Developmental Mathematics at Community Colleges

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Community College Students

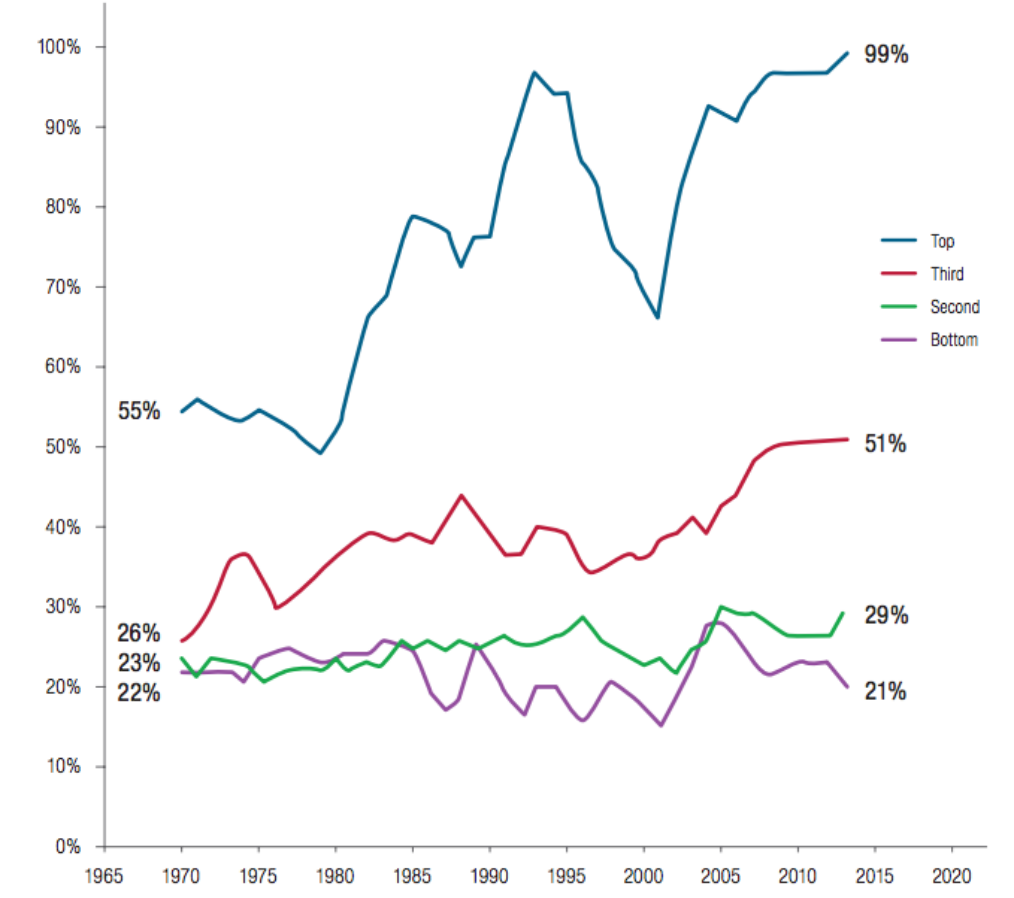
- 45% of all undergraduate students are enrolled CCs
- Among US undergrads, CCs include
  - 56% of Hispanic students
  - 48% of black students
  - 59% of native American students
- An estimated 60% - 70% of CC students are placed into developmental math.

Financial Constraints

- One in three CC students have family income less than $20,000, putting them near or below the poverty line.
- 69% of CC students work while in college, with 33% working 35 or more hours per week.
- Only 2% of CC students receive any Federal Work Study aid, compared to 25% of students at private four-year colleges.

Bachelor Degree by age 24 and Family Income

Pell Institute for Opportunity in Higher Education



What is developmental mathematics?

Math courses that do not earn credit towards a baccalaureate degree. A typical developmental math sequence looks like this:

1. Arithmetic and/or Prealgebra
2. Elementary Algebra
3. Intermediate Algebra

“Toward what ends?”

