MATHLAB DESIGN and EQUIPMENT
William Bricken
August 17, 2007

PHYSICAL MATERIALS (see attached to-scale layout)

- 22 computers
  - -- 18 Vista/Windows PCs
  - -- 4 iMacs
- 14 6x3 workstation tables
- 7 5x2 trapezoid tables
- 2 3x3 carrols
- 40 chairs
- 4 small cabinets
- 1 printer
- 1 TV monitor with DVD player

COMPUTING INFRASTRUCTURE

Lab server
- -- gateway to Internet
- -- SQL database software
- -- appropriate admin software
  - client/server (file system, database, transaction,...)
  - version control
  - lab network software updater
  - permissions
  - resource allocation (student accounts)

1 Tb+ communal harddisc storage

SOFTWARE (* potential purchases, can discuss)

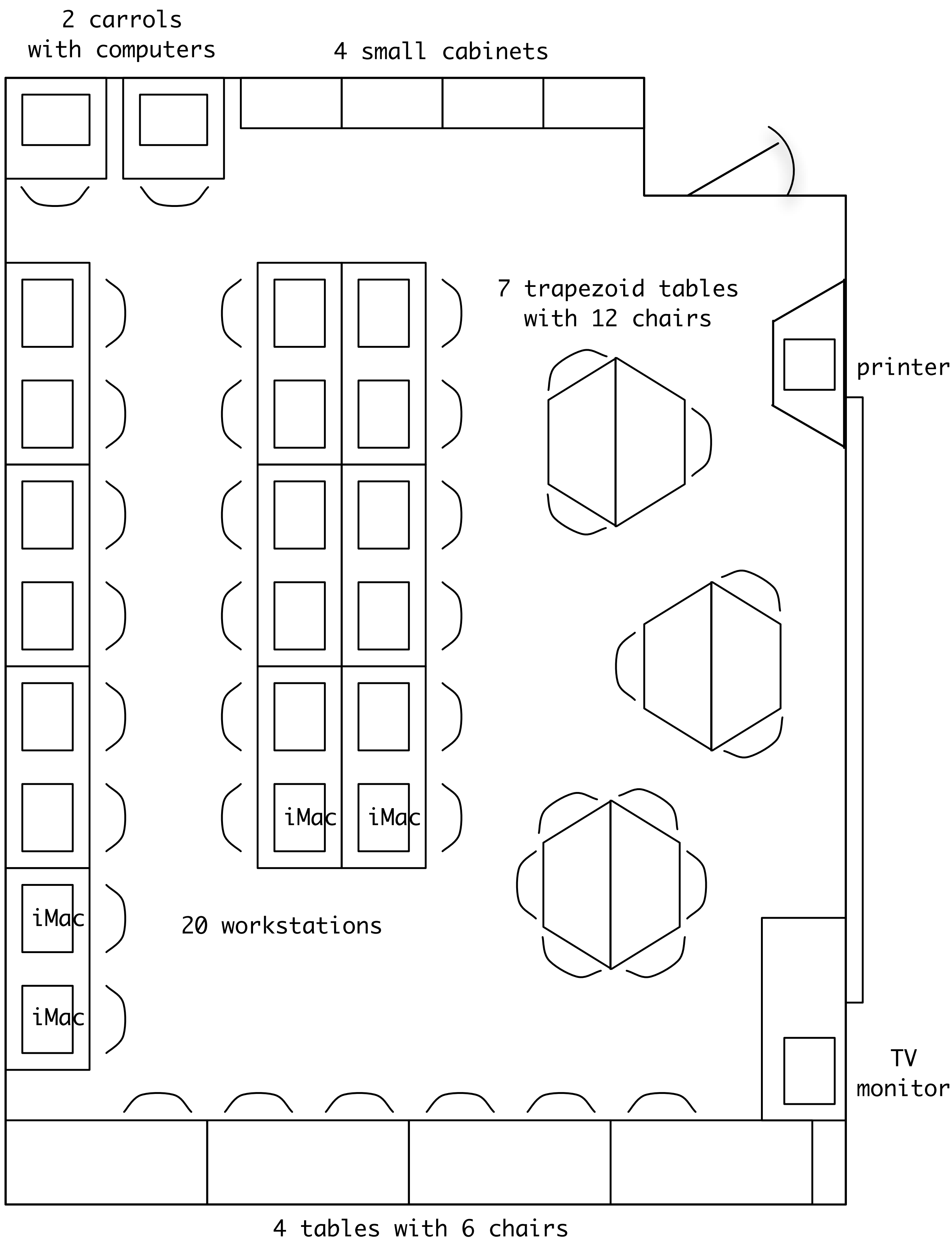
18 computers with MS OS suite
- Office
- Zippit

4 iMacs with Mac OS 10.4 suite
- iWork
- iLife
- OmniGraffle*
- Adobe Creative Suite (any version)
- Stuffit
- Office (any version)

all
Firefox
Adobe PDF
VLC
Google Earth
Mathematica Player

1-2 Macs
Adobe Creative Suite including CS3 webdesign tools
Mathematica 6.0*
Cheetah3D v4*
Adobe Acrobat v7 Pro

some PCs
Quicken*


2 carrols
with computers
4 small cabinets
7 trapezoid tables
with 12 chairs
printer
iMac
iMac
iMac
iMac
20 workstations
TV
monitor
4 tables with 6 chairs

Math 80 Syllabus Guidelines

For Autumn 2008, the LWTC Math Department is changing the Math 80 textbook to: Martin-Gay, Prealgebra 5/E ISBN: 0-13-157643-7.
The suggested content coverage for the 5-unit Math 80 course is listed below:

Necessary Content

Chapter 1 (all)	The Whole Numbers
Ch 2 (all)	Integers and Introduction to Solving Equations
Ch 3 (all)	Solving Equations and Problem Solving
Ch 4.1 - 4.5, 4.7 & 4.8	Fractions and Mixed Numbers
Ch 5 (all)	Decimals
Appendix D	Scientific Notation (include in Chapter 5)
Ch 6.1 - 6.3	Ratio and Proportion
Ch 7.1 - 7.5	Percent
Ch 8.1 - 8.2	Introduction to Statistics
Ch 9 (all)	Geometry and Measurement

Optional Content

Ch 6.4	Square Roots
Ch 6.5	Congruent and Similar Triangles

Not Recommended Content

Ch 4.6	Complex Fractions
Ch 7.6	Percent and Problem Solving: Interest
Ch 8.3	The Rectangular Coordinate System and Paired Data
Ch 8.4	Graphing Linear Equations in Two Variables
Ch 8.5	Counting and Introduction to Probability
Ch 10 (all)	Exponents and Polynomials

The Martin-Gay prealgebra text has these changes in emphasis:

Whole number operations are covered more quickly.
Equations are introduced earlier, emphasized more, and better integrated.
Geometry and Statistics are emphasized more and better integrated.

Math 90 Syllabus Guidelines

For Autumn 2008, the LWTC Math Department is changing the Math 90 textbook to: Martin-Gay, Beginning and Intermediate Algebra 4/E ISBN: 0-13-600731-7. This is an integrated Math 90 (Chapters 1-6) and Math 99 (Chapters 7-11) text.

