TEACHER'S JOURNAL AUTUMN 2006 through AUTUMN 2008

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========== TEACHING AND WORKING WITH STUDENTS ==========
================ PHILOSOPHY SUBSECTION =================

----------- THIRD TENURE REPORT, DECEMBER 2008 ----------

Philosophy is the study of problems that are never resolved. In the Philosophy of Education there are no right or wrong methods; this can easily be seen in the vast diversity of teaching styles across successful teachers. Socrates asked questions. The Zen Master famously hits his student with a stick until the student stops asking questions. Apprentice programs put learners in close one-to-one contact with a master. Chinese professors are very distant from their students, Chinese students call this distance "respect". Young children need caring and consistency. Established professionals need enforced inconsistency to move them from practice to mastery. American general education tries to teach almost every person a little bit of almost every thing. Olympic athletes are often educated from birth with a single focus for their entire childhood.

I find that LWTC students respond to one-to-one interaction as adults, within a context of mutual respect and realism. To achieve this, I have disassembled the lockstep of classroom instruction, spending the majority of class time in individualized and small group tutorial instruction and guidance. About half of my lectures are "cultural", material not in the book and not part of the explicit curriculum.

=========== TEACHING AND WORKING WITH STUDENTS ===========
================= COURSEWORK SUBSECTION ==================

SUMMARY OF SELF GRADES, chronological order within courses.

Math 80:	B+, B+	3.4
Math 90:	A, B-, A, A-, A, B+, A-, A-, A	3.7
Math 99:	B+, A, A, A+, A-, A, A, A+	3.9
Math 102:	A+, B+, B, A+, A	3.8
Math 107:	A+, A	4.2
Math 141:	B	3.0
Math 146:	B-	2.7
Overall:		3.8

----------- THIRD TENURE REPORT, DECEMBER 2008 ----------

COMMENTARY ON COURSES, AUTUMN 2008

General

Students who I have had the opportunity to teach in a prior course are interesting, especially those who have suffered from a poor math self-image. They know how my teaching style works and obviously do not strongly object. Those going from Math 90 to Math 99 come into class believing that the content is easy, and that they will succeed in the class. Several have been rather excited to test their new found prowess. Those going from Math 90 to Math 102 are at first a bit shocked that the rules of the game (the teaching style) has been changed. For the group-work of Math 102, for example, regular attendance is far more important, but some students had hoped that the course would be self-paced. All students are explicitly thankful that the focus is on acquiring math skills in an adult learning context free from grading used as coercion.

Check for Understanding

A couple of my earlier teaching evaluations suggested that I should "check for understanding" regularly during the lecture portion of the class. This is, of course, a good idea, particularly when the lecture is intended as the teaching vehicle. In an individualized classroom, the primary teaching vehicle is one-to-one dialog, in the presence of a particular problem that a student needs help or guidance for. With all students knowing that they will be speaking with the instructor one-on-

one, their desire to bring out questions in class is significantly lessened. The lecture turns into more of a conventional "lecture at a distance", with the instructor focussed solely on conveying content, rather than on checking for understanding. Analogously, consider lecturing in an auditorium of 100 students. The check for understanding still takes place, but it comes after the lecture, in small group tutorial sessions that accompany such lectures.

Another factor working against interrupting the flow of a lecture to check for understanding is that LWTC students are particularly non-conversant, especially about math. So I've developed the style of using the lecture for exposure and for presentation of problem-solving technique. Without the expectation that the lecture will "be understood", at least immediately, lecture content can more freely range over cultural material not covered in the text, over more difficult material that a student is not expected to learn, and over exemplary material intended to exhibit skills that students do not yet possess. Checking for understanding takes the form of a personal communication, between mutually respectful adults.

The general idea is what Ausubel has called "advanced organizers", material that the students see but do not yet understand. An advanced organizer allows content to sink in prior to approaching it as a skill, it takes the shock out of the content when it is presented later (in my case, in one-to-one conversation with a student). It also permits students who do understand a particular content to verify their comfort level, again without being put on the spot to perform.

There is a somewhat deeper issue: what we as teachers believe about the nature of passive listening. Certainly, checking for understanding is an (appropriate) attempt to make learning active. But what exactly do we expect a student to learn from the lecture which precedes the check for understanding? Is a student expected to learn significant content by listening (actively or passively) for five minutes? Or should dialog occur during practice and skill acquisition?

The issue comes down to the famous Bloom's taxonomy of cognitive learning behaviors: pay attention, comprehend, apply, analyze, synthesize, and evaluate. Each step must be present for the following step to be effective. Educators of Bloom's era believed that learning is a cognitive (as opposed to an emotional or physiological) activity. Emotional and physiological components were recognized not as modes of learning, but as types of content.

This taxonomy is half-a-century old, and has incorporated within it a severe psychological miscomprehension about how learning works! In particular, evaluation takes place as the second rather than the final step. Students "comprehend" only after they have evaluated the content to determine whether or not they believe it, whether or not they find it of sufficient value to then put in the effort to comprehend. This emotional component was artificially removed in Bloom's attempt to construct a purely cognitive taxonomy. During Bloom's day, the dominant theory of learning was that it could be divided into discrete categories and actions, much like science factors observations in order to generate separate components of a scientific theory. (This approach is called reductionism, and is completely inappropriate for whole systems such as people and environments.) It was not until the 1980s that educators came to realize that the emotional component of learning, the "desire", could not be separated from the cognitive process of understanding.

Students must have made up their minds explicitly to want to comprehend. Checking for understanding is effective only when a student is putting forth effort to understand. With math-shy LWTC students, the delicate balance between maintaining confidence (and desire) and verifying skill acquisition often turns into a private matter, one that is not shared with the entire class. Of course, this too can be overcome, but I've found that my students have a preference to focus on the lecture content without sharing their understanding with the rest of the class. Every now and then a student will initiate a question during lecture, and this provides an excellent content for dialog. The key is that the checking is student-initiated, the evaluative component having been met.

The summarize, I've found it of utmost importance to respect the learning process of students, to be a facilitator responding to their initiative, rather than to conform their behavior to my expectations.

LWTC Math 99, Autumn 2008

The new textbook has required a complete review and revision of teaching materials for Math 99. It is always exciting to teach with updated resources, since they are exploratory and "unrefined". This causes teaching to be exploratory and unexplored, both very good things.

PreFinal

To become immediately accustomed to the new text, I gave the class a prefinal on the second day of class. A prefinal is a practice final exam, given at the beginning rather than the end of a course. This alerts students to what they know, what they do not know, and what they will be expected to know. It also helps to determine if students are misplaced. If a student can pass the prefinal, then they are overqualified for the particular course. Since the new text permits us to begin intermediate algebra without extensive review of Math 9 materials, the prefinal also included content for Math 90, providing a convenient assessment of readiness as well.

Textbook Feedback

Well, the students really loved the new texts. Many commented that it was easy to read and very helpful. It is such a relief to have a text that supports rather than interferes with teaching. This lead to more students working independently, and coming in with fewer questions. The lectures in turn improved, cause they didn't have as much "textbook remediation", ie fixing misconceptions that were a direct result of poor exposition in the text.

In general, this class felt particularly good. Students worked a more more in pairs, discussed and shared problems and insights, and were extremely attentive during lecture.

Self-grade for Math 99, Autumn 2008: A+

LWTC Math 102, Autumn 2008

The class started slow, with several students feeling uncomfortable with group assignments. Perhaps they did not expect the group oriented activities in a math course. In the end, many commented on how they had become more tolerant about working with folks who were very different than themselves (mostly a comment on the diversity of ages within the class).

The class took very well to the discovery style of this course. They caught on to the way the text was guiding them to conclusions. Part of this success was that I had learned to give a conventional lecture about the content of each unit first, so that they all knew where they were heading. The benefit was bidirectional: students did not need to fully understand the lecture cause they had several more class sessions to explore and discover the lecture content, and students did not get lost in the discovery cause they knew where they were heading. The lecture presented the "math" part, the abstractions, while the discovery component presented the applications part, how to use the math.

