teaching, more, perhaps, than can be reasonably expected in a more research-focused environment. But their basic approach—love for their students and a commitment to learn—can apply in many different environments.

A few of Stephens’ guiding principles for teaching:

- Regardless of time and place, you can teach mathematics effectively to most students only if you are successful in protecting and strengthening the self-esteem of the students.
- Believe in your students—everyone can do mathematics.
- You can best achieve your goal as a teacher by helping students to learn to think for themselves, to read mathematical literature independently with understanding and enjoyment, and to become free from the need of a teacher.
- If a student learns well the basic concepts of the course and learns to work independently, the student can learn additional subject matter rapidly.
- It is not the responsibility of the students to learn in the style that the professor wishes to teach; it is the professor’s responsibility to teach the students in the style in which they can learn.
- You cannot push students from the bottom; you must also raise them up from above.
- Be more concerned about promoting a favorable environment in which students can learn than about protecting academic standards.
- Work with the students you have, rather than fantasizing about the students you want.

A few additional principles

- Potsdam saw math as part of the liberal arts—there was little applied emphasis, it was math for its own sake—and encouraged students to pursue double majors with other fields. Note that even though Potsdam emphasized pure math and inspired many students to go on to grad school, the focus wasn’t simply pushing people on to math Ph.D.s; students went on to a wide variety of careers.
  
  I really love this approach; indeed, I often think of mathematics as part of the humanities, and wish we could treat it at least partially as such (while still acknowledging its crucial role in the sciences, engineering, and elsewhere).

- As part of the philosophy of encouraging everyone to believe that they could succeed in math, the department emphasized successful previous students as role models. This was built into the program, with older students acting as peer mentors and students, and alumni being cited to current students as examples of success.

- In spite of John Poland’s comment above, there were key institutional elements that facilitated this Potsdam miracle. Early on, at least, Stephens had the support of the administration. There’s some interesting stuff in Datta’s book about the role of course requirements, etc. Notably, students weren’t required to take math courses during the 1980s; they did so voluntarily. By the 1990s, adding a math course requirement paradoxically might have weakened the department, since many students stopped taking the calculus courses that had been designed as a gateway to the major.

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12Because it keeps needing to be said, the singular they is by far the best approach in current writing. In most cases, we should just keep old documents as they are—please don’t go around trying to rewrite the great English prose stylists—but in a discussion of math, with its long history of being unwelcome to women, it seems important to make this remark. (I was going to change it to singular they, but then the anaphora doesn’t read as well.)

13Taken verbatim from Datta, pp. 84-85, except the last one, which I’m paraphrasing from somewhere else in the book.

14There is also the even more inscrutable instruction “Go fast slowly.”

The physical environment was conducive to learning. Classes were held in the same cluster of classrooms, close together; hallways were narrow, encouraging students and faculty to bump into each other; and professors kept their doors open.

The department was very open in its philosophy and its discussion to students. Datta describes pamphlets that the department prepares for its students. Every single student he met there said they’d read the pamphlets. (If only all of my students would read my materials!)

The department didn’t emphasize technology at all—no fancy calculators or computers. This is just one specific example of a specific teacher’s technique, not representative of the program, but Professor Armond Spencer’s Mantra for the relief of anxiety that accompanies attempts to create and write proofs, if a bit too silly in tone for my taste, contains really good advice for all undergraduates.

Discussion: Moving Beyond Potsdam

First, let me emphasize the most important fact from this Potsdam miracle, so important that I’m going to obnoxiously write it in bold all-caps:

**FAR MORE STUDENTS ARE CAPABLE OF SUCCESSFULLY LEARNING ADVANCED MATHEMATICS THAN WE ACKNOWLEDGE, SO LONG AS WE BELIEVE IN THEM.**

This is wonderful news, since mathematical thinking is so important in our world. So: how can the Potsdam model be applied elsewhere? It’s important to think about how to apply it at other state schools, and in our secondary education system, but I’m going to focus on two areas where I have the most background/interest: in the elite research university, and in the freshman seminar I’m teaching in the fall.