Students who are placed into developmental math may take some or all of the sequence for various reasons:

- As preparation for a credit-bearing course
- As the “critical thinking” breadth requirement
- To satisfy gateway prerequisites

Transfer students' success at CSU

- 6-year graduation rates for CCC transfer students narrowly exceed native CSU students, 1989 - 2003:
- 71.2% of 2003 CCC transfer students graduated within 6 years
- 69.9% of 2003 CSU freshmen who continued for at least 3 years.

http://asd.calstate.edu/gradrates/comparison.shtml

Transfer students' success at UC

6-year graduation rates for CCC transfer students exceed native UC students:

- The "four-year after transfer" rate for CCC transfer students is 86%
- The six-year rate for native students is 83%

http://accountability.universityofcalifornia.edu/index/chapter/4

Policy Issues Facing CC's

1. Intermediate Algebra and alternative pathways
2. Common Core State Standards in Math
3. Money

Policy Issue #1: Intermediate Algebra vs Alternative Pathways

CCs are caught between:

- demands to move more students through the pipeline by creating alternative pathways, and
- resistance from institutions to accept alternative pathways.

Faculty outside math (where most of these students are headed) often don't know the content of Intermediate Algebra and whether it is relevant to their disciplines.

- Graphing systems of linear inequalities
- Polynomial division
- Rationalizing denominators

There is a feeling at many 4-year institutions that if you don't require Intermediate Algebra as a prerequisite, then you are not a respectable institution:

“I believe that anyone who cannot pass a fairly rigorous intermediate algebra course should not get a BA degree, pure and simple.”

Policy Issue #2: Common Core State Standards in Math

The UC Board of Admissions and Relations with Schools (BOARS) states that the CCSSM college-ready standards should be prerequisite to any course that receives UC credit.

Standards for **ALL** High School students include topics currently in CC courses that receive college credit:

- derivation of the equation of a parabola given a focus and directrix
- 6 trig functions of real numbers
- proof and use of the identity $\sin^2\theta + \cos^2\theta = 1$

Including the content of the standard introductory statistics course:

- sample spaces
- independent events
- conditional probability
- permutations and combinations
- simulations
- using probability to make decisions

Creating new courses

Changes in the high school curriculum will require CC’s to revise old courses and create new ones.

Articulation

There is a lengthy timeline required to get new CC courses articulated at the 4-year schools.

(Pierce College requires at least 2 years to approve a course after the course outline is submitted, and articulation from the UC can take another 3 years or longer.)

Appropriate content?

It's not clear that all the Common Core standards required of all students are appropriate for the majority of CC students.

At Pierce College, about 75% of students placed into dev math are in non-math intensive disciplines.

Policy Issue #3: Money

Some CC's have been required to eliminate all material below algebra, or to offer only non-credit (CC credit) developmental courses.

Resources are spread thin among many sections of developmental courses. Large classes and pedagogical styles ill-suited to developmental students are common.

Which leads us to ...

Curricular Issues

1. All Algebra All the Time
2. Defining Appropriate Content
3. Inadequate Support

Curricular Issue #1: All Algebra All the Time

The typical math sequence at a CC is heavily algebra-dependent and aimed toward calculus.

Intermediate Algebra is the gateway course for almost all students, STEM or non-STEM, but contains many topics not relevant for non-STEM students.

Attempts to detach statistics from the Intermediate Algebra prerequisite are meeting resistance.