Presentations by this class were stronger than prior classes. Partly I believe cause I had learned how to be very specific about the components and the expectations of the presentations, and partly because the working groups tended to have a more mature student who organized more interesting topics.

Self-grade for Math 102, Autumn 2008: A

LWTC Math 107, Autumn 2008

A wonderful class!

I presented students with a choice of class structure and style on the first day, explaining the range from traditional lecture to seminar. Several students were apprehensive about a seminar approach , since they felt uncomfortable with the idea of assuming responsible for studying a topic in depth and leading the class in that topic. After assurances that they would be co-teaching with me, and that their individual styles could be reflected in their presentations, the vote for a seminar was unanimous.

Concurrent with this decision was the idea of not having a textbook. rather each student responsible for the day’s seminar would xerox materials for the whole class. This idea, although it saved students $150 each, did not work well. Materials were uneven, and we failed to get materials in the hands of other students *prior* to the class of relevance. I intend to incorporate a textbook next time, and use seminar style with students electing to cover a particular chapter in the text.

Seminar Style

The idea of a seminar is that each student take responsibility for the content of the class on a particular meeting. By having to present content, I hoped that each student would examine a topic in depth and prepare their ideas. What actually happened is that each student downloaded the Wiki page for their topic, and then attempted to read it to the class. Of course, the difficulty levels of pages were not correlated with student understanding or ability, and “reading” the Wiki was a failure. The material did provide context for teaching and for discussion.

Another feature of seminar style is that students could customize course topics to their particular interests. As well, with 22 meetings, we could cover 20 or so topics, enhancing the diversity of the “Mathematics in Society” course. This worked exceptionally well, the course was rich, exploratory, and most importantly, up to date (most texts teach content that was relevant literally hundreds of years ago). I have no problem exposing students to rich and deep content, even though their math sophistication was lacking. We achieved the course goal of diversifying understanding of the nature and application was math today. Simply put, “Math is not only about numbers.”

Impact of the Math Lab

I moved the class from a regular classroom to the Math Lab on the second day. The intent was simply to provide computer access which deciding upon topics of interest. Once in the Lab, it became apparent that the environment was far more conducive to the seminar style and to the content of the course than a conventional classroom, so we stayed in the Lab for the rest of the quarter.

To my surprise, about half of the students showed up for class about 15 minutes early, not to prepare for class, but because they had internet access to do many different things. This really highlighted the problem with locked classrooms. We are effectively *wasting* 15 minutes of each student’s time by having them wait in halls for classroom access.

The net effect of having students in the classroom ready to go and working on computers when class began was very positive. The transition from Lab to classroom was seamless, and students began work “warmed up” rather than in a daze. However, the most surprising positive was that the students themselves introduced a new component into my teaching: an “explore” component to the class. It began informally, with students wanting to drift to the computers as we discussed various topics. I assigned particular websites a few times, and discovered that the students were also actively exploring the math ideas at a variety of sites. This turned into a formal “explore time” that ended each class. Between 15 to 30 minutes prior to the end of class, I would write the concepts and references we had studied that evening on the board, and students would Google and YouTube their interests. They found sites that I was unaware of many times, thus enriching the curriculum. They shared neat discoveries with each other dynamically, and *took control of their own learning*. I wandered the room, learning from their explorations, rather than telling them what to do. I learned a lot about what interested them (within the confines of the topic of the day), and how they thought about various math ideas. I was introduced to new lesson components, to new ways of perceiving the content, and to new understandings of relevance.

Any Interesting Thoughts?

I began an experiment every Monday of asking students if they had had any interesting thoughts or experiences related to math over the weekend. this was a failure, cause very few students ever spoke up. I experimented with different ways of asking the question to no avail. Somehow, asking for community disclosure was too intimidating, or perhaps students did not feel comfortable with what they had to say Many times, a student would begin with a disclaimer that what they were about to say was “not related to math” or “not important”. They were placing too high of standards on their potential contributions, when all I was trying to do was to create an icebreaker. Or maybe they never thought about anything related to math!

Self-grade for Math 107, Autumn 2008: A

LWTC ABED 30, ABED 40, and Math 95, Autumn 2008

The quarter began with an unusual number of students in these self-study courses needing guidance and assistance, not in Math per se, but in the way that LWTC worked. I came across several cases of erroneous and partial counseling that were relatively easy to fix. Once students understood the requirements and style of these courses, they settled down to work without problem.

COMMENTARY ON COURSES, SUMMER 2008

General

I've taught each of these courses (M99, M102) several times, and the classroom methodology is fairly refined. The flow of the Summer was lesson preparation on Monday and Wednesday, and 9 solid hours of teaching on Tuesday and Thursday. Three courses on one day is a heavy load, and would not feasible without days-off in between. As it turns out, all three classes had students who liked to stay late, so between class time was even less than expected.

Summer classes have two ten-minute breaks built-in. I found that teaching straight through permitted us to officially finish 20 minutes earlier, however several students regularly kept working for the entire 3 1/2 hour period. This would, of course, be infeasible for a lecture-based teaching style, but quite frankly, lecturing on Math for 3 hours at a time is infeasible in any event, particularly for students. Conventional teachers break up time using problem sets and quizzes, but this does not change the classroom dynamic of focussed math. So I find it mandatory in these longer sessions to incorporate group work, discussion, off-subject exploration time, etc. The fact is that students do not "discuss" math (do not, for example, tell anyone at a party that you are a mathematician, it is a sure fire conversation killer).

LWTC Math 99, Summer 2008

A surprisingly dedicated group. After the initial drop-out pruning of about 1/3 of the 18 person class, the remaining students all showed up nearly every class meeting. They appreciated a regular 1/2 hour lecture, and some would stay only an hour, preferring to do their assignments at home or on flex-time. Due to the longer class periods, I lectured every class meeting, keeping closely to the syllabus. Almost all students finished the text (somewhat unusual), I even had time to introduce some advanced content. All received relatively high grades for their concerted efforts.

The class was marked by several overtly happy people, and they seemed to lighten the mood of all. The class was also different than normal in that several students approached Intermediate Algebra with unique mathematical styles. One student did pages and pages of concentrated work, explicitly avoiding short-cuts, so that he could "explore the way math is done". My job was to teach him that math is done using short-cuts!

Another student, apparently dyslectic, wrote down polynomials in an assembly fashion, putting in pieces (coefficients, terms, signs) seemingly randomly until the whole structure was assembled. I watched him closely, and when left to his own method, he made very few slips or errors. This student began doing a lot of the computational work in his head, so that it was difficult to follow his process. But his process met the objective of doing math correctly, and had the added advantage of meeting the objective of doing math creatively. He even devised new algorithms on the fly. This student was very visual in his thinking patterns, which I learned after stumbling around trying to figure out what he was doing.

Another student had a severe difficulty with syntax (with writing equations down), but knew the concepts and approaches clearly. He was somewhat bored by the simplicity of the algebraic tasks, and wanted to move quickly through the material, but he could not communicate (write down) algebra clearly. My focus was on getting him to generate one or two template problems with everything written correctly, and then to keep him interested with new approaches.

What struck me about this class was the huge effort each student put into completing the course content.

Self-grade for Math 99, Summer 2008: A

LWTC Math 102 morning, Summer 2008

This was a large class, with almost all of the seats in the classroom filled each meeting. Attendance stayed high throughout the Summer, although I did need to remind two students that they could not attend two classes at the same time (!). I've noticed on several occasions that students in some block programs believe that they can enroll in Math classes at the same time as their block classes. It's difficult for me to believe that these students do not know how school works, so I suspect something more systemic is at work. These two students, on several occasions, came with a note from their block class saying they they had immediate work to finish for a client, and had to leave class early. Sort of like having a job (and I have had several students with job hours that conflicted with class hours). Some have said that they had to take vacation leave to attend class (such sacrifice!).