The suggested content coverage for the 5-unit Math 90 course is listed below:

Necessary Content

Chapter 1 (all)	Review of Real Numbers
Ch 2 (all)	Equations, Inequalities, and Problem Solving
Ch 3 (all)	Graphs and Introduction to Functions
Ch 4.1-4.3 & 4.5	Solving Systems of Linear Equations
Ch 5.1-5.6	Exponents and Polynomials
Ch 6 (almost all)	Factoring Polynomials

Optional Content

Ch 6.1 (part)	Factoring by Grouping

Not Recommended Content

Ch 4.4	Systems of Linear Equations in Three Variables
Ch 5.6 (part)	Long Division of Polynomials
Ch 5.7	Synthetic Division and the Remainder Theorem
Ch 6.5 (part)	Sum or Difference of Cubes

The Martin-Gay algebra text has these changes in emphasis:

Functions are introduced earlier.
Problem-solving strategies are discussed more.
Much less redundancy between Math 90 and Math 99 content.
Appendix C provides a condensed overview of algebra topics.

Math 99 Syllabus Guidelines

For Autumn 2008, the LWTC Math Department is changing the Math 99 textbook to: Martin-Gay, Beginning and Intermediate Algebra 4/E ISBN: 0-13-600731-7. This is an integrated Math 90 (Chapters 1-6) and Math 99 (Chapters 7-11) text.

The suggested content coverage for the 5-unit Math 99 course is listed below:

Necessary Content

Chapter 7 (all)	Rational Expressions
Ch 8.1-8.2 & 8.4	More on Functions and Graphs
Ch 9.2 & 9.4	Absolute Value Equations, Linear Inequalities
Ch 10 (all)	Rational Exponents, Radicals, Complex Numbers
Ch 11.1-11.3, 11.5-11.6	Quadratic Equations and Functions

Optional Content

Ch 9.1	Compound Inequalities
Ch 11.1 (part)	Completing the Square
Ch 11.4	Non-linear Inequalities
Ch 12.1-12.3	Exponential Functions
Ch 4.4	Systems of Linear Equations in Three Variables
Appendices D, E	Matrices and Determinants

Not Recommended Content

Ch 8.3	Graphing Piecewise Functions, Shifting, Reflecting
Ch 9.3	Absolute Value Inequalities

Instructors may wish to visit either Appendix C or earlier chapters for review of Math 90 content.

The Martin-Gay algebra text has these changes in emphasis:

- Functions are introduced earlier, with more emphasis.
- Problem-solving strategies are discussed more.
- Intermediate algebra is introduced much more quickly.
- Much less redundancy between Math 90 and Math 99 content.
- More instructor choice for deeper algebraic content.

COLLEGE-LEVEL MATHEMATICS AT LWTC

William Bricken
October 2008

As LWTC heads toward four-year status, our college-level math offerings will need to mature. The majority of our math teaching is currently at the high-school and remedial levels, which has led to a decreased emphasis on our college-level courses. One exception is Statistics, which is a requirement for the Health Sciences. In the future, we should expect other programs to require higher levels of math training, particularly those programs seeking four-year credentials. This memo provides an outline for a more robust offering. The Table below shows a possible alignment between math coursework and technical programs. A discussion of courses then follows.

Course	Content	Programs
Math 90	Algebra	all
New Math 99	Trigonometry,Exponents, Logic, Probability, Geometry,Measurement	all
Math 101	College Algebra	Cultural/Physical Sciences
Math 107	Math in Society	non-Science, Business
Math 141,142,151,152	Precalculus & Calculus	Physics, Engineering
Math 146	Statistics	Health Sciences
Math 1xx	Digital Math	MMDP, IT, CSNT, Engineering Graphics, Electronic Design

To meet State requirements, all students must pass (or test out of) Math 90 and New Math 99. All LWTC students will then have a baseline of the math skills we currently require for the technical AA. Since New Math 99 is not a college-level (100-level) math course, all students would need to take one additional math course to qualify for an AA. This requirement is already in place for students currently taking the Old Math 99. So the additional requirement would be placed on students who currently take the non-transferable (paradoxically non-100-level) Math 102.

This additional requirement is supported by four observations:

1. Math 102 is dysfunctional for students since it limits their ability to continue their college education in a four-year program.

2. BAT programs must abandon Math 102 anyway. In particular, MMDP students are not currently required to take Old Math 99, but it will be a requirement for entry into a four-year program.

3. The students who find Old Math 99 to be an insurmountable obstacle are precisely those who need additional training in mathematics, and precisely those for whom Old Math 99 is irrelevant.

4. Math training is a national priority, and the LWTC math curriculum will continue to be an obstacle to the growth of the college as long as Math 102 is available (since Math 102 is a stop-gap measure to bypass math training that is required in all other community colleges).

One problem is that we are short-circuiting higher math pathways for non-Science students by offering Math 102. This in turn is due to technical programs not requiring college-level math. And this is because the State requirement for Math 99 (Intermediate Algebra) puts too much of an academic burden on technical students. Indeed, Math 99 is not appropriate for our students; a more diversified second-year high-school level math course is needed. This outline is critically dependent on solving the Intermediate Algebra Bottleneck. Once this obstacle is removed, many of our technical students can benefit from Math 107.

A primary aspect for this proposal is to bolster our 100-level math course offerings with sufficiently diverse content that all technical students would benefit from the additional math course. Rather than requiring a potentially irrelevant course in Intermediate Algebra, we would require a 100-level course specialized for the student's technical program. The following list is minimal, and has been constructed without guidance from the technical programs:

Math 90 Algebra

Our current algebra course, which provides sufficient algebra skills for students to succeed in math topics other than algebra.

New Math 99 Applied Mathematics

This course replaces our current Intermediate Algebra. The curriculum is the same as our current Math 102. That is, New Math 99 is Old Math 102. Content includes trigonometry, sets, logic, and exponential modeling.

Additional content could be added, and in the past, has been dynamically added and taken out of the Math 102 curriculum. Of particular interest would be topics of measurement, geometry, and data analysis.

Math 101 College Algebra

This transferrable course provides more algebra skills for Physical and Cultural Science students. It aligns with the standard first-year of college algebra offered in most four-year institutions. Subsumes Old Math 99.

Math 107 Mathematics in Society

This course for non-Science majors has been classically under-enrolled. It is sufficiently non-rigorous for most non-Sciences technical students to pass and to benefit. Content includes a wide diversity of applied mathematical topics, including computer logic, finance, statistics, number systems, graph theory, matrices, and the historical and cultural evolution of mathematics.

Math 146 Statistics

No modifications necessary. Appropriate for the Health Sciences and Science Technician programs.

Math 141-142-151-152 Precalculus and Calculus

Should more engineering disciplines require preparation for calculus, these courses are in place. A primary motivation for this outline is that Calculus is inappropriate in today's computer-based workforce; it should be the default coursework in higher math only for the physical sciences and some engineering disciplines.

Math 1xx Digital Mathematics

There is currently an anachronism in most college math offerings. Students in computer-based programs do not study appropriate math content, instead they are required to take calculus. LWTC has the opportunity to address this problem while serving student needs in MMDP, IT, CSNT, Engineering Graphics, and Electronic Design. The proposed new Digital Math course might be described as follows:

> 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.

LWTC MATH DEPARTMENT GLOBAL OUTCOMES MATRIX and ASSESSMENT STRATEGY
William Bricken
September 2008

Mathematics is the formal study of symbolic structure, and traditionally includes these areas:

- -- logical symbols and their association with reason and rigor
- -- numerical symbols and their association with quantity and measurement
- -- geometric symbols and their association with space and time
- -- abstract symbol structures and their association with pattern and symmetry
- -- description and analysis of data, including probabilistic interpretations
- -- rigorous techniques of problem solving and understanding

The LWTC Math Department provides critical thinking experience and training for all students. Each Math department course contributes directly to the global objective of critical thinking. 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.