I like this anecdote from Vasily Cateforis, the chairman who succeeded Stephens:

I received a call from a transfer student, entering in the fall of 1992 and transferring to Potsdam from a community college. She wanted to know whether our program requires the use of sophisticated calculators because she was about to invest in an expensive one at her community college and if we did not use such calculators, then she would rather not spend the money. She had asked Patty (the math department secretary) all this and Patty had, on my instruction, assured the student that no such calculators were in use by us. Well the student was skeptical, and politely asked to talk to me. I assured her of the correctness of Patty’s information. Several days later, on a request by the admissions office, I called an incoming student who had a question about our program. It turned out it was the same young lady. She said, “You have already answered my questions. But since you called me, I must tell you that my teachers here at the community college are questioning whether I am transferring to a mathematics program which is as advanced as the one we are having here at my community college.” I assured her that all was fine and sent her literature on us. (p. 108)

Of course technology used properly can certainly add to instruction. (And the algorithmic thinking that underlies this technology is a crucial part of mathematics education.) But there’s certainly a dangerous fetishization of technology—especially by people who don’t fully understand it—in many education circles.

In the name of intellectual honesty—after all, mathematical thinking requires it—I should pause for moment: am I being duped in all of this? I’m pretty impressed with the results at Potsdam. No, these aren’t rigorous studies full of data, but the basic numbers are pretty impressive: a huge proportion of Potsdam students voluntarily taking math courses, with many of them going on to major in math, coming from a non-elite state school with a presumably average student body and no obvious selection bias. Sure, this might not work for everyone, and Datta’s book is largely based on anecdotes, but there’s a lot that’s convincing here, especially because the core pedagogical principles—believing in students, treating them with kindness and respect in a supportive environment, having high expectations for them, and teaching them to think and work independently—are natural and yet so rarely done in higher education.

Also, Datta notes that enrollments have declined since the peak in the mid-1980s. He attributes this partly to the retirement of Stephens, partly to changes in administrative support (including the arrangement of course requirements), and partly perhaps to a shift in students, declaring that the students of the 1980s were more willing to work hard than those of the 1990s. (Does this augur well for students today?)
In the Elite Research University

Can this work in elite research universities? Here I mean both private schools like the Ivies or Stanford and flagship public universities like Michigan or the UCs. At schools like these, the faculty maintain active research careers, and spend much of their teaching energies mentoring graduate students, who often do a significant portion of undergraduate teaching, especially in lower-level courses.

From the start, it’s clear that certain things can’t carry over: it’s unrealistic to expect faculty to spend the hours on teaching that they did at Potsdam. Also, it’s important to acknowledge the very real barriers of institutional inertia in these universities. Professors primarily care about and are rewarded based on their research. Yes, there are many, many professors at these universities who are both elite researchers and dedicated teachers. But it’s one thing to be a dedicated teacher; it’s another to take on the Sisyphean task of committee-work and administrative responsibility necessary to revamp an undergraduate program.

Still, much of the Potsdam philosophy could work. First, let’s consider what an individual teacher could do unilaterally. To follow the Potsdam philosophy, they would:

- Believe that students can succeed in math—and let the students know this. (The best approach would, I think, be to explicitly tell their students about the Potsdam miracle. I wish there was a good short article about this approach that could serve this purpose; none of the resources I found are ideal. Someone should write such an article!)
- Treat students humanely, creating a comfortable classroom environment.
- Emphasize the importance of students learning to work independently, making sure they can learn by reading and ensuring they truly understand what they’re doing.

There are still some pretty significant constraints. When I teach calculus as a grad student instructor, I’m serving as the primary instructor for a section 30 students, but there are dozens of sections all following a unified syllabus and taking the same uniform exams. Yes, I could try to follow some of the Potsdam philosophy—but I couldn’t really create a fully humane environment when students’ grades are almost completely determined by uniform exams: I couldn’t focus on teaching students to learn independently when the assignments and syllabi are prescribed for me; I couldn’t adjust my pace to ensure that students really learn the material (since they would kill me if I don’t cover all the material that’s on the test, and I would be out of a job); and I certainly couldn’t try to teach them actual mathematical concepts of proof.