The Math 102 classes began with a one hour content lecture (half of the time with content not in the text). This class was unusually attentive. We then broke into group and project work for the remainder of the class. The lecture became especially important, since I tried to summarize the textbook, to provide the content organization lacking in the discovery approach of the text. Hmmm, in this discovery class, the lecture focussed on structured knowledge; in my Math 90 and 99 algebra classes, the lecture focusses on discovery and exploration of ideas, while the book presents structure.

Any Math Thoughts?

I began each Tuesday class with the question "Did anyone come across anything interesting about Math over the weekend?" Got an average of one comment per week (over all three classes). Much of the time, the commenting student began: "This is not about Math, but..."

This situation is not as dire as it sounds. Since I spend 5-10 minutes in one-to-one conversation with each student in each class meeting, it was always possible to elicit their "math thoughts" during personal interaction. Yes, many did not have any math thoughts. Most students did, however, have a focussed desire to complete the coursework, and did have "math questions" that they were more comfortable discussing one-to-one.

In the group-work format of Math 102, conversation about Math was far more dynamic, presumably because the students were already in the flow of conversation. Again this emphasizes that the formal classroom structure, with the teacher lecturing from high at the front of the class, is not a natural human communication pattern. Asking students to initiate a conversation ("Any math thoughts?") from this format is simply unnatural.

I added two new teaching techniques to this (and the other 102) class:

Discovery Journal

"Keep a journal of the emotional component of your learning. Briefly describe times when you thought Aha!, or Haha!, Ohno!, Ugh!, Yuck!, Hmmm!, Duh!, Ohh!, Ahh!" The idea, of course, is that long-term learning is anchored to emotional activity, not to cognitive activity.

OK, it sure bothers me that many teachers have forgotten how their own brains work. Cognitive classrooms are strong in short-term memory, but the typical statistic is that 90% of what is learned cognitively is forgotten within six months. For math, it is far worse. This "neglect of the mammalian brain" syndrome is another face of the "critical thinking" rube (er, not rubric!). The idealized steps of the scientific method are an idealistic fabrication that have little empirical support from both scientists and learners.

Education is the most conservative institution. What we teach as daily lessons is usually hundreds of years old. It was not until the Renaissance that the idea of observation of reality as a path to knowledge came into being. The Scientific Method was very important during the 18th and 19th centuries, as people learned how to observe. But the 20th century brought relativity and quantum mechanics, sciences built upon the foundation that objective observation was not possible. This century, the vitally important concepts of ecology stress that we cannot step outside of our environment to "observe" it. We are always and intimately within it.

My thoughts here come from my mentor Heinz vonFoerster. Heinz was a charming Austrian who contributed to the construction of the field of cybernetics. He was a systemicist rather than a scientist. One distinction he made was between science and systemics. The heart of science is reductionism, taking apart the world into its components, and then taking apart those parts. In science, the interrelations between parts, the system, is lost. In contrast, a system is put together rather than taken apart.

Heinz vonFoerster's passion was to consider himself as part of the world. He rigorously contested the idea that we can observe the world by being apart from it, and thus he rigorously contested the notion of objectivity. Heinz said: "Objectivity is the delusion that observations can be made without an observer." He also said: "When I change, the universe changes with me because I am part of the universe." Heinz was sufficiently clear about this position that he thought of it as fundamental, it is not derived from an idea of connectivity or ecology, it is not the result of a theory of being, but it is as itself the ethical basis of knowledge. It is as obvious as one's experience. Heinz did not believe in Truth, in facts that could be established, he believed only in Trust, in the common union of shared experience. He warned his students that once you establish a theory, you have constructed a partition and a lie.

So yes, our approach to critical thinking as a Global Objective basks in the absence of critical thinking. All this come down to: Cognitive math teaching is math learning that is forgotten. My teaching goal is for content that will be recalled five years hence. Such learning is anchored to emotional experiences with math content.

Daily Quizzes

The textbook provides quizzes for each lesson. I distributed these during group-work time and asked students to complete them as a group. The quizzes seemed to organize and focus content activities, providing a content agenda that was not available in the discovery-oriented textbook presentation. The quizzes were not graded, they were activity organizers.

This class had several folks who appreciated "cultural materials", lectures on materials not discussed in the text. Hmmm, another quick rant: There are sections in the Math 102 text where the authors are deeply in error about the technical facts of what they are presenting. Somehow, textbook authors freely step into territories they do not have expertise in. These excursions often result in pedagogy built on false knowledge.

Student Presentations

Math 102 is organized around three math topics (trig, logic, exponents). I have students groups (three to a group) give a presentation of their application of each topic content to some problem. This Summer, the structuring of presentations came a bit clearer.

Each presentation should have these four components: symbolic math, numerical math, visual math, and communication. That is, an equation, an equation used with data, a graph or picture, and a discovery journal component. On each successive topic, I increased the requirement of data (as opposed to a canned book problem), so that for the final topic, students were doing mathematical modeling of real world data using the tools of that topic.

Forming Groups

An issue that I have been unclear about is how to form groups in a groupwork course. I've found that three students is ideal, however for Math 102, we have three different topics. Should groups remain the same over the course, or should they change three times? In the Spring, I tried keeping the same groups. In the Summer I enforced changing groups, so that no student who had worked with another previously could be in the same group. At the end of the course, asked the students what they thought. (We also discussed group formation several times during the course). The majority said they benefited from the diversity of groups. I was reminded of some wisdom Sue shared on this: "Changing groups is part of the Teamwork curriculum."

Self-grade for Math 102 morning, Summer 2008: A+

LWTC Math 102 afternoon, Summer 2008

This was a smaller class, half the size of the morning session. Early in the quarter several students changed from one group to the other. I offered this opportunity as an attempt to even the class sizes, but as it turned out, an equal number went in each direction.

Avoiding Repetition

I usually have a deep concern when teaching the same class twice (on the same day, during the same quarter -- I've had to get used to teaching the same class twice in the same year, something I had avoided until coming to LWTC!). It is difficult to keep the second class fresh, to avoid repeating what had happened just before, in a different context with a different group of students. The personalty of this class lightened the concern, many lectures seemed fresh, although a definite side effect from the morning class was that lectures ran significantly shorter in the afternoon, since I had a distinct sequence of classroom events in mind for the second class.

A major difference between the classes is that this class had a greater percentage of disinterested students. Not much dialog, a lot more dozing off. A byproduct of the disinterest was that groups often fragmented, with students dropping out or not attending. This class had a high count of sickness, injury, and job-related absence.

A student who had attended a discovery-oriented high school helped with integration, explaining to several students (as new groups formed) the ideas of discovery learning. Well, not the abstract ideas, just what the appropriate expected behavior was.

"I'm a Math Dummy"

I've seen many times one or two students in a class who were vocal about their "dumbness" in math. And I usually take it as a goal to have those students leave the classroom feeling competent, although perhaps not having memorized equations. An interesting dynamic developed with this class's student. To preserve the dumb self-image, she would not believe her own right answers (actually this is quite common). I kept on driving the content toward simplicity, until she finally volunteered that she had been thinking about math problems in a too complicated way (again quite common). But this was not true, she had been thinking in a confused way, and the source of the confusion was (of course) her immediate blockage as being a dummy. There was insufficient time to remove all the doubt, but after a while we did reach a regular comment of "I knew that!" The lever that proved successful was to have her teach students (in her group) who were even more confused that she was.

The highlight of this class was seeing the strength and good teaching offered by students to other students while working in small groups. I'm thinking about how to make that happen in the algebra classroom.

Self-grade for Math 102 afternoon, Summer 2008: B

LWTC ABED 30, ABED 40, Math 70, and Math 85, Summer 2008

During the Summer, I manage all of the self-paced courses. There were an unusual number of phone enquiries to begin this quarter, students thinking they needed permission or help to do self-paced work. Seems like something in advising was short-circuiting them from going straight to the ASC and diving in. A weakness is that because I was on campus only two days a week, and because on those two days I was almost constantly in class, I did not adequately respond to several of these phone calls. Maybe. I left messages, and the student questions appeared to go away, and those with questions passed their self-paced courses. But I still get the feeling that these students would be better served with advising that was definitive, responsive and available. I just can't provide that on Summer hours.