LWTC MATHEMATICS DEPARTMENT COURSE MATRIX

All courses contribute to the global objective of critical thinking.

COURSE	UNITS	CONTENT	LEVEL	ENROLLMENT
ABED 30	5	arithmetic	developmental	variable
ABED 40	5	arithmetic	developmental	variable
Math 70	5	arithmetic	developmental	160
Math 80*	5	prealgebra	developmental	300
Math 85	1 or 2	prealgebra topics	developmental	variable
Math 90*	5	beginning algebra	high school	500
Math 95	1 or 2	algebra topics	high school	variable
Math 99	5	intermediate algebra	high school	100
Math 102	5	quantitative reasoning	LWTC special	160
Math 107	5	math in society	college	30
Math 141	5	precalculus (functions)	college	40
Math 142	5	precalculus (trigonometry)	college	20
Math 146	5	statistics	college	100
Math 151	5	beginning calculus	college	20
Math 152	5	intermediate calculus	college	10
Math 1xx	5	digital math	college	new course
Phil 106	5	symbolic logic	college	new course

Enrollment figures are yearly averages.

* Math 80 and Math 90 are indicator courses for assessment due to their high enrollment.

MATH TEACHING STYLE SURVEY RESULTS

William Bricken
November 2008

The LWTC Math Department began a pilot program of teaching math classes in the Math Lab in Spring 2008. In Autumn 2008, we began fully using the Math Lab as a teaching environment. To determine the expected student demand for Math Lab courses, we conducted a survey of student preferences for different types of math teaching styles. The one page survey describes four different teaching styles and asks students to rank order their preferences. This form is included as Appendix A. This report contains the results of the survey.

CONTENTS

EXECUTIVE SUMMARY

Over 400 students currently enrolled in LWTC math classes ranked their preferences for four different mathematics teaching styles: Traditional classroom, MathLab, Hybrid, and Online. MathLab courses teach content via online computer-assisted coursework, but with the continuous presence of a live teacher to provide instruction and guidance. Hybrid courses divide classes into one-half Traditional (in a classroom with a teacher) and one-half Online without the presence of a teacher. Online courses conduct all teaching without the physical presence of a teacher.

Results

Two out of three LWTC students identify Traditional classroom math teaching as their First preference. Two out of three identify Online math teaching as their Last preference. Student dislike for the Online style increases as they take more math courses, being replaced by a preference for the MathLab style. Taking a MathLab course also increases a student's preference for the MathLab style.

Recommendations

Recommendations are based on student satisfaction only; administrative convenience is not considered.

At 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 sophisticated.

To serve its students, at least in mathematics, LWTC should emphasize personalized classroom interaction as its marketable advantage, while providing a small number of MathLab courses to satisfy the students who do not prefer the conventional classroom. LWTC should not offer online math courses, other than those offered through WAOL.

From an educational perspective, LWTC students want and need human interaction while learning math. Computer-based teaching programs do not exhibit many teaching skills that satisfy the needs of learners, including informed diagnosis, immediate and compassionate interaction, personalized feedback, enforced structure, peer discussion, interpretation of steps taken while problem solving, the convenience of paper and pencil jotting, flexible input and recording, and warmth. Necessarily, computer-based math teaching focuses on symbol manipulation rather than on comprehension and problem-solving.

CONTEXT

Computer-Aided Coursework

As an aspect of our ongoing departmental assessment of the quality of our teaching, the Math faculty obtained permission to open a math teaching lab. The MathLab includes classroom teaching space and 24 online computers. In 2007, we evaluated several online math teaching programs, and settled on the Pearson product, MyMathLab. The Department also standardized its textbook selections on Pearson products, so that potentially all math courses could be offered in two teaching styles, traditional classroom and computer-assisted.

Commercial software products for teaching math provide a diversity of functions for instructional support, centermost of which is a structured rendition of the conventional textbook. The program provides organizational support (automated rolls, attendance, grading, tracking, etc.), online student assistance (webpages, online help, FAQs), and a customizable curriculum. The online student experience provides instructional videos, animations, worked-out sample problems, practice problems, and step-by-step hints, all focussed on manipulation of mathematical symbol structures. Students work their way through a sequence of problems, take practice tests, receive right/wrong feedback, and pass online exams in order to move on to following chapters. Progress is self-paced within specific deadlines for completion.

Computer-assisted teaching in the LWTC MathLab incorporates a live instructor who introduces mini-lectures and paper-and-pencil exercises, who provides personal help and guidance, and who encourages class interaction. The commercial teaching software augments rather than determines learning. The Math faculty expended considerable effort (hundreds of hours collectively) setting up the MathLab, learning the MyMathLab product, and hand selecting every math problem presented to students for several courses. Customizing the product for a course must be repeated for each different course; construction of testing materials is a ongoing overhead.

Although programs for teaching math have been researched and developed for over two decades, these products are still quite immature. The software development skills of book publishers are wanting, and publishers are not particularly wise about quality teaching. However the main drawback of teaching software is that it embodies limitations that are counter-productive to learning. In addition to the obvious absence of human warmth and understanding, software imposes rigid and unfamiliar restrictions on content and interaction. Typographical errors are treated the same as conceptual errors. The convenience and flexibility of paper and pencil is replaced by keyboard data entry. Students cannot search for ideas and methods, explore techniques, skip over content, experiment with diverse styles, make intentional errors to see where they lead, talk over ideas with friends, and in general interact as human beings. Worst, though, is that these software systems teach a very narrow interpretation of what math is, they fail to develop conceptual understanding and problem-solving skills. The LWTC MathLab approach is designed to minimize these problems.

Software inadequacies are not limited to computer-assisted teaching, they are also prevalent in computer-assisted placement and skill evaluation. Computer-assisted coursework does offer several distinct advantages, including flex-time, immediate feedback, and administrative convenience. Computers, as well, are the dominant media that people use to do mathematics in the workplace.

Diversity of Teaching Styles

The original purpose of the survey was organizational, to provide estimates of expected course enrollment in both traditional and computer-based classes. The Math faculty also participated in various training seminars, site visits, and other activities addressing computer-assisted teaching. We learned that purely online courses do not work well, and that students need a combination of both human and computer-assisted teaching for computer-assisted approaches to achieve quality learning.

We also learned that LWTC students are not well informed about the teaching style of math classes they are enrolling in. We wanted to make sure that each student knew on the first day of class that their class was either conventional or computer-assisted. Accompanying the survey was a listing of Winter 2009 math courses, categorized by teaching style. All but the Hybrid style are available to students, although the diversity of styles are not available over all courses. Another question we are trying to answer is which courses should be diversified by providing alternative teaching styles.

DATA AND RESULTS

The survey was distributed to all Autumn 2008 math classes. Each student provided a rank ordering of the four different teaching styles. 53 students provided additional written comments. 39 students did not conform with the instructions to make a rank ordering. Results were collected from 31 classes, covering 10 different courses, and taught by 15 different instructors. The 415 students who responded represent about three-quarters of currently enrolled math students. The size and diversity of the sample assures that the result accurately represents the opinions of the student body as a whole.

The analysis is presented top-down, beginning with results aggregated over all responding students, and then subdivided by preferences for different styles, by enrollment in different courses, and by student emphasis. No analysis of different instructors was conducted, and data across instructors was intentionally not collected.

Data analysis is usually presented with some form of evaluation of statistical significance. This report takes a slightly different approach since the sample size represents about 3/4 of the entire population. When a sample includes most of the population, statistical generalization is not necessary.