And if I were the non-tenured lecturer who’s coordinating all these sections, it would be essentially impossible for me to make the changes in the program that would let me teach in this Potsdam way. First, why would I put my neck out to do this—both given risk to my job security, and given the immense amount of work I would spend on something with little prospect for reward? Then, how would I manage to convince the engineering departments that it’s better for students to learn to think mathematically than for us to teach them how to calculate work problems? And how would I ensure that all of my graduate student instructors, many of them first-time teachers, can succeed at teaching this way? It’s far easier to keep going with what we’re used to.

Sure, a tenured prof teaching an introductory course might have enough flexibility to accomplish these goals, but the scale would be small. To make a bigger impact, a department would need to make a conscious decision to shift.

Here’s how I think it could happen. At many universities, there are only a few introductory courses in the math department. If a tenured professor—or, better yet, a small group of tenured professors—decided

17There’s more to say about grades, of course; we can’t simply follow the approach of Stephens (see quote above).
18Indeed, as grad student co-coordinator mentoring newer graduate student instructors, I’ve had to tell instructors that, alas, given the constraints of the course, we really can’t try to teach proofs—it doesn’t work.
19It so happens that I just finished reading former Harvard College Dean Harry Lewis’s very interesting book Excellence without a Soul. Lewis discusses a wide range of important topics in higher education, from an unusual and provocative perspective. I’m not saying I agree with everything in it (I don’t), but those interested in higher education, especially in the elite university, should certainly read the book. (The best book on the elite university remains former Harvard Arts & Sciences Dean Harry Rosovksy’s The University: An Owner’s Manual.) In my brainstorming here about how to implement the Potsdam, I’ve been influenced by Lewis’s discussion of the role of the professor at Harvard, especially regarding the core.
to take the time to revamp those courses, they certainly could. No, it couldn’t work (at least at first) in Michigan’s model, where dozens of young graduate students teach individual sections, but this could work in the vast majority of schools, which rely on large lectures. Two or three professors, along with enough grad student TAs, certainly could offer large courses that follow the Potsdam philosophy. Why can this work? At first, it would be a lot of work for a few professors. (After a few semesters of designing the course, it would become more manageable.) You’d need enough support (or salutary neglect) from the rest of the department; sufficient backing from the dean in terms of grad students, etc.; and enough political strength to withstand the demands of science and engineering departments that the introductory courses cover such-and-such specific material. But there are several reasons for hope:

- Academics aren’t rational self-interested beasts. (Self-interested, yes, but not in any rational way.) The quip goes that academic politics are so dirty because the stakes are so low, but at least part of the real reason is that academics are the types to work passionately on things they believe in. There are many professors at elite universities who care a tremendous amount about undergraduate education, and who might be willing to invest their energies in such a program.
- Math is important, and yet we’re doing a bad job teaching it. Everyone acknowledges this—and so perhaps higher-ups (as well as foundations and the government) will offer more support.
- Math is relatively cheap. Unlike natural scientists or engineers, (pure) mathematicians don’t have massive research budgets—nor do they have the types of grants that mean that there isn’t a supply of grad students to teach. Furthermore, math education is cheap: we don’t need anything more than blackboards.
- The Potsdam program has done an amazing job addressing the problem of underrepresentation of women in mathematics (and, based on the Morgan State experience, it could likewise do so for underrepresented minorities). Fixing this problem is rightfully a major priority for universities and foundations; surely a program that could improve this would attract funding.

This sort of a program could start small (in terms of numbers of professors involved), in just the introductory courses. A relatively small group of professors—as well as non-tenure-track lecturers who buy into the program—could easily handle this. If only the best instructors teach the introductory courses, the vast majority of professors would still be successful teaching upper-level courses. The uncreative ones could still stick to a lecture-based format; by this point, students would be independent enough to rely primarily on their books in such courses. The key would be to develop an appropriate system of advising and mentoring, and to encourage the spirit to spread in the department. Throughout, a supportive administration—especially one that can offer the appropriate incentives for professors who do this—is important.

Once a department establishes a positive reputation, it feeds on itself. For example, at Stanford, the computer science department does a great job with its introductory courses, and a huge proportion of the student body, including many humanities and social sciences majors, takes these courses. Yes, the Silicon Valley boom and economic considerations play a role (during my four years there, during the blip between Google’s IPO in 2004 and the bubble from the growth of Facebook and the various iPhone apps around 2008, enrollments dropped), but a lot of it had to do with the course’s excellent reputation.