COMMENTARY ON COURSES, SPRING 2008

General

One of the worst strategic errors I have made at LWTC was to attempt to teach four 5-unit courses in one quarter. The load would have been fine if I had had no other responsibilities, but my enrichment work suffered under this teaching load. In particular, I had volunteered as a Global Objectives Mentor, but GO meetings were scheduled when I was in class. So I lost touch with the decision making body, and eventually volunteered to do some auxiliary projects in order to make a contribution to the GO effort. I also got almost no writing done on my book project. At least the busy quarter kept me from getting overly involved with the Union/LWTC Faculty teaching load negotiations.

The American Math Phobia

LWTC has a unique student body, and a unique problem in math. I don't as yet know how to address it systemically, but somehow we are requiring an inordinate number of students to repeat work that they already know. I assume this is related to an admission issue of certifying prior work for students educated in different countries. There may perhaps be a justification for requiring repetition of subjects for which we have significant content to add. But for math in particular, the content is standardized worldwide (a consequence of what math is) and is taught very competently worldwide. So there is a double embarrassment here. Not only are we not respecting these students' knowledge, but we ourselves are insufficiently educated in math even to be able to recognize their knowledge. Although my teaching style is not motivated by guilt (it is, I believe, motivated by quality teaching practices), I find that it is responsible not to add insult to injury for these students.

The USA is suffering with math phobia and underperformance. The nationally known math educator Marilyn Burns begins one of her books with "Math is right up there with snakes, public speaking, and heights..." as things that the American public fears and loathes. A modern contributor to this fear and loathing is the rampant deception and dishonesty about math in textbooks. Here's a simple example: Newton's Method (yes, invented by Sir Isaac) of solving algebra problems was the primary method used in schools until about 1880. The method is to guess at the answer, and then to successively refine the guess based on results from the incorrect answer. This method is excellent for developing skills of estimation, approximation, and rapid calculation. It is not algorithmic in the sense of the Rules of Algebra. When modern symbolic algebra became established around the turn of the 20th century, Newton's method was rigorously removed from every textbook, so that there is now no longer any evidence of its existence (that is, until you get to Calculus). The deletion of the method was purely political. And it is not as though all older techniques have been expunged. The last chapter of the Math 99 textbook, for example, dwells on "Completing the Square", a solution technique developed about 900 AD and of interest during the 13th century. All of this is connected to Hilbert's Program of the early 20th century, to remove human intuition from mathematical computation. Great for machines, terrible for students!

LWTC Math 90, Spring 2008

The room was not appropriate for this class, since it contained workbenches rather than desks. Perhaps I should have taken the hint and converted the algebra teaching style to group project work. An interesting idea for later.

I have begun, recently, to increase the algebraic content of Math 90, completing one chapter more than our curriculum for Math 90 specifies. This probably because I'm making a classroom point that algebra is one of the easiest possible subjects. The "follow the rules with very little thought" approach is particularly targeted for students with math anxiety; the idea is to provide success first with symbol juggling, next with thought of strategy, and later with thought of application.

Additional Content

It is important to maintain curriculum structure, since a Math 99 instructor should be comfortable with the skills of students completing the prerequisite Math 90. Usually though, students who complete an additional chapter early are not considered a disadvantage. Especially since the particular chapter that I transfer into Math 90, "Rational Polynomial Expressions", is by far the most difficult in the text. So

I use this chapter to differentiate between A and B grades. Students who can take on the Challenge Chapter and complete it achieve the A level of performance. Any student can elect not to do the Challenge Chapter in exchange for a B grade and completing all other chapters.

LWTC has a quite bimodal student population with regard to algebra performance. Our ESL students, educated in algebra outside of our country, have already seen all of the material in Math 99. Our technical trade students are sometimes still struggling with arithmetic. The Challenge Chapter is a way for those who know algebra already to show the way for those who do not. And oh, I'd *never* call Chapter Six a "Challenge Chapter"! It is simply on the syllabus as something that all students are expected to complete.

A great little anecdote about foreign math education happened in this class. I saw that one Eastern European student was breezing through Chapter Six, and asked him if this was easy work for him. He looked at me somewhat sadly and held up five widely spread fingers. "Fifth grade in my country!" he said. I personally had learned the same material as a student in Australia in seventh grade. Yes this does suggest that something is wrong with our placement process.

Self-grade for Math 90, Spring 2008: A

LWTC Math 99, Spring 2008

A fairly large class for Math 99.

Self-pacing

Several students elected to attend irregularly, and to do their work at home. This is acceptable to me under two conditions. First, I need to look at the student's work at the beginning of Math 99 to evaluate competence and performance levels. Again, almost all foreign students are highly competent in algebra, and I try to permit them to jump through our math hurdles as conveniently as possible. These students do not particularly benefit from listening to lectures or sitting in a supervised class. Yes, most have forgotten some of their algebra skills, but all regain competence remarkably quickly, within days. The deep math learning they get from first grade on strengthens recall. Second, I need to meet with them after they have finished the work in each chapter, to assure even progress and to catch any misunderstandings. For each of the eight chapters, I assign forty problems in the text for which answer keys are available, and another 15 or so for which answer keys are not available. When a student has finished with these, I sit down with the student and go over each problem in depth. Well, usually "in depth" just means looking at the work and noting that indeed they have demonstrated mastery of the techniques.

I do have an occasional student who does not know algebra, but who elects to work at home with a tutor (usually a family member). These students also perform well, although not at the level of foreign students. The only problem is that they end up doing literally twice as much work as those who come to class. I tell them early on that by following the book as their only guide, they often learn too many techniques and do too many problems. They cut themselves off from the guidance about which topics are of fundamental importance and which are tangential tricky areas (which creep into text books in the attempt to address the better students). The main problem is that textbooks are *not* designed for student learning. They are designed for mass sales, which means that they are packed with every possible technique, every possible variation, and many problems that are simply inappropriate for the average student. This problem is certainly exacerbated by the nominal emphasis on "applications", ie word problems. Since adding the phrase "through Applications" to a title sells more books, modern texts tack on word problems to every section, give the word problems categorical names such as Engineering or Economics, and pretend that these entirely artificial problems are somehow related to real-world applications. It is a classic example of face validity, key words patched into a problem make it appear to be a valid application.

Only about one student in fifty takes inappropriate advantage of self-paced work, and either cheats or stumbles. It is very easy to identify these students, since going over their chapter work one-to-one invariably exposes lack of knowledge. I say "How did you do this?" and provide a very similar problem, saying "Show me on this example." The give away is a blank stare, or a mutter "Er, I did this so long ago that I don't remember how I did it." Sometimes a student will page through notes or the text for a long time, hoping (I presume) that I will just go away.

Self-grade for Math 99, Spring 2008: A

LWTC Math 102, Spring 2008

I have begun teaching students how their memory works, and what to do to manage forgetting math skills. Many reach Math 102 after taking a break from Math (ie Math 90), and they find that they have "forgotten" how to do math. I remind them that for *any* non-practiced skill, 60%

is lost one hour after hearing it (ie after class), 80% is lost after one week, and 90% is lost after a few months. I also show them techniques to retain memory and skills with minimal effort. This battle is more about self-perception than about skill retention. By helping students to understand how their bodies work, I hope to focus them on the aspects of skill retention that they can control.

Experiential Learning

Math 102 is taught using experiential learning (aka discovery learning) rather than rote memorization and practice. The learning is conducted in small groups, emphasizing both the experience and the communication aspects of learning. We know that discovery learning is slower, but that long-term retention is much greater. I am beginning to believe that discovery learning itself is not a slower method of teaching, it is that students have to learn both the content and the *style* of discovery, since very few of them have encountered other discovery courses, in high school or at LWTC. For certain, the students really appreciate the discovery approach, once they become accustomed to it. They feel as though they are being treated as adults, all co-participants in the process of learning. More importantly, the focus of discovery, and of Math 102, is on meta-learning, learning the skills of learning itself (learning how to learn, tolerance of ambiguity, thinking about how to think, self-observation, data exploration, problem solving, etc.) Math 102 has perhaps its greatest success in helping students to feel comfortable with their own math skills.