Technical note: With a sample size of 400, sampling distributions of rankings approach the assumed underlying normal distribution. If a fair coin were flipped 100 times, it would be quite unusual for it to come up heads on 60 of the flips. Analogously, if we assume that students do not have a preference, then about half would choose one style of teaching and the other half would choose the other style. If 60% of students choose one teaching method and 40% choose the other, then it is statistically assured that this is an actual preference, rather than a random event. As well, here we emphasize only large differences in percentages of students with particular ranking preferences. Percentage spreads of more than 20 points are statistically powerful, they provide overwhelming evidence. Here we focus only on overwhelming evidence.

The Main Result

To provide the simplest perspective, rankings for all students in all courses are collapsed into two preference groups (First choice and Not First choice). Teaching style is also collapsed into two groups (Traditional vs Computer-assisted), with the computer-assisted category including MathLab, Hybrid, and Online styles. The resulting choices convey a clear message:

First choice Traditional classroom	69%
First choice Computer-assisted	31%

This result underestimates student preference for traditional classrooms, since the distinguishing quality of the Hybrid style is that it is one-half traditional classroom, while the distinguishing quality of the MathLab style is that a traditional teacher is available at all times during computer-assisted work.

There are several ways to assess the degree to which students dislike Online content delivery. By eliminating MathLab and Hybrid styles, we can compare First choice rankings for Traditional and Online teaching only (N=321):

First-choice Traditional	93%
First-choice Online	7%

Alternatively, we can count First or Second choice of Traditional classrooms:

First or Second choice Traditional	83%
Third or Fourth choice Traditional	17%

Or we can view Fourth choice as a kind of veto:

Last choice Computer-assisted	92%
Last choice Traditional	8%

The most disliked style is Online:

Last choice Online	67%
Last choice other than Online	33%

The main result is that LWTC students strongly prefer conventional classrooms. Since we have the option to provide a diversity of teaching styles, LWTC should offer at least three out of every four math courses in the Traditional format, while providing some computer-assisted classes to accommodate students who dislike Traditional.

Washington State provides a State-wide online program of coursework (WAOL). These courses are not limited by enrollment, and entail little overhead. LWTC can continue to make these courses available, but should expect no more than 20 to 30 students to enroll in them quarterly (this projection was adjusted to reflect enrollment in those courses offered by WAOL, since WAOL does not offer every type of math course). LWTC should not consider offering College administered online coursework in mathematics. The danger of WAOL courses is that they may end up alienating students who take them. We next examine the MathLab and Hybrid styles that combine online with conventional teaching.

MathLab and Hybrid Styles

The Math faculty is interested in whether or not students would prefer MathLab or Hybrid styles of mixed traditional and computer-assisted learning. With both the explicit preference for Traditional and the explicit dislike of Online styles, it is difficult to determine whether or not the mixed styles were preferred at all. Perhaps they were liked because they included a Traditional component, or perhaps they were disliked because they included an Online component. To tease this information from the data, it is necessary to look at covariation, that is, what happens when some aspect of the data is held constant.

We can eliminate the effect of First choice of Traditional by considering the Second choice of all students who chose Traditional first. Given Traditional as First choice (N=286), there is equal preference for MathLab and Hybrid, while Online is least preferred:

MathLab	45%
Hybrid	44%
Online	11%

We can also look only at First choices other than Traditional (N=129), with similar results:

First choice MathLab	43%
First choice Hybrid	40%
First choice Online	17%

From the veto perspective, the most disliked Fourth choices are:

Traditional	8%
MathLab	15%
Hybrid	10%
Online	67%

From this perspective, MathLab and Hybrid are again equivalent. Last choice is dominated by the Online style.

Is it reasonable to conclude that students like MathLab or Hybrid styles because of their similarity to Traditional, while students dislike MathLab or Hybrid styles because of their similarity to Online? We could explore this idea further by holding Online constant, but there are not sufficient students who prefer Online for this approach to be useful.

An alternative is to ask: How many students chose MathLab and Hybrid both, specifically as their First and Second choices? A random result would predict 17% would rank the two as first choices.

MathLab/Hybrid preferred	8%
Otherwise	92%

Similarly, how many students placed both MathLab and Hybrid styles as Third and Fourth choices (that is, how many students choose the pure Traditional and Online styles as their top preferences)? A random result would predict 17% would rank the two as last choices.

Anything but MathLab/Hybrid	9%
Otherwise	91%

This comparison shows that MathLab/Hybrid are neither liked nor disliked. The results of this section suggest nothing to differentiate MathLab and Hybrid styles. Since both styles are relatively unfamiliar to students, it may be that there is no dominant impression in students' minds about the mixed mode styles. Both are less preferred than Traditional and more preferred than Online, but offer no overall intrinsic advantage as options.

The Ranking Matrix

The four-by-four matrix below shows rankings of the four proposed teaching styles. All entries are in percentages, with rows and columns adding to 100%. Rows show the teaching style and the distribution of rankings for each style. Columns show the proportional share of First (Second, Third, and Fourth) place votes received by each style. On the far right, the data is aggregated to show gross likes and dislikes by adding First/Second choices into Liked styles, and Third/Fourth choices into Disliked styles.

RANKING	1st	2nd	3rd	4th	LIKE	DISLIKE
Traditional	69	14	9	8	83	17
MathLab	13	36	36	15	49	51
Hybrid	13	37	40	10	50	50
Online	5	13	15	67	18	72

This matrix simply confirms that the aggregated data hides no interactions. We next look at sub-samples of students enrolled in various math courses. The technique again is to first examine aggregated sub-samples, then to look in more detail at trends across levels of math courses.

STUDENTS ENROLLED IN DIFFERENT MATH COURSES

The data can be subdivided into groups of students enrolled in different math courses (and by inference into groups of differing levels of math ability):

COURSE	CONTENT	SAMPLE SIZE
Math 70	Basic Arithmetic,	55
Math 80	Prealgebra	85
Math 90	Introductory Algebra	125
Math 99	Intermediate Algebra	39
Math 102	Quantitative Reasoning	39
100-level	Various, college-level	72
Total		415

An initial aggregation is examined first:

	N	
Beginning Math	265	(Math 70, 80, 90)
Continuing Math	150	(all other courses)

Then we consider trends across four levels of math coursework (Arithmetic, Algebra I, Algebra II, and College-Level).

Beginning and Continuing Math

The four-by-four ranking matrices for these subgroups and the Like/Dislike aggregations follow. In terms of the main results presented above, any interesting differences in the two subgroups would show up as interactions, that is, one subgroup would contribute disproportionately to the main result. All data is presented in percentages.

RANKING	1st	2nd	3rd	4th	LIKE	DISLIKE
BEGINNING						
Traditional	67	14	9	10	81	19
MathLab	15	30	38	17	45	55
Hybrid	12	40	36	12	52	48
Online	6	16	17	61	22	78
CONTINUING						
Traditional	72	16	8	4	88	12
MathLab	11	45	33	11	56	44
Hybrid	13	32	47	8	45	55
Online	4	7	12	77	11	89

Considering the Like/Dislike aggregate data, Beginning students like Traditional and dislike Online less extremely than Continuing students (81% vs 88% for Traditional, 78% vs 89% against Online), while the preference for MathLab over Hybrid is greater for Continuing students (45% increasing to 56% for MathLab, 52% decreasing to 45% for Hybrid). The 7% swing in Traditional is not significant, while the 11% difference for Online is significant. The 11% change in support of MathLab is also significant. Consistently, Continuing math students dislike both the Online style and the Hybrid style that is 50% online more than the other two styles. This result suggests that MathLab classes for higher-level math courses are more appropriate when Traditional classrooms are not available, perhaps due to low enrollment.

