

## THE INTERMEDIATE ALGEBRA BOTTLENECK

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October 2008

LWTC is a community technical college serving a primarily adult student body returning to school for job training and advancement. The Math Department provides coursework to meet the State requirements for high school math, and to meet the minimal one math course at the college level for the AA degree. Our certificate and degree programs fall into two groups: those that do not require a year of college math and those that do.

It is widely recognized that college math is highly desirable, and the LWTC Math Department is eager to provide math training for today's workforce. There is, however, a significant pragmatic obstacle that discourages rather than encourages math coursework, and that incapacitates our technical programs from including college-level math coursework into their curriculum. This obstacle has been a significant problem at LWTC for over a decade.

### The Bottleneck

The State of Washington requires two years of high school math for students to be eligible to enroll in college-level mathematics courses. The problem is not this requirement itself, but rather the narrow and dysfunctional interpretation that LWTC places on the intention of "a second year of high school math".

Currently, LWTC is interpreting the two-year requirement as two years of high school algebra, which we teach in two integrated one-quarter courses, called Math 90 (Introduction to Algebra) and Math 99 (Intermediate Algebra). Intermediate Algebra is the study of algebraic transformations such as simplification of the following algebraic expression:

$$\frac{4x - 3}{2x^2 + x - 1} - \frac{2x + 7}{3x^2 + x - 2} - \frac{3}{3x - 2}$$

Although the above algebra problem strengthens a student's ability to apply algebraic rules and transforms, it does so in a context removed from any practical interpretation, as a purely intellectual exercise.

We are in no way suggesting that two years of high-school mathematics is inappropriate, or that students should not be required to study algebra. We are observing that, as currently defined, the requirement of two courses in algebra is a strong and effective disincentive for students to pursue their higher education and job training in math.

## Integrated Math

Many State high schools currently offer a second year of math studies called Integrated Math, with content that is diversified, relevant, and practical. These high schools have already recognized and addressed the Intermediate Algebra bottleneck. Requiring one pre-college course in algebra and one in Integrated Math would provide a route to college-level math that has already been shown to be effective for LWTC students. LWTC already teaches this integrated course, Math 102 (Quantitative Reasoning).

Math 102 was put into place to service the math needs of technical programs. It includes a diversity of mathematical content specifically requested by technical faculty, and it aligns with the Integrated Math courses offered in high schools as their second year of math study.

The existence of Math 102 is explicit documentation that the pre-college math sequence passing through Math 99 is a failure. In order to study relevant math, students must take a terminal course that does not contribute to their future educational advancement. Math 99 and Math 102 are equally rigorous in mathematical content, and are equally representative of what modern high schools teach as a second year of math.

## The Simple Short-term Solution

A simple proposal to address the LWTC Intermediate Algebra bottleneck would be to accept either Math 99 or Math 102 as meeting the requirement of two years of high school mathematics, in effect providing two routes to college-level math studies. This proposal requires no new courses, no changes to curriculum, and no changes to degree requirements. It is a simple administrative adjustment that permits students to choose their second pre-college math course to emphasize either mathematics (Math 99) or pragmatism (Math 102). A consequence is that either course would then allow students to continue their study of mathematics at the college level, effectively removing Math 102 from its current status as a dead-end math course.

## The Four-year College Problem

The proposed short-term solution opens the door for students to study college-level math, but it unfortunately does not open the door to Washington State four-year colleges. State colleges require Intermediate Algebra for admission.

We see this requirement as a well-intentioned error, and propose to finesse it. Specifically, the current LWTC Math 99 requirement establishes that all LWTC college-level math courses are recognized by Washington State four-year colleges. However, the State math requirement for admission into four-year colleges is not particularly sensitive to the needs and motivations of LWTC

adult students. We accept that any LWTC student with the specific intent to transfer directly to a four-year Washington State college must take Math 99. What we would like to do is to make LWTC college-level math courses accessible to all mathematically qualified students, even if they have not taken Math 99 specifically. The proposal to permit Math 102 to qualify students to take college-level math courses at LWTC achieves this objective.

We believe it is defensible that LWTC students who have met high school graduation requirements for mathematics be permitted the same rights as high school graduates who have not taken a second course in algebra (but who have taken two high-school math courses, such as Algebra I in combination with either Geometry or Integrated Math or Technical Math). These rights include the ability to enroll in two-year colleges, in technical programs, and in a great number of four-year colleges without the Algebra II requirement for entry.

Stated succinctly, LWTC is denying all of its students the right to enroll in college-level math courses in order to conform to a growth path that very few of those students take.

Should a student elect to transfer to a State four-year college, we believe that taking Intermediate Algebra at that time, even after completing college-level math courses at LWTC, is not only viable, but also appropriate, since Intermediate Algebra is more challenging mathematically than several college-level math courses. Specifically, from the perspective of the mathematics curriculum, Intermediate Algebra is a necessary prerequisite only for Precalculus (Math 141), and not for Math in Society (Math 107), Statistics (Math 146), or Logic (Phil 106).

The consequences of recognizing Math 102 as a gateway to college-level math coursework include greater importance of correct advising and more complicated pathways to math success. Providing options does introduce complexity. However, denying options for administrative convenience is antithetical to the objectives of Education.

#### About the Problem

The source of the Intermediate Algebra bottleneck is both cultural and historical. Prior to the advent of the personal computer, and prior to the many innovations in mathematics during the twentieth century, and prior to pervasive use of mathematics in technology, advanced math was defined solely as the study of calculus. Two years of algebra, and as is commonly practiced an additional year of precalculus (more advanced algebra), is needed to prepare for the content of calculus. However, it is a fact of the twenty-first century that calculus is of importance to many engineering disciplines but is largely irrelevant to computer-based technologies, where logic is of the highest import, and to all non-sciences.