Student-centered Teaching

There is a transition occurring in American math education, from teacher-centered to student-centered. Most of my discussion on the first day of class is about the difference in these styles. One student in every class earnestly requests "more structure", and one of the more fun things in Math 102 is guiding these very students into self-confidence and into taking responsibility for their own learning. The Math 102 text is not 600 pages of detailed math information (unlike Math 80, 90 and 99), it encourages teaching to multiple forms of intelligence. Not only is the traditional lecture method bad for learning today's job skills (ie meta-skills; folks change jobs now on average every five years, and change job focus within organizations every six months), it is bad for knowledge retention. Um, it's also bad for self-confidence.

Many teachers seem to me to be hiding behind "what everyone else does" in order to avoid the difficult (er, effortful!) challenges of teaching for learning. This concern is not great at LWTC, since so many of our instructors are not formally trained teachers, they still interact with students like mentors, like colleagues. Thank goodness for technical training!

I've also begun taking students in each class into the MathLab for one or two sessions per quarter. This increases diversity of experience, opens the internet for interactive math teaching (there are tremendous free math resources there), and injects a much needed "let's move our bodies" component into the math classroom.

Bok (former President of Harvard) notes the solid base of research showing the value of teaching with diverse and interactive styles, and the costs to memory, confidence, and problem solving skills of teaching massive amounts of content through traditional lecture.

Balancing Project Teams

This particular class did pose some unique problems. At least two students should not have been there, since their skill levels in Math 80 and 90 were inadequate. I had passed one of these students through Math 90 myself, on compassion grounds (and in support of the Trio program), now I had to accept the consequences. It was a deep and difficult decision, to elect to pass him through Math 102 early, knowing that he would not comprehend the material. Well, the individual decision was easy, the difficulty came in forming three person project teams with known weak members. Students prefer balanced project teams, so the question was: how much burden should other students bear in supporting my choice to maintain a weak student in the classroom? Of course, I could not bring this issue to the class for discussion. I ended up taking a rather cowardly position, I put the weak students together in the same group, and spent additional time personally guiding them.

Another imbalance in project teams is dealing with students who are significantly absent (due to supportable and unsupportable circumstances). I have come across more students at LWTC than elsewhere who double-schedule class time. It's very tempting just to fail these students, but as it turns out, when I enquire, their circumstances are often both unavoidable and reasonable. People simply need to be able to pay the rent while trying to improve themselves. For egregious cases, I have been able to say: "Looks like you have made a choice to do one thing rather than the other." But what if the choice comes down to leaving young children at home or coming to class? Again it is easy to think that a student should be able to "make arrangements", but I believe this does not address the reality of our particular students. Bluntly, it is mistaking LWTC students (who support jobs and families) for UW students (who are supported solely to attend school). So I judge each circumstance individually, and continue to refuse to confound grades with attendance. Attendance is particularly important for this project-oriented course, but *flex-time* is also a necessity of today's world. If groups need to meet together other than on class time (and particularly if they do not need to meet physically but can coordinate virtually), then we as teachers need to provide that option.

Self-grade for Math 102, Spring 2008: B+

LWTC Math 107, Spring 2008

Oh boy, was this a fun course! Math 107 has not been offered in several years, and I had to solicit students to make enrollment viable. And I do love to teach new courses.

Seminar

An issue is that there was no curriculum or textbook in place for this course. I met with the students and discussed options. We elected a seminar structure. Each class period, we would meet to cover a different math topic. Each meeting, a student would take responsibility for the material and for co-teaching it with me. Rather than every student learning every topic at some superficial level, each would learn two topics in depth, and then be treated to lectures and discussions on other topics organized by the other students.

The seminar teaching model is prevalent in graduate school, where students teach content related to their research and dissertation interests. At LWTC, students do not necessarily have a deep interest in a particular topic of mathematics. As well, across the board, they have never participated in a seminar class. No one knew what to expect, but the liberation of the structure (ie no canned textbook topics with toy test problems) excited almost everyone. We arranged tables in a large block, and sat around it in a circle as co-learners.

Over half of the students did find a deep personal interest, and did do in depth research for their presentations/teaching. Topics included:

- -- algebraic models of physiology and energy consumption
- -- very large numbers in Physics
- -- Mayan mathematics
- -- Greek mathematics
- -- history of Asian mathematics
- -- how to get a good home loan

-- mathematical art
-- radioactive decay
-- probabilities of extraterrestrial life

I had the opportunity to present topics that I was particularly interested in, mainly from new areas in innovative mathematics:

-- computation with very large numbers
-- mathematical induction and recursion
-- fractals
-- history of logic
-- boundary logic
-- imaginary structures
-- computational void
-- graph theory
-- evolution of mathematical theorems

I felt at times that the specialized topics may have been boring, but the class as a whole supported the teaching structure enthusiastically.

Seminar Preparation

One weakness was that I failed to prepare readings and content assignments in advance of each session. Many students submitted their presentations for prior editing and refinement, but it was too late to pass out readings prior to the particular class. It is actually a delicate issue whether or not to trade the spontaneity of learning and exploration for pre-assigned content that many students would not do anyway.

The resolution was to accept that the content required a "second pass". After the initial presentation of a topic, I provided resources and readings, and then put aside the first half-hour of each following class for discussion of "old business". This dynamic worked well. For topics that did not hold interest, nothing more was said. For topics that had made students think (actually most of the topics covered, probably due to the fact that the content had been selected by the students), we had a time and space to answer questions, explore new ideas, and elaborate on points. Some topics even continued to show up as relevant and interesting over several class meetings.

Content Integration

The real thrill was that it soon became apparent to all that all these diverse topics were interrelated. Ideas from one "subject" showed up as central to other subjects; connections that were not at first present became articulated; some ideas came up repeatedly regardless of the day's focus. We were able to articulate how advanced geometry was important to preschool teaching; how gambling was related to the search for extraterrestrial life; how ancient civilizations faced the same mathematical challenges as advanced societies; how mathematical decisions are political decisions; how scientific and religious world views were supported by different styles of math; how physics can get something from nothing; ...

Toward the end of the quarter, I thought that explicit integration would be beneficial, so I gave this final assignment: "Make a map of the mathematics that you know and the interrelations of each topic. Pay particular attention to topics covered in class." This worked wonderfully for showing me (at least) that the students were indeed learning to see the broad-based impact of math in society, and how tightly different ideas were connected. During the final class debriefing session, students were complementary, enthusiastic, in wonder, and genuinely delighted by their experience. So I'll be sticking with this model, and I look forward to trying it again in Autumn 2008.

Self-grade for Math 107, Spring 2008: A+

LWTC Math 70 and Math 85, Spring 2008

Sue and I began an experiment this quarter. Two of her MathLab-based Math 90 students were failing, so we transferred them over into Math 85 to provide bridging options. After meeting several times with both students, the students elected to continue with the MyMathLab (internet-based) course that they originally enrolled in, but to change the enrollment to the 2-unit Math 85 and to do a much reduced workload in MyMathLab. First time through, this involved a considerable amount of work for Sue, setting up the MyMathLab course to accommodate the new structure. The students were expected to complete three of six chapters from Math 90, and this basis would then provide a foundation for success when they re-enrolled in Math 90 the following quarter. We all thought the plan to be a good one.

Well, as it turned out, both students simply stopped signing into MyMathLab (the system provides explicit records of times and activities), in effect dropping out of Math 85. The intent of self-paced learning is to lighten the burden of staff nagging students to do their work, so it was not the idea for me to meet with these students each week. Perhaps that would have worked, as it was we all failed to achieve the intended objectives.

This brings up an administrative issue: my teaching load is the standard 15 units, but I have an additional 7 units each quarter of self-study support. If "self-study" means "classwork as usual", then my teaching load becomes unreasonable (er, that is, things fail when overloaded). If it does not, then it appears that some students (particularly the ones in need) will not get the support they require. It is common for educational systems to use some revenue sources to support others. LWTC appears to be taking tuition for self-paced programs without providing adequate services. This is an administrative rather than a teaching issue, but it certainly does not feel good.