Subdividing the main result into the two subgroups provides additional perspective on this interaction:

	BEGINNING	CONTINUING
FIRST CHOICE		
Traditional classroom	67%	72%
FIRST CHOICE (omit MathLab and Hybrid)		
Traditional	86%	95%
FIRST OR SECOND CHOICE		
Traditional	80%	88%
LAST CHOICE		
Computer-assisted (vs Traditional)	89%	96%
LAST CHOICE		
Online (vs Any Other)	61%	77%

The primary result of the sub-sample analysis is that more mature students select Online teaching as their Last choice, more so than Beginning students. What "mature" means is ambiguous, it could mean more mathematically mature, or more experienced taking math classes, or having had experience with online courses, or simply older. In any event, it is safe to say that preference for Traditional over Online classes grows with experience. Student rankings suggest an increasing dislike of Online rather than a growing fondness of Traditional (Online changes from 61% to 77% of Fourth place choices).

MathLab and Hybrid Styles Across Math Education

Again we isolate rankings for MathLab and Hybrid styles, this time across the different sub-samples of Beginning and Continuing math students. Given Traditional as First choice (N=286), MathLab is the preferred alternative for Continuing students:

SECOND CHOICE	Beginning N=178	Continuing N=108
MathLab	38%	56%
Hybrid	49%	38%
Online	13%	6%

First choices that are not Traditional (N=129) show no differential preference across sub-samples:

FIRST CHOICE	Beginning N=87	Continuing N=42
MathLab	44%	40%
Hybrid	39%	43%
Online	17%	17%

From the veto perspective, Fourth choices confirm that Online is least preferred by more mature students:

LAST CHOICE	Beginning	Continuing
Traditional	11%	4%
MathLab	17%	11%
Hybrid	11%	8%
Online	61%	77%

MathLab and Hybrid selected specifically as First and Second choices shows no sub-sample difference, nor does their selection as Third and Fourth choices:

	Beginning	Continuing
PREFERRED		
MathLab/Hybrid	8%	8%
ANYTHING BUT		
MathLab/Hybrid	10%	8%

Continuing math students who rank Traditional as their First choice have a significant preference for the MathLab style. MathLab is preferred over Hybrid by mature students possibly because Hybrid is 50% online. This interaction in the data indicates two different populations. Interactions are of primary importance when considering policies that include options. Students who begin in Traditional classrooms are more likely to prefer MathLab coursework as their math becomes more sophisticated. Those who begin with computer-assisted coursework are more likely to prefer Hybrid coursework later in their math education. Few students select Online as their First choice.

One possible source of bias in this data is that three of the classes in the survey were MathLab classes (the rest were Traditional). Ten of the 25 MathLab students are in a Beginning course (Math 90), the rest are in advanced courses. The MathLab sub-sample is examined later.

Trends Across Levels of Math Education

If the above differences between Beginning and Continuing math students generalize to all levels of math, then the interaction should show up as a trend when maturity is examined in finer detail. The absence of such trends would indicate that something more complex is going on, perhaps involving individual courses, instructors, program requirements, or random variation.

Four groups of math ability were further distinguished for trend analysis:

	N	
Arithmetic	140	(Math 70, 80)
Algebra I	125	(Math 90)
Algebra II	78	(Math 99, 102)
College-level	72	(Math 107, 146, 141, 142, 151)

Trends in the Main Result

PERCENT	Arithmetic	Algebra I	Algebra II	College
Prefer Traditional	67	67	72	72
Traditional vs Online	93	91	91	95
First/Second Traditional	80	81	90	86
Last choice Computer-assisted	93	86	95	96
Last choice Online	54	69	74	79

The only trend in the main result (that students like Traditional and dislike Online) is that lower preference for Online increases with math maturity (going from 54% for beginners to 79% for students taking college level courses).

Trends in Preferred Styles

Here, First or Second preference is aggregated for each specific style.

FIRST OR SECOND CHOICE	Arithmetic	Algebra I	Algebra II	College
Traditional	80	81	90	86
MathLab	40	51	50	62
Hybrid	47	48	45	45
Online	23	20	15	7

Maturity is associated with decreasing preference with Online (decreasing from 23% to 7%), not necessarily with increasing preference for Traditional style (from 80% to 86%). Here, the decrease in preference for Online is compensated by an increase in preference for MathLab (from 40% to 62%). The attractiveness of the MathLab style may be associated with a greater familiarity of the MathLab style within the student sample.

Trends in MathLab and Hybrid Styles

Given Traditional as First choice, increasing preference for MathLab is a confirmed trend (from 35% to 58%):

	N=94	N=84	N=56	N=52
SECOND CHOICE	Arithmetic	Algebra I	Algebra II	College
MathLab	35	42	54	58
Hybrid	47	50	39	37
Online	18	8	7	5

Both Hybrid and Online show decreasing preference for students whose First choice is Traditional. This change occurs between Algebra I and Algebra II for those with an initial preference for Hybrid (from 50% to 39%), and between Arithmetic and Algebra I for those with an initial preference for Online (from 18% to 8%).

First choices that were not Traditional shows no consistent trends:

	N=46	N=41	N=22	N=20
FIRST CHOICE	Arithmetic	Algebra I	Algebra II	College
MathLab	33	56	36	45
Hybrid	52	24	41	45
Online	15	20	23	10

From the veto perspective, Last choice of Online increases steadily with mathematical maturity (from 54% to 79%), while Last choice of MathLab and of Hybrid both decrease sharply between Arithmetic and Algebra I:

LAST CHOICE	Arithmetic	Algebra I	Algebra II	College
Traditional	7	14	5	4
MathLab	22	11	13	10
Hybrid	17	6	8	7
Online	54	69	74	79

Selecting MathLab and Hybrid specifically as First and Second choices, or specifically as Third and fourth choices both show no trends:

PREFERRED	Arithmetic	Algebra I	Algebra II	College
Hybrid/MathLab	10	6	4	12
ANYTHING BUT				
Hybrid/MathLab	13	6	10	6

The dominant effect exposed by trend analysis is the decreasing preference for Online as students take more math courses.

ANALYSIS OF SPECIAL CASES

Special cases are events that highlight the numerical data collection strategy. They have particular value, since they can represent strongly held or well-informed opinions. For this survey, special cases include current MathLab students, voluntary written comments, and non-conformance to the ranking scale.

Current MathLab Students

The sample of current MathLab students is small, consisting of 25 students in three courses (Math 90, Math 99 and Math 151/152). Results from this sub-sample should be interpreted cautiously. Since the sample was somewhat self-selected, results cannot be seen to be causal.

In terms of the main result, MathLab students more frequently choose MathLab as their First choice. For the entire sample, 13% chose MathLab as First choice, while 28% of MathLab students chose MathLab first. Fourth choices show no differences for the whole sample compared to the MathLab subsample:

	FIRST CHOICE	LAST CHOICE
Traditional	44	16
MathLab	28	8
Hybrid	16	12
Online	12	64

Experience in MathLab appears to favorably influence preference for MathLab. The shift comes primarily from students initially preferring Traditional. This result suggests that the MathLab option is a good idea.

Non-conforming Ranks

Non-conformance to the ranking task includes two subgroups, those who did not understand the task, and those whose opinions were sufficiently strong that they felt compelled to provide additional information through the ranking process. A rank-ordering such as 2-3-4-2 may indicate a slip or a misunderstanding, but a rank-ordering of 1-4-4-4 indicates a very strong preference. Despite being contaminated by data generated out of confusion, non-conforming ranks are a valuable source of strong opinions.