So I don’t think it’s too much to imagine that such a program could work. It would require a few dedicated professors; the right department and culture; and a supportive administration—but with these it could happen.

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20 Datta’s book also notes that lecturing isn’t necessarily the best way of teaching material: interactive approaches often work better. Still, most of the Potsdam philosophy is orthogonal to the specific teaching method, and the emphasis on encouraging student independence makes large lecture-ish courses far less problematic. (It’s worth pointing out that once a class reaches 50 or so students, the marginal cost of new students is very low. A well-designed 500-person lecture course, with an excellent professor and enough TA support, can be far more efficient, both in cost and in quality of output, than five different 100-person lectures.) Better yet, these courses could be taught partially or fully with flipped classrooms: one lecture a week, say, about bigger picture and to provide the human touch of a great professor, and then 2-3 problem sessions led by grad students.

21 University administrators who have received emails from me about issues I care about can certainly attest to this.

22 Harry Lewis points out how the Harvard core courses used to awarded only to the best professors. (This has apparently changed over the decades.) My experience at Stanford was that the now-replaced IHUM program, for all of its problems, attracted professors who were extremely talented lecturers and teachers. So it’s possible for research-focused universities to attract the best professors to core courses.
In my course

I came upon Potsdam as I was looking for material for my course in the fall, a freshman seminar about math, linguistics, and writing. One of my main goals in the course is to introduce students to the beauty and power of pure math. This goal is based on a belief that pure math both can and should be taught to far more students than see it now. In planning the course, I’ve been pretty confident that this sort of an approach (including my ideas of unifying math and linguistics, and then using both to teach writing) would work for really strong students. But what about less well-prepared students? I really think this can work, and I’m excited to try—but I was a bit scared.

Reading about Potsdam was a huge relief. Yes, this can work, for a wide range of students. So long as I follow the Potsdam model—many of whose philosophies I already subscribe to, even if I hadn’t fully articulated them—these students can succeed. So, as I was planning to, I’m going to go into the course with the conviction that my students can and will learn, the patience and flexibility to adjust things to fit their needs, an emphasis on teaching my students to learn independently, a humane and loving approach to teaching, and an enthusiasm unknown to mankind.

The one thing I’m going to change after my reading is this: I think it’s important that students themselves be aware of their power, so I’m going to make sure that they, too, know about Potsdam. Everyone should.

Postscript: Friends in both computer science and philosophy pointed out that many of the lessons of the Potsdam miracle apply in those fields, too.

Post-Postscript: (3.1.14) I received a nice note from Wes Mitchell, who was on the Potsdam math faculty during the 1980s. He said my description here was a fair portrayal of life at Potsdam back then (in which case the credit goes to Datta for his reporting). With his permission, I’m going to post a few comments he had:

A couple of points, particularly when attempting to scale the model out:

It is essential to get students to write, and you have to spend the time discussing what they have written, and actually reading what they write. This is very time-consuming for any math course, but particularly for proofs.

It is essential to get the more mature or qualified students to help those struggling more. This is hand-in-hand with developing a community; at Potsdam, it was cool to be a math major, even in the fraternities. And it was really enjoyable to be immersed in all the cross-pollination provided by all the double majors.

Mathematics is a critical part of a liberal-arts education, in the best sense of the word. When I was on the faculty senate, there was a movement to instill “Critical Thinking” into the curriculum. I wasn’t very popular when I kept asking people from other departments what they had been doing previously, and why they felt it was important to start now.

My last point, one not often mentioned: an electorate capable of critical thinking is essential to our country. The study of mathematics is a pretty good place to develop and sharpen those skills.

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23 Let’s leave “strong” ambigious: some appropriate combination of talent and preparation, the relative ratio of which is of course a fraught issue.

24 A logical caveat: just because I follow this approach doesn’t necessarily mean I will succeed, nor that my course will succeed in its first incarnation. It’s an experiment. But this is the way to go, and it has a good chance of succeeding in many ways if not all.