COMMENTARY ON COURSES, WINTER 2008

LWTC Math 90 afternoon, Winter 2008

This class had a delightful group of Academy students who livened up the class with interaction and dialog. They were not afraid to interrupt lecture for clarification (something the adult students rarely did), and to talk with me about the style of teaching. I let them work as a group, since they were going to do that anyway, and by making math a group project, there was more likelihood that the stronger students would help to teach the weaker students. As it turned out, one strong student assumed responsibility for the entire group, enforcing their understanding, their work, and their cooperation in the classroom. Usually 80% of Academy students drop out of my math classes, but this class maintained full retention.

One adult student was vocally adamant that she "did not understand", at least five times each class. It was necessary for me to explain in detail often (not a bad thing), to which she would say "I don't understand". After a while I learned the game, no matter what I said, she did not understand. We began looking deeper, at what it was that was not understood, this after me showing her several times that she was doing problems correctly. What she wanted was instant expertise. She somehow thought that if I said it correctly, then all of her math confusions would go away. I tried to lead her into gentle growth of understanding, but with little short-term success. Fortunately the entire interaction was light-hearted.

Self-grade for Math 90 afternoon, Winter 2008: A-

LWTC Math 90 evening, Winter 2008

This class was pretty much business as usual. I'm continuing to teach the entire course content on the first day, trying for one-half hour rather than a whole hour. The only disadvantage is that I feel like I'm repeating myself when we get to each chapter during the quarter.

Textbook Rant

A couple of students were quite anxious about math, they calmed down as the course evolved. Still, each time I spoke with them, there was a constant self-doubt, "Did I do this correctly?" Loss of confidence is so terribly difficult to overcome. I ended up constructing a path of selected problems for these students, problems that would not frustrate and would provide success. Here again the text is an enemy rather than an ally. It makes no distinction between basic skills and "hard and tricky" problems. Nothing is more detrimental to a student who is gathering confidence than to run into trick problems, or exceptions to a rule, basically undermining any understanding of the rule that was in place. Math materials need to be organized hierarchically, so that students can take small steps toward success, and solve problems tailored for their current level of understanding.

Not only does the text practice poor pedagogy, it overwhelms with detail, each section containing a basic skill mixed in with lots of special cases, insight problems that require different and more sophisticated math skills, and the dreaded word problems that serve to confuse rather than to guide. Students rightly fear word problems, since the skill-base for addressing them is often orthogonal to the math needed to "solve" them. After looking at many beginning algebra textbooks, I've noticed that the collection of word problems is actually a carefully honed sampling of "words that fit techniques". This would probably be fine, but the techniques are not related to math content they intend to teach. Specifically, the skills needed to address a problem such as "One person does a job in 2 hours and another in 4 hours. How long would they take if they worked together?" are very specific to the structure of the question type. This type of question does not easily generalize, never shows up as a real world problem, is exquisitely difficult to comprehend, and requires a twist of thinking that is as creative as it is tricky. OK material for an advanced math problem training class, not OK for the second chapter of Introductory Algebra.

Where do these problems come from? Well they show up with identical wording in my 1938 Introduction to Algebra text, on page 53. It is as though math education is defined by whatever was being done one hundred years ago!

Self-grade for Math 90 evening, Winter 2008: A-

LWTC Math 99, Winter 2008

This was a smaller class that dwindled in enrollment and attendance as the quarter progressed.

Individualized Lectures

Here is a difficulty with self-pacing: those who finish early leave the rest stranded, often in small groups. Toward the end of the quarter I gave up lecturing altogether, because the students in class were no longer working on the material in the lecture. Well, I actually gave the class lecture on a one-to-one basis several times. It seems as though others who overheard the same ideas being repeated several times benefitted.

This then is a new teaching technique that I have not seen recorded in teacher education texts. Give the lecture to each student individually, on an as-needed basis. In that way, the class hears the lecture a dozen times, and is hopefully impressed about how to approach a particular type of problem. There is a self-balancing mechanism with this technique. Content that does not need to be repeated (cause every student follows it) is not repeated, while content that does need repetition is repeated exactly the number of times necessary for everyone in the class to comprehend it!

Self-pacing

I had a couple of students show up after a month of absence with the entire text and all assignments completed. This is OK, but I did not get a confirmation with them that this is what they were doing. Their work was excellent, and they did demonstrate all necessary skills, so the only refinement is to make sure I know a student's intention for self-pacing.

I felt that one of these students did not have sufficient grasp of a latter chapter in the book. I asked her to work a couple of problems for me, and she did them quickly and correctly. Still, I had committed to questioning her understanding. I offered a B grade for the current work, or a potential A grade if she were to do an additional collection of difficult problems that I selected. Although she was eager to finish the course, she said she wanted to work for the higher grade, and came back two days later with all problems done correctly. What I'm wondering is: had I made her jump through hoops that were more beneficial to me than to her learning? It was as though my ego was uncomfortable with the style she had used to complete her work. So a caution to myself: I need to be less involved in the self-pacing process and more focussed on skill attainment.

Self-grade for Math 99, Winter 2008: A-

LWTC ABED 30, ABED 40 and Math 95, Winter 2008

We had a departmental discussion about how to provide grades for the self-paced courses. Clearly the ABED courses were pass/fail, but I had thought that self-paced Math 70 was also not given decimal grades. Corrected without incident.

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=============== WORKING WITH FACULTY/STAFF ===============

----------- THIRD TENURE REPORT, DECEMBER 2008 ----------

Administrative Duties

Successfully assumed responsibility for half of the management jobs for the Department. Supported development of the Math Lab.

The division of departmental responsibilities with Sue is working excellently. She is apparently happy with the things that I handle, and I'm definitely happy with the things that she handles.

Global Outcomes

Failed to be able to attend the Global Outcomes Committee meetings because of scheduling conflicts with classes. Did manage to find other ways to contribute.

Mastering Math Course

Neera Mehta has developed a one-unit course, "Mastering Math", intended to address math anxiety and math study skills. With Sue, I met with Neera, offered suggestions and refinements, and participated in the course by attending the class once.

New ECE Course

I met with Pat McPherson of Early Childhood Education to discuss a math course for Preschool teachers. With available funds, I designed, developed, documented, and built curricula modules for this course, which I plan to teach in Winter 2009.

The course description for Mathematics for Preschool Teachers:

> Mathematics for Preschool Teachers provides the necessary tools and knowledge for successful teaching of mathematics to pre-school children ages 2 through 6. Teachers will learn how to play with the mathematical ideas that define the content standards for pre-elementary mathematical skills: number and operations; patterns, functions and relations; geometry and measurement; and problem solving and data analysis. This hands-on course covers a diversity of math activities, including pattern blocks, art, virtual manipulatives, cooking, inside and outside games, math problems, and group activities.

New Math Course for LWTC Computer-based Programs

Digital Mathematics was prepared for computer-oriented departments such as MMDP, Electronic Design, and IT. The course description:

> Digital Mathematics is focused on the mathematical knowledge, skills and techniques necessary for success in computer-based technologies. Content includes counting, number systems, logic, relations, recursion, graphs and trees, algorithms, data structures, digital circuits, software languages, and programming. This course is often named Discrete Mathematics when taught in Computer Science departments.

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========= SERVICE (COLLEGE, COMMUNITY, INDUSTRY) =========

----------- THIRD TENURE REPORT, DECEMBER 2008 ----------

Grant Proposals

The infrastructure and support materials for NSF and industry grant proposals was developed during tenure periods 1 and 2. None of the three submissions was funded.

I've worked on correcting and extending the prior proposals to meet the concerns of reviewers during this tenure period. Another submission to NSF should be made in early 2009. No submissions have been sent thus far this year cause I've been too busy with other things.

I'm not surprised that the three proposals have not been funded. The Honda proposal was a guess about what a corporation may fund; the NSF proposal had definite weaknesses, and was a trial run; and the DoEd proposal was directed to the wrong client, since DoEd funds evaluative rather than exploratory research. All three were appropriate for exploring the possibilities and requirements of funding.