39 students (9%) provided non-conforming rankings. Strong statements of preference are of interest. Data is in percentage of all non-conforming rankings.

EMPHASIS ON	FIRST CHOICE	LAST CHOICE
Traditional	29	13
MathLab	15	5
Hybrid	5	5
Online	3	5
No first choice		20

Interpretation of this data is somewhat subjective. Non-conforming students wanted to emphasize their strong preference for or against Traditional, and to a lesser extent, in favor of MathLab. An expected emphasis on the dislike of Online is not in evidence.

Written Comments

Written comments in particular provide a detailed viewpoint of student opinions. 53 students (13% of the sample) provided written comments. All written comments are included as Appendix B.

The numerical results should at least be supported in written comments. A subjective categorization of written comments confirms this:

Prefer Traditional classroom:	more than one-half of all comments
Interact with a live instructor:	about a third of the comments
Dislike Online:	about a quarter of the comments
Need personalized help:	half-a-dozen comments
Know personal learning style:	half-a-dozen comments
Like Online/MathLab/Hybrid:	a couple for each

In their written comments students express a desire to learn, and seem to have already engaged in the meta-cognitive skills of learning how they learn best. Written comments support the non-conforming rankings, emphasizing a preference for Traditional classrooms. The message is that LWTC should not consider moving all math coursework to a computer-based system. Of course, the primary value of written comments is the direct expressions of opinion themselves. Excerpts from Appendix B follow (spelling has been corrected here).

On Traditional classrooms:

"Traditional classrooms provide more interactive and interesting techniques."

"I would like class to be entertaining like the first paragraph of an essay."

"In traditional classroom you get the best knowledge."

On the need to interact with live instructors:

"Nothing beats human interaction."

"I love the classroom because it's so interactive."

"I learn best when interacting with another human."

"I want teacher grade me, but not computer."

On Online learning:

"Online is hard cause you don't have anyone to ask questions and its at your own pace."

"I think LWTC should offer more computer assisted and online classes."

"the computer often confuses me so <u>please</u> continue classes with instructors."

"I will avoid any online classes of any kind."

"If I wanted a cyborg teaching me I would buy a vacuum."

On knowledge of personal learning style:

"I can learn better being taught visually and being able to listen to instructions."

"I need the physical interaction of coming to a classroom"

"I need the structure of in class lectures to understand & retain info from the course."

"I do much better with a structured class setting with due dates & other 'goals'"

"The easiest way for me to learn is to work at my own pace with instructor helping me whenever I need help."

On particular teaching methods:

"Computer based math lab may be the best because it adapts to different learning methods."

"I like the idea of the Hybrid - I still have the self paced work, but only need to attend class once a week."

SUMMARY OF RESULTS

- Students strongly prefer the Traditional classroom style.

- Students do not prefer Online courses (WAOL).

- Dislike of Online increases as students take more math courses.

- MathLab and Hybrid styles are equally viable alternatives.

- MathLab increases in preference more than does Hybrid as students take more math courses. An interpretation is that Hybrid is not preferable since it includes a 50% online component.

- MathLab experience positively influences preference for the MathLab style.

- LWTC should teach three out of every four math classes in Traditional style, and the other one-in-four in the MathLab style, with increasing frequency of MathLab options as math content becomes more complex.

- LWTC should not move its math courses to the Online style.

APPENDICES

A: The Math Teaching Style Survey Form

B: All written comments from the sample (53 students provided comments)

MATH TEACHING STYLE SURVEY   AUTUMN 2008

The LWTC Math Department might be offering four different types of math instruction for the Winter quarter 2009. To better meet student needs, we would like to know which types you prefer.

TRADITIONAL CLASSROOM

This is the classroom lecture, discussion, and problem solving that you are most familiar with.

Students meet in a classroom at regularly scheduled times for five hours per week of instruction and testing.

COMPUTER-BASED MATH LAB

Classes meet in the Math Lab at regularly scheduled times for five hours per week. Instruction is primarily through online videos, animations, interactive problems, and an online textbook. The math instructor is always present, offering mini-lectures and helping students individually.

Students can work at their own pace, and students who are successful working independently can work at home for some of the class hours. Homework and tests are mainly online, with some written assignments and tests.

HYBRID (both CLASSROOM and ONLINE)

Class time is divided between online and traditional classroom. Instruction is both through online interactive activities, and for two or three hours per week of regularly scheduled classroom activities. The math instructor is available in person only during the classroom hours.

Students can work at their own pace. Homework and tests are mainly online, with some written assignments and tests.

ONLINE

Classes meet online, regularly scheduled hours are decided by the online instructor. Students do assignments online and interact with the online instructor and with other online students.

Students can work at their own pace. Students do not have to come to a classroom at a given time, but do have to take tests in a proctored environment.

WHICH TYPE OF MATH INSTRUCTION DO YOU PREFER?

PLEASE RANK THE FOUR TEACHING STYLES IN ORDER OF YOUR PREFERENCE.
Put a "1" for the style you most like, "2" for the next, "3" for the next, and "4" for the style you least like.

TRADITIONAL CLASSROOM ____________

COMPUTER-BASED MATH LAB ____________

HYBRID ____________

ONLINE ____________

Please write any comments you may have on the back of this sheet. THANK YOU!

APPENDIX B WRITTEN COMMENTS FROM STUDENTS

The four digit code in front of each comment is that student's ranking preferences, with digit places sequentially standing in place of Traditional, MathLab, Hybrid, and Online teaching styles. 53 of the the sample of 415 students (13%) provided written commentary. Spelling and grammar have been directly transcribed, with no corrections.

Math 70

• 1234: I prefer being [in] the classroom for all classes.

Math 80

• 4231: Classes should have more individual help available to prep for tests. Tests are way too high of a percentage of the final grade. Notes should be available as guides. Computer based math lab may be the best because it adapts to different learning methods.

• 1234: People shouldn't be so lazy and come to school.

Math 90

• 1234: Having a traditional classroom enviornment is the best for me because I don't have internet and that would be hard for me. But with a traditional classroom I can ask the teacher questions and see them explain it, with online I wouldn't be able to follow the explanation. So its the best for me to be put into a traditional classroom enviorment.

• 1234: I like the traditional the best. I haven't tried the computer-based but I think I'll try it next quarter.

• 1342: Personally I work better by learning mostly through examples in the book. I have never got a better understanding by doing busy work in the class. I would perfer to do homework and review it the next day and then be dismissed. This way works much better for me.

• 1324: Online is hard cause you don't have anyone to ask questions and its at your own pace. I like traditional classes.

• 1342: I prefer traditional math class, because I can learn better being taught visually and being able to listen to instructions.

• 1234: I need the physical interaction of coming to a classroom, having specific times and deadlines, and having a teacher teach me and be able to ask any questions I need to. Online courses are too disconnected for me to learn very easily or as well.

• 1342: Math is one of the most difficult subjects for me. I really benifit from watching a teacher work out problems. I find that math books are often written in a way that can be confusing.

• 4321: I like to work on my own pace, and want to concentrate on my weaknesses.

• 1234: I found that the computer based math lab made it so that I could depend on guessing the right answer because on the HW you could select an answer until you get it right but on the tests it was one chance to get it right. Plus there wasn't any transitioning lectures we just move on to the next subject. I prefer traditional to any style because the whole class is involved and if one person doesn't get it then more than likely someone else won't get it and ask a question and the teacher will answer it for everyone in the class even for those too embarrassed or shy to ask.