The second-year of high school algebra is becoming more and more like a year of high school Latin, good for thinking but lacking in relevance. A year of study in mathematics is far too valuable to squander on a mathematical topic that has been marginalized by technological progress.

Of course, students need to master algebraic manipulation and modeling. But algebraic manipulation is embedded in many other mathematical topics. We believe that the time, effort, and economic resources of a second year of pre-college math should be invested in teaching students the basic concepts of a diversity of mathematical topics, topics that teach algebraic manipulation but do so in an applied context. Math 99, in contrast, teaches algebraic manipulation devoid of application. But what is worse is that Math 99 robs students of the opportunity to study other important mathematical areas such as geometry, logic, and measurement.

A student who has successfully completed one course of pre-college algebra (that is, Math 90) has acquired the skills necessary to formulate and solve algebraic equations, to graph linear functions, to work accurately with exponents and polynomials, and to solve systems of linear equalities and inequalities. The second course of algebra teaches skills associated with solution of complex algebraic equations, preparing the student only for further study of mathematical functions in precalculus and calculus.

#### Diversification of Math Skills

We recommend that the content of the second course be diversified to include mathematical topics that contribute to a well-rounded and informed citizenry, topics such as geometry, logic, trigonometry, estimation, mathematical modeling, aspects of probability and statistics, and computer-based mathematics and software, exactly those mathematical topics that a well-rounded high school student should know about. The benefits include relevance, diversity, applicability, and student acceptance of mathematical skills.

Of the students at LWTC, one in a hundred actually continues on to study calculus. Our students need math skills that are in use in industry, skills that are required by certificate programs as job skills. The health sciences require statistics, information services requires logic, engineering design requires trigonometry. The pragmatic issue is that to receive training in these math skills, training that might later contribute toward a college degree, our students must pass Math 99, and most do not. Instead, they cripple their potential advancement and avoid Math 99. By removing the Intermediate Algebra bottleneck, more students will be able to take more courses in mathematics, without loss of rigor or relevance.

## The Long-term Solution Now

The recommended short-term solution is a necessary step that will be taken tomorrow if not today.

"Currently, students must complete two credits of high school level math (Algebra I and Geometry or Integrated I and II). SBE [the Washington State Board of Education] adopted a rule that, beginning with the class of 2013, students will be required to take a third credit of math, Algebra II or election of a math credit tailored to their career path, in order to graduate. All math credits may be satisfied through equivalent career and technical education math courses."

-- Washington State Board of Education, [www.sbe.wa.gov](http://www.sbe.wa.gov)

This SBE decision will have a substantive impact on the LWTC math curriculum. We advocate preparing now.

## Three Pre-college Courses in Math

Thirty-nine states currently or will soon require three high-school math courses. LWTC students will inevitably be learning more math. This suggests that the current LWTC use of Math 102 to avoid Math 99 will soon no longer be feasible.

Washington State does not currently require Intermediate Algebra as one of the two math courses needed for high school graduation. It will not be requiring Intermediate Algebra as one of the three pre-college math courses for graduation. Yes, Intermediate Algebra will continue as the traditional route to college math, but as the above quote suggests, LWTC will have the opportunity to offer a diversity of career related math courses to satisfy the high school math requirements. With this mandate, we see the suggested short-term solution to be a necessary immediate step to prepare for tomorrow's math education requirements.

We also recommend taking immediate steps to develop a range of pre-college math courses, taught by the Math Department, but like Math 102, targeted toward the needs of technical programs. The intent of the SBE decision is to allow students to choose one of several paths to satisfy the math requirements for graduation. Those high school students who do not choose Intermediate Algebra are also choosing not to apply for enrollment in a State four-year college. But they will need technical training beyond high school, and they will be precisely the LWTC clientele. If these students can make the decision not to take Intermediate Algebra in high school and still be eligible to take college-level math in two-year colleges, then LWTC should certainly not require them to take Math 99 in order to enroll in LWTC college-level math courses.

## Alternative Math Pathways

The SBE decision emphasizes choice in pre-college math coursework. This emphasis is part of the negotiated decision to increase math requirements. Linda Plattner of the SBE identifies three pathways that students can take:

- traditional: Algebra I, Geometry, Algebra II
- integrated: Integrated Math I, II, III
- mixed: any two of the above plus one applied math course

She notes that Algebra II is not required for most State approved apprenticeships, for admission to two-year colleges to pursue AA, certificate and transfer programs, and for admission to private colleges. She also cites as reasons not to require Algebra II:

- that the State does not have the capacity to prepare students for success in Algebra II, and
- that new math topics provide a dimension of rigor that is equal to but separate from more sophisticated math content.

We are advocating that LWTC students have already selected the non-traditional pathway, so that the math offerings at LWTC should recognize this fact and provide integrated and mixed math requirements at the pre-college level.

An important aspect of this change is to recognize the need for college-level math courses that are also non-traditional, courses that provide college-level math sophistication in integrated and mixed content modes. LWTC has an excellent opportunity to lead the State two-year colleges in the development of college-level applied math courses. LWTC has both the need and the content expertise within its technical programs, and has the demand within its student body. All that is necessary to effect this move into the future of math education is to see that

- (1) the current LWTC math offerings are based on the traditional model,
- (2) LWTC does not serve the traditional student clientele, and
- (3) the mission of LWTC is consistent with constructing a diversified offering of college-level applied math courses.

We can begin by immediately offering one or two forward looking college-level math courses with technical content, and most importantly, by removing Math 99 as a prerequisite for enrollment in them. The Math Department has designed and is ready to teach one such course right now. Digital Mathematics is targeted for computer-based technical programs, and supports MMDP in particular as it grows toward BAT status.