What I was surprised about is that this work came to an almost total halt during 2008. I had hoped to resubmit to the NSF at least. But 2008 brought several new obligations, including family matters, more work within the Math department, and the big programming task.

While exploring future avenues of funding I discovered some explicitly political issues that strongly indicate to wait until 2009 for resubmission of proposals. One surprise is that governmental agencies in Washington DC had changed funding policies in that proposal writers were required to visit decision makers in DC and sell their causes in order to be eligible for funding. This was a procedural change, and indicates just how political the national government has become. Another surprise was not unexpected: the government had more or less stopped funding innovative research channelling monies instead into programs that had already been approved through earlier funding.

I'm teetering, here, on the brink of political commentary, but I feel that it is reasonable to acknowledge the sadness shared by 80% of Americans that the federal government has stopped serving the American people.

College in the High School

Continued participation.

College Assessment Contributions

(1) I wrote a qualitative analysis piece for Institutional Effectiveness (Dave Cunningham) on the bottleneck in access to Math courses caused by the State requirement of Math 99, "The Intermediate Algebra Bottleneck".

(2) I reviewed statements of global objectives incorporated in course descriptions for all 1200 courses taught under 106 departmental codes at LWTC. Work included the identification and analysis of

-- missing course descriptions

-- course descriptions missing global objectives

-- the number of courses in each department incorporating global objectives, and

-- the breakdown in types of global objectives identified in the 400 courses which incorporate global objectives in their description.

(3) I wrote a series of memos to contribute ideas to the Global Outcomes Committee. These memos included:

"The Assessment Plan"

How to develop a formal public document that identifies a program's learning goals and assessment procedures.

"Assessment Without and With Three Syllable Words"

One problem with assessment literature is that it is steeped in jargon. This memo presents assessment techniques and strategies in simple language in bullet form.

"Some Assessment Tools and Methods"

There is a wide variety of assessment techniques that can be customized to specific structures and needs within LWTC programs. This memo surveys the choices.

"Exercises for Program Goals"

Sometimes programs are inexperienced in developing goals that conform to assessment procedures. This memo presents many exercises that help to clarify program goals.

"Multiple Levels of Analysis: Detail and Recommendations"

Dean Emory asked for suggestions about organizing the LWTC global objectives project. Although not an explicit roadmap, this memo contains structural suggestions and techniques to make assessment planning more tractable.

Faculty/Administration Contract Negotiations

I wrote a short tutorial about how to think about the Interest-Based Bargaining process from the perspective of its origins as a mathematical theory, "Game Theory and Interest-Based Bargaining".

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============ PROGRAM MANAGEMENT/ADVANCEMENT ============

----------- THIRD TENURE REPORT, DECEMBER 2008 ----------

Math Teaching Styles Student Survey

The Math Department began a pilot program of teaching math classes in the Math Lab in Spring 2008. To determine the expected student demand for Math Lab courses, I designed and conducted a survey of student preferences for different types of math teaching styles. The one page survey described four different teaching styles and asked students to rank order their preferences.

Over 400 students ranked their preferences for four different mathematics teaching styles: Traditional classroom, MathLab, Hybrid, and Online. Two out of three LWTC students identify Traditional classroom math teaching as their first preference. Two out of three strongly dislike Online math teaching.

I recommended that least three of every four math courses should be offered in the Traditional classroom format. The remaining one-in-four should be MathLab classes, with increasing frequency as coursework becomes more mathematically complex.

College-Level Math Offerings

As LWTC grows into a four-year institution, college-level math will become more important, both as a requirement for degrees and as a response to national initiatives to enhance math learning. I wrote the memo "College-level Math at LWTC" to begin to address the organization of our college-level math offerings. The general idea is to change the content of Math 99 from Intermediate Algebra to Quantitative Reasoning (ie the content of Math 102), making it a path to college-level math courses that has already been vetted by the LWTC technical faculty.

Global Assessment

Developed global assessment rubrics and assessment plans for the department.

Math 80 (prealgebra) and Math 90 (introductory algebra) have been designated as the sampled courses for assessment studies. For these courses, the activities of learning, practicing, and applying the skills of algebra serve as behavioral indicators of critical thinking. The assessment loop is:

-- Construct final exams that reflect course content and objectives, in particular, that measure student performance in algebraic critical thinking.
Conduct item analysis for each test question to assess alignment of items to specific instructional content objectives.

-- Evaluate student performance using these department wide final exams. Conduct performance analysis at the item level to determine student performance on specific instructional content objectives.

-- Review performance metrics with entire faculty once each quarter, to identify strengths and weaknesses in students performance.

-- Review departmental objectives for student performance, in light of current trends in mathematics education, State requirements, and service to students.

-- On a yearly cycle, design and implement changes in teaching styles, curriculum and final exam structure (at the item level) that address both weaknesses in desired student performance and changing trends in mathematics education.

-- Correlate changes in student performance on final exams with the previous year's changes in curriculum and teaching. Generalize successful strategies to other Math Department courses. Target unsuccessful strategies for revision and modification. Iterate the assessment and evaluation process yearly.

Departmental Course Descriptions

While reviewing the Math Department course descriptions, I noticed several technical errors and a sundry collection of grammatical errors. Without substantively changing the content of the courses, I re-wrote all course descriptions to:

- -- improve consistency of presentation style and language
- -- remove illiteracy and bad grammar
- -- remove a few technical errors in content objectives
- -- update descriptions to current practices.

The entire set of new descriptions was submitted to the Curriculum Review Committee in 11/08.

Departmental Textbooks

The textbooks for the main math courses offered by the Department (Math 80, 90, 99) recently came out in a new edition. Since we were facing the possibility of changing textbook editions, I decided to review all texts for suitability for the Math department. Many textbook decisions were made years ago, and these possibly needed updating.

We divided the courses into two sets, those to be reviewed this year (80, 90, 99, 141, 142, 151, 152) and those to be reviewed during the 2009-2010 academic year (ABED 30, ABED 40, 70, 85, 95, 102, 107, 146).

I did a critical analysis and review of all current math textbooks used by the department and then ordered over 50 relevant textbooks for the target courses I reviewed these prealgebra, algebra, and calculus textbooks as potential candidates for use and suggested new texts for each of the eight courses being considered.

We eventually decided upon these selection criteria:

-- coverage of content currently in LWTC course descriptions
-- clearer presentation style
-- customization for the needs of LWTC
-- support by the part-time Math faculty
-- integration with MyMathLab software
-- publication date in 2008/9
-- cost of textbook to students

I selected the best candidates, queried the faculty, and made several suggestions which were discussed in our quarterly faculty meeting. With refinements, I then obtained instructor's editions, distributed new textbooks, answered questions, and managed integration of coursework for new texts.

With the selection of new texts comes a more-or-less complete revision of curriculum materials (not in content but in details). This includes constructing new department-wide final exams for Math 80 and Math 90, and providing faculty with updated support materials, chapter sequences, and content emphases. I managed this transition, made sure all faculty had the course materials they needed, and prepared new department-wide final exams.

LWTC Math Lab

Support for Sue and other faculty teaching in the MathLab included troubleshooting of software, hardware, furniture, and supplies. I introduced my classes to the MathLab and taught several lessons there for each class (except for Winter 2008).

Math Lab Resource Materials

Collecting and organizing available math resources on the internet is an important component of the Math Lab. This is a large job that has only just begun. I was surprised that given search words, almost all students can find relevant and useful materials. This suggests that we may not need to collect a compendium of URLs to guide students to. They can find them themselves. This removes a significant obstacle to this process, since URLs tend to long and difficult to type, as well as being highly transient and generally unreliable.

Math 80 Departmental Final

Analysis of items with regard to content emphasis in new text books. Selection of new items and revision of old items.

Rewriting the Math 80 final requires reviewing all questions for their relevance to the new textbook, anchoring the questions with page numbers that teach their content, and customizing many questions for the specific emphasis on content in the new textbook.