• 1234: I learn best when I can visually see the instructor. It's hard to learn online...

• 1234: I prefer to have an instructor on hand in case I need help. I also learn better by hearing an instructor lecture, and not just reading myself.

• 1324: Traditional classrooms provide more interactive and interesting tecniques. When you have a question you can ask & get an immediate response rather than waiting.

• 1324: Traditional Classroom. Because I like to be able to listen & see what we're learning. And that way I can have a teacher show me what I'm doing wrong & right.

• 1324: I preferred hands-on daily assignments to keep pace with the course. Structured class and assignments/tests.

• 1324: Nothing beats human interaction.

• 1423: I would like if the traditional was more move at your own pace because I often will finish my homework for the night in class and be stuck listening to the teacher talk about what to do for the homework for an average of 30 min.

• 4132: I think LWTC should offer more computer assisted and online classes. Especially in today's tech world, people like me in there 20's are more comfortable on a computer and tend to have an easier time learning that way.

• 2134: I would like class to be intertanting like the first paragraph of an essay. And to move at our own pace.

• 2134: A computer based math lab would provide the students with as many tools as they need. The teacher would be there to answer questions that the computer programs may not explain adequately enough.

• 1324: I only register for traditional classes. I will avoid any online classes of any kind. I learn best being in the classroom daily.

• 1324 (MathLab): I think that you should have deadlines for each section so that people don't forget and get behind.

• 4312 (MathLab): Problem with computers - very easy to make typo errors, and there is no partial credit. Advantage - can work at own pace which is a huge +!

Math 99

• 2314: I have struggled with math since junior high. Having a self-paced program where I have contact with a teacher, I have thrived. William Bricken has made math less frightening to me, and I feel I would do terribly with an on-line only math class. I like the idea of the Hybrid - I still have the selfed paced work, but only need to attend class once a week.

• 1244: In traditional classroom you get the best knowledge.

• 1234: The traditional style class is one that works best for me for the math setting, other classes I like different styles.

• 1423: Early in day, 2 hour length is preferable - 2 days per wk. too late at night is harder to learn math concepts.

• 3421: I wish Math099 was offered online to fit my schedule better.

Math 102

• 1234: I like the interaction with instructor and classmates.

• 1432: I love the classroom because it's so interactive. I also took an online class during h.s. and loved the ability to lay in bed and work. Thats why those are my favs.

• 1324: classrooms are an important part of the learning process for myself, being able to come in and discuss w/ other ppl helps sort out any learning issues.

• 1324: the text book is too brief, and the answer book does not have all the answers. So learn with teacher step by step is the best choice.

• 1324: I like live teachers.. they make me more accountable to do my work, when with online classes I procrastinate until the very last minute, lowering the quality. It's also easier to get questions answered in person, than to wait until your instructor is able to check his/her email to get back to you. I'm just a procrastinator. I need the structure of in class lectures to understand & retain info from the course.

• 1432: traditional classroom has always worked and will always work. Online, depends on the kind of math. But it is a good idea.

• 1234: I <u>need</u> the help one on one w/ an instructor sometimes. And the computer often confusses me so <u>please</u> continue classes with instructors. finding the time to work w/ a computer for me is almost impossible.

• 1234: I learn best when interacting with another human. If "discovery learning" was a choice, it would be my #1.

Math 146

• 4213: I would love to do online but I feel there is no time to meet w/ the instructor, it would be helpful to have "online class time", a time when you know that the teacher would be on to help you.

• 1243: Traditional method of teaching is the best, because, it gives students sense of responsibility to be regular, report on time, pay attention in the class, interact with other students, doing homework sincerely and handing it out on time. The class taken by "William" is excellent. He is a very good instructor, & a very cooperative person. I believe that he should be continued to taking statistics & other math courses. I think the computer lab math class would make a very good idea for working in the math-lab. It could serve as a good option to the traditional method, but I would recommend traditional method to be the best as it puts efforts to improve students performance drastically.

• 1---: I don't like others math classes. I prefer only traditional classroom. I want teacher grade me, but not computer.

• 1234: I do much better with a structured class setting with due dates & other "goals" as opposed to "work at your own pace".

• 1234: While other classes such as pyschology or sciences may be effective as traditional classroom, I feel that math is most effectively learned w/ traditional classroom lecture. I have taken online classes, hybrid classes and traditional classroom. I have found by this experience that I learn math most effectively by traditional classroom instruction.

Math 141

• 4231: I do prefer an instructor be readily present for walking through the new material.

• 2134: The easiest way for me to learn is to work at my own pace with instructor helping me whenever I need help. This way I won't slow the whole class down. we worked in a similar way in my Math 099 class and it was the easyest way for me to deal with math. The instructor was there for me every time I needed help -- almost 2, 3 times every class.

• 1324: Math should be held earlier in the day and only for an hour 2x weekly with Quizes not HW.

• 1234: Computers aren't people. If I wanted a cyborg teaching me I would buy a vacuum.

• 1432: I think traditional classrooms are important to have because it's nice to be able to interact with the teacher in person, especially for students who need some extra help. However, I also think online classes are important to have too because sometimes students need more flexibility and cannot always attend classes at the same time. I believe students should be given a choice.

• 1234: Traditional class is better to ask questions than others.

• 1324: Traditional classes when dealing with math is way easier to understand.

• 2134: I find that when it comes to a math class an online class, or portion of a class, might not be the best idea because math is difficult for some people to understand so having a teacher you can ask questions to directly is important.

• 1243: I like the 2x a week style of math class, works well with HW volume and work schedule.

Math 142

• 1224: I like the classes that are think w/ other people. Online class are only for write, reading classes. Math is the class that if I don't understand and I can ask/ discuss w/ teacher or other students and I + helps more than read/try to understand from textbook.

TRIP REPORT: National Council of Teachers of Mathematics Regional Conference
William Bricken
November 2008

I attended the NCTM Regional Conference in Reno Nevada, November 5-7, 2008.

SUMMARY

The '60s are alive and well in the math education theory of the '00s. That is, the primary math ed research finding is to teach with passion and compassion, via engaged interaction with problems rather than with symbols. Math without meaning is not even math.

OVERVIEW

More than 250 presentations, half were trying to sell something. Big presence of textbook and calculator salespersons. Many folks sharing their delight in new learning strategies, most of which were closely related to Singapore math. Manipulatives were everywhere, with lots of ways to avoid simplifying and solving algebraic symbol patterns. Here are some representative talk and workshop titles:

General

-- Inspiring Students to Be Problem Solvers

-- Middle Level Mathematics and Real-World Engineering Problems

-- Zero to Infinity: Teaching How Numbers and Notions Evolve and Grow

-- Diversify Instruction by Connecting Mathematics and the Arts

-- Using Literature and Technology to Open Doors to "Aha" Moments
for Students in Diverse Classrooms

-- Communicating: Speaking, Writing, and Sketching -- About Math!

-- Mathematics in Contemporary Culture: The Comic Strips

-- Oh, My Gosh! I Really Get It! Understanding Math with Highly Interactive Software

-- Math-Magical Arithmetricks

Algebra

-- Patterns in Linear Functions

-- Algebra as a Life Skill: Making Mathematics Make Sense

-- Involve All Students in Algebraic and Logical Thinking
with Practical, Hands-On Activities

-- Algebra in the Physical Sense

-- Using Tiles and Games to Teach Algebra

-- The Power of Investigative Calculus Projects

HIGHLIGHTS

-- Standardized tests are designed to discriminate between students, that is, to establish *differences*. Thus, they not about assessment, they are about establishing social hierarchies. The majority of low-performing schools in the US are low performing because they have limited the curriculum to what is testable. (Wesson)

-- Students need to be active in the classroom. The best way to achieve that is for the teacher to stop talking. (Burger)

-- Algebra is a way of thinking about the world, that leads to a way of manipulating symbolic structures. (Kaput)

-- Singapore math *is* really good!