If we are going to revise the developmental math sequence, we'll need to look carefully at the curriculum. It's not just a question of which topics to keep and which to discard, but the complexity level of each topic.

$$\frac{1}{2} + \frac{1}{4}$$

$$\frac{1}{2} + \frac{1}{4}$$

$$\frac{1}{2} + \frac{2}{3}$$

$$\frac{1}{2} + \frac{1}{4}$$

$$\frac{1}{2} + \frac{2}{3}$$

$$\frac{3}{8} + \frac{5}{12}$$

$$\frac{1}{x} + \frac{1}{x+2}$$

$$\frac{1}{x} + \frac{1}{x+2}$$

$$\frac{x}{x+1} + \frac{1}{x^2-1}$$

$$\frac{1}{x} + \frac{1}{x+2}$$

$$\frac{x}{x+1} + \frac{1}{x^2-1}$$

$$\frac{4x^2+4x-15}{6x^2-7x-3} + \frac{9x^2-1}{6x^2+17x+5}$$

Many faculty at 4-year schools (and CC’s) feel that drill on algebraic skills is sufficient to prepare students for college level mathematics.

$$x^2 - 3x - 18$$

$$x^2 - 3x - 18$$

$$3x^2 - 9x - 54$$

$$x^2 - 3x - 18$$

$$3x^2 - 9x - 54$$

$$8x^2 + 18x - 45$$

Here is the equation of a parabola.
What is the *x*-coordinate of its vertex?

$$y = 0.8(x - 16)(x - 24)$$

Curricular Issue #2: Appropriate Content

Traditional arithmetic content in developmental math courses does not address conceptual gaps in students' knowledge; it consists mainly of teaching algorithms.

Add 36 + 47

Left-to-right method

$$(30 + 40) + (6 + 7) = 70 + 13 = 83$$

Rounding and adjusting

$$(40 + 50) - 4 - 3 = 90 - 7 = 83$$

Students who have mastered some algebra skills and place into higher courses may still have large gaps in conceptual knowledge.

Many nontraditional students need support for study skills and noncognitive issues.

What is appropriate content?

We don’t know.

- Is one-size-fits-all appropriate?
- Is mastering content more important than developing learning skills?
- What can we learn from cognitive science?

Curricular Issue #3: Inadequate Support

Many first-time college students who have poor study skills are put in programs with little human interaction, such as Emporium and on-line.

Placement

Placement tests are outdated and test towards traditional curriculum.

For example,the California common assessment does not reflect CCSSM.

Textbooks

- Students often do not purchase textbooks
- Most textbooks are traditional
- Open Source collections offer little at the developmental level (mainly old books released by publishers)

Computer homework systems

Use of electronic homework encourages emphasis on algorithm mastery and short answers, neglecting development of conceptual understanding.

Faculty issues

1. Faculty Attitude and Preparation
2. Dependence upon Adjuncts

Faculty Issue #1: Faculty Attitude and Preparation

Developmental math is sometimes separate from the math department. In some colleges, this creates a two-tiered hierarchy of prestige.

Attitudes of full-time faculty

- Most CC faculty have no experience teaching for understanding in developmental courses.
- Many CC faculty rely on a lecture-style presentation unsuited to basic material.
- Some CC faculty resent having to teach developmental mathematics

Faculty Issue #2: Dependence upon Adjuncts

Many developmental classes are taught by adjuncts, and often there is little communication between adjuncts and full-time faculty.

Program coherence

Adjuncts may teach on multiple campuses and try to use the same text and/or lessons in all their classes, instead of following the program on each campus.

Adjunct training

Adjuncts are not paid for time outside the classroom, and cannot be required to attend workshops or other training

Collaboration

How can 2-year and 4-year schools work together to improve developmental math programs?

What can community colleges teach 4-year schools about teaching developmental math?

- There is intellectual content in developmental math
- Focusing on rote skills undermines development of productive math practices and attitudes
- TA’s need training

How can 4-year schools help community colleges improve their developmental math programs?

- Meet with CC faculty to streamline the content of developmental math courses
- Meet with faculty in other disciplines to determine their needs
- Allow CC's to handle remediation

How can 4-year schools help with articulation?

- Remove or modify the Intermediate Algebra prerequisite for statistics and non-STEM courses
- Don’t require Common Core alignment for CC courses (CC is not High School)
- Consider alternative pathways