Math 90 Departmental Final

As a next step in the departmental assessment plan, I’ve developed a Math 90 departmental final, similar to the Math 80 final, but reflecting curriculum and textbook objectives in beginning algebra.

Math 107 Curriculum

Math 107 had not been taught for several years. I felt that this course was an important component of the LWTC higher math offerings. Our Health Sciences students take the Statistics course, leaving the precalculus series as the other primary higher math options. However LTWC students are rarely interested in pursuing higher math, so I felt there was a coursework vacuum for students who did not want or need precalculus. Math 107 fills this vacuum.

I redesigned the course and presented as a seminar class. I had to solicit students to fill the enrollment quota. Now in place, this course can provide an appropriate college-level math experience for students not in the physical or health sciences programs.

An important component of this idea is adding another college-level math course for students in computer-related programs (Digital Mathematics).

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================ PROFESSIONAL DEVELOPMENT ================

----------- THIRD TENURE REPORT, DECEMBER 2008 -----------

NEW PROJECTS

I wrote a short piece for AI Magazine on experiences while implementing algorithms for Boolean minimization, published in April 2008.

Contributed to Boundary Institute proposals to FQXI, NSF, Microsoft, and DARPA.

Attended the 2008 National Council of Mathematics Teachers Regional Conference.

CONTINUING PROJECTS

Spatial Math Book

This writing project has moved forward in spurts. After the initial draft, work stopped for several months because I was too busy with family matters. I picked it up in Summer '07 for a while, after thinking about the target audience. I was not happy about how technical the text had become. At the start I was writing a book about revising the axiomatic basis of arithmetic and algebra, and felt that the first item to be addressed was to provide the alternative axiomatic basis and to compare and contrast it to existing approaches. This at first did not seem too esoteric, since the conventional basis is taught universally as the Rules of Arithmetic and the Laws of Algebra, appearing in some form in every introductory math text from first grade on! The whole idea was to show that formal mathematics could be far easier, far more palatable for students, without loosing its strength or its formality. But the result was not easy reading, and more importantly, would potentially only be of interest to a very small community of mathematicians interested in the foundations of math.

Nonetheless, developing a new and much simpler set of "rules" for algebra is an accomplishment. The last comprehensive set of algebraic axioms were developed about a century ago. The field of Axiomatic Foundations is rather unusual in that it addresses the formal basis and "definition" of arithmetic and algebra, and its results are in every math textbook, but very few mathematicians are interested in moving the field forward. It is generally believed that there is only one definition of algebra, and that it has been fully explored. So the technical area I work in is both controversial and politically suppressed. The technical work, although necessary, was unlikely to be published or accepted, and so I had decided to take the semi-popular route, emphasizing not the formal structures I had developed, but the pragmatic convenience that they offer in making math both simple and intuitive. I should emphasize that the formal work is not an attempt to explain or make clearer the existing structure of math, but to provide a completely different foundation for math that is closer to its origins, does not alter how it works, but that does remove the inaccessible and remote approach to math that has dominated the 20th century.

Over the Summer I expanded and generalized and softened the formal text. The main technical body became a later chapter for specialized interests. The new material needed to address two questions from a more popular perspective. First, why do Americans think that math is difficult, and what are we currently doing to create the math chasm? Second, what is math anyway? The idea is to link the technical content first to a real problem, and then to show that the problem is linked to a country-wide misconception about the nature of mathematics itself. Math is constructed as a highly technical subject that is the provence of only a few highly trained academics. Math currently has virtually no structural qualities intended to be *learnable*. The theme of the text is that this is not necessary on any level. Math can be structured to be easily understood by students, without changing its formal appraoch. All that needs to be changed is the merciless approach to math as it is taught today. My objective is both to provide the simpler approach and to explain why it is preferable.

The current text is still a loosely connected set of essays and ideas and examples, far from integration, although the conceptual structure is fairly tight. But another distraction, or rather "important focus", come up. I needed demonstration material to make the new approach to math accessible. Again, a very small audience would be interested in a critique without easy access to the alternative. So I began to more closely integrate the Mma Programming Project (below) to the text. Now here's something about programming: it eats up all your time. For all of 2008, rather than write, I've been programming the systems described in the book, an adventure described next.

<u>Mathematica Programming</u>

The project focus is described in the Second Tenure Report below. Here I'll describe the evolution of system functionality.

The idea is to make an interactive computer display that does arithmetic in an entirely new way. Well, it is actually doing arithmetic in an entirely old way, the way the Babylonians did it 5,000 years ago, when ideas about math were simple. The modern components are pragmatic (a computer-based, visual and interactive implementation) and formal (an axiom system to replace the century old conventional Rules of Algebra).

I built the core display system over the second tenure period, using binary arithmetic. The binary approach illustrated the differences in axiomatic and computational style very clearly, and supported a secondary objective, to provide design models for an entirely new form of silicon architecture.

Intuitive Interface

This year, I added an intuitive interface, so that the core could be accessed without the distortion of conventional assumptions about how arithmetic should work. The interface (below) is identical to a simple handheld calculator, something most people are well familiar with. The substantive difference is that rather than showing the computed result as a string of digits, it shows the spatial form of the problem. More importantly, it shows an animation of the entire computational process, something hidden in hand calculators and requiring memorization and computational effort unavailable in conventional arithmetic.

Decimal Notation

Continuing the evolution toward accessibility, I re-implemented the display system for decimal (conventional) notation. A user can now enter a problem as if using a conventional calculator and see the process of spatial computation in decimal notation. The result then looks identical to the result of a conventional handheld calculator. The difference is that the conventional calculator does not show how the result is obtained. And indeed, the way the result is obtained in silicon circuity is substantively different than what we currently teach. That is, calculators do not even follow the rules of arithmetic (er, they follow the rules of Boolean logic). The simpler rules of algebra implemented in decimal notation within the spatial algebra system clearly identifies and separates the intuitive components of math understanding from the aspects coming solely from the choice of notation.

Return to Simplicity

As everybody knows, "how to do arithmetic" is taught by memorization of complex and esoteric (at least for a three year old) algorithms. Conventional computation in arithmetic involves these ideas:

-- Addition and Multiplication tables, which must be memorized.
-- rules for aligning place values in columns
-- rules for carrying and borrowing, to manage overflow and underflow within each place value.

It is these artifacts that I'm seeking to get rid of, making addition as simple as shoving piles of things together, and multiplication as simple as substituting a pile for each individual thing in a different pile. These ideas are not new, they are embodied in addition blocks and Cuisennaire rods used in preschool. The display system simply shows these processes (shoving and substituting), and then solves the problem of knowing how many you have after the simple arithmetic actions are done.

It is easy to shove piles together, but then from a conventional approach, you have to count up the collected pile to know the result of the addition. Place-value arithmetic is a method of counting up the results, not of doing the act of addition! Place-value arithmetic provides a way that large numbers can be managed. We teach all children this method as the algorithms of addition, multiplication, long division, etc. This way is called the "Rules of Arithmetic", and includes ideas such as commutativity, associativity, the zero laws, the inverse laws, and distribution.

Math teaching confuses very simple and intuitive mathematical actions (combining and substituting) with very specific and complex algorithmic processes (computing the sum, computing the product, applying the rules).

The number management efficiencies offered by place-value computation come with a dual cost. We must abandon the simple ideas of combining and substituting, and we must embrace the memorization of non-intuitive rules. The animation component of this project shows directly that both costs are unnecessary. The cost, instead, is that a student must return to preschool, to relearn the simplicity of math.

Of course, there is no way that society is going to change the way we do math. The current rules of algebra are universal, even if they are misleading and inefficient. It is not my intent to change anybody, just to make a different way of thinking about math accessible to others who may be interested.

To Do List

The original project was scoped broadly, and supported by the original architecture. Here's the status:

CAPABILITY	IMPLEMENTED	TO DO
Input and Display	all functionality	
Base System	unary, binary, decimal	refine unary
Display Dimension	2D	1D, 3D
Arithmetic Function	plus, minus	multiply, divide
Modality	visual (b&w)	color, audial

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