-- Classroom math is fundamentally more visual and diagrammatic than symbolic.

KEYNOTE

The Keynote Speaker, Ken Wesson, presented the case for "brain-considerate learning", that is, establishing teaching practices that incorporate the recent rapid advances in knowledge about how the brain works, in particular, how we learn, remember, and think. Some important points (that are actually not very new, but are just emerging from the brain research community into the education community):

-- Brains don't mature until folks are in their thirties.

-- What the brain values is 1) patterns, 2) emotions, 3) relevance, 4) appropriate context, and 5) sense-making.

-- All information is first processed by the emotional system. Attention first requires relevance and involvement. Teachers need to establish emotional bonds with students prior to expecting them to learn.

-- Where the hands go, the brain will follow. Hands-on learning is literal.

-- Hemispheric coordination is a physiological necessity. Content must be multimodal. Not different and separate modes of teaching and learning (visual, audial, tactile, kinesthetic, symbolic, etc), but all of these at the same time. Every individual is multimodal.

-- All academic content areas (particularly and especially math) implicitly incorporate aspects of art, music, language, belief, physical action, cognitive abstraction, and emotion.

-- Never teach more than 20 minutes at one time. Time for integration, discussion, and yes escape, is mandatory if learning is to take place.

-- It's lunacy to expect that a student should be able to learn from listening to a new idea for an hour. Learning takes long-term practice and exploration. What we get from the traditional classroom is pseudo-learning, stuff that stays around for an hour or a day and then goes away.

-- Math education in modern countries (er, not the US) focuses on key concepts that are taught in depth, in careful sequence, and over years. US classrooms focus on huge amounts of forgettable details.

-- Textbooks should be extremely small, and contain only the most powerful ideas.

-- The two most destructive educational ideas (peculiar to the US): 1) with enough training, anyone can achieve excellence in anything, and 2) for individuals, the greatest room for growth is in areas that are their weakest.

-- Brain-considerate learning takes place by 1) physical involvement, 2) emotional engagement, 3) quietness that permits internal dialog and reflection, 4) a non-threatening environment, and 5) conversation focussed on change.

I came away from this presentation with an awkward feeling that took a couple of days to articulate. The issue is simply that American schools and teaching practices have never been concerned with physiological wisdom, otherwise, for example, we would never expect people (especially children and teenagers) to sit in one place for hours every day. Brain cells use glucose for energy; glucose is generated by physical activity.

To incorporate much of the learning research from the last decade, we would need to completely redefine the structure of the classroom, the knowledge of teachers, the organization of schools, the objectives of education, the policies of government, the whole system. And this indeed is what many of the researchers are calling for, and they are saying that half-way measures and gradual change will never get us there. Sounds like every other crisis are currently face.

So the ethical question for me is this: Should we subscribe to impossible expectations about good teaching? Should we just admit that schooling is not really about increasing knowledge, and in effect, end the charade? Should we all just learn to live with the idea that we will always be, due to our educational environment, terrible teachers? Or should we risk everything to change everything? Viva the '60s!

TEACHING IN VIRTUAL ENVIRONMENTS

I thought this would be on virtual worlds, but it was on putting courses online.

-- Teachers are struggling with huge workloads in getting courses online.

-- It's a fundamental error to try to keep coursework academic. There's a mismatch between the teaching model (conventional) and the media model (rapid communication, shorthand texting, chat, deep connectivity, frequent change of focus).

My son's high school solves the problem by banning personal technologies in the classroom. Who needs to live in this century anyway?

SUBTRACTION

-- It is very difficult.

-- The historical aim of teaching arithmetic: to think things through, to think clearly, quickly and accurately (Welch 1889). That's LWTC's "critical thinking", but oops we forgot the goal and got lost in teaching symbol manipulation.

-- Definition of "concept": a picture in your mind of an idea.

-- Arithmetic is a dialog between concrete and verbal. There's no real reason to introduce symbols.

-- Manipulatives aid thinking, algorithms do not.

-- New word: Subitize. To recognize quantity without counting.

-- Avoid teaching vertical addition until at least three digit numbers. One and two digit addition and subtraction should be approached using strategies rather than memorization of facts and algorithms.

-- Strategies: subitize, double, bridge to ten, pair off, compose and decompose, benchmarks.

NUMBER SENSE

-- Focus on meaning, relations, estimation, applications.

-- Some good examples of non-algorithmic questions:
- -- is 4x12 closer to 40 or to 50?
- -- how many paperclips can you hold in your hand?
- -- what tip should you leave if the bill is $199.23?
- -- how long does it take you to drive 50 miles?
- -- if a 10 year-old is 5' tall, how tall will he be at 20?

-- We should always attach meanings to numbers. Don't ask to multiply two three digit numbers unless each number has a meaningful anchor.

-- Be able to explain how the operations (+,-,x,÷) work using diagrams and no numbers or symbols.

-- Ignored concept: number density. How many numbers are between 100 and 1000?

-- Sort fractions in order. Which are close to 0, close to 1?

VISUAL LEARNING

-- 1%-5% of people have dyscalculia, an inability to use numbers clearly.

-- Children are natural visual learners, and can grasp visual abstractions.

-- Use visual models for problem solving: illustrations, photos, diagrams, graphs, icons,...

-- Visual language is cross-cultural, no ESL problem.

-- Ask students to draw the problem and the answer. This is easier than stating the problem in symbols.

-- Ask students to *show* the answer, not to figure it out.

MAKING MATH MEANINGFUL FOR LIVING

-- The (historical) rationale for teaching algebra is to get to calculus. If a student does not take calculus, algebra is not a necessity.

-- If a student asks, "When would we ever use this?", then the teacher has already made a mistake.

-- Invert homework and classwork. The classroom should be where students do math activity. Monotonous activities should be done at home, when students can be multitasking (watch TV, chat with friends, etc.).

-- An experiment: permit only questions in class, no answers (a refrain from Postman and Weingartner, "Teaching as a Subversive Activity" 1969).

-- Emphasize *Show No Work*. Do the problem in your head (for empowerment and for problem solving skill development).

-- Tests are inappropriate to assess thinking. Activities other than thinking are inappropriate for the math classroom.

-- Give 10% of the grade for making mistakes. Without errors, learning does not move forward. Error making needs to be legitimized as a productive activity, worth points. Also helps with math anxiety.

SINGAPORE MATH

-- Main style: careful attention to teaching heuristics, to moving from simple to complex, and from routine to non-routine problems to be solved.

-- Focus on problem solving (not symbol manipulation), use diagrams and models more than symbols.

-- Fourth grade: "Mel has 48 books for sale. She sold 1/3 of them on the first day and 1/4 of the remainder on the second day. How many books were not sold?" Turns out this is a relatively easy problem for the Singapore technique, which focusses on diagrammatic part-part-whole relations.

-- Introduce difficult problems that require non-algorithmic, creative thinking early. Use lots of open-ended and real-world problems.

After seeing this approach working *for teachers*, I left thinking that it would not be difficult to teach the entire Singapore curriculum to LWTC students starting at Math 80. Downside: we need different textbooks.