A Process Approach for Improving Student Performance in Learning Mathematics

Abstract: Changing the developmental mathematics program to a student centered, discovery learning format incorporating how to learn mathematics is a process that includes extensive faculty development, curriculum design, and assessment. This article chronicles the design and implementation of such changes in the developmental mathematics program at the University of Louisville. Results of the changes have been promising with higher retention and pass rates.

Problem

Public colleges and universities are forever faced with a paradox. We must ensure equal access to educational opportunity by recruiting non-traditional students, under-represented minorities, and women. But what do we do with the students that we recruit when the students are underprepared for college courses? It is well documented that student retention of these students is crucial to the success of an institution as well as the success of the country. (NRC, 1989) Being underprepared in how to learn mathematics is one major cause of failure to progress. Thus, mathematics programs are also caught in this paradox. On the one hand very large numbers of students enter underprepared while on the other hand mathematics is still the "gatekeeper" to the sciences (natural, social, and health) and high standards must be ensured. One solution to the paradox is to develop key mathematical learning skills as a part of the developmental mathematics curriculum.

Context

At the University of Louisville, which is a large metropolitan research university, 40% of the entering freshman class needs at least one developmental mathematics course. The developmental mathematics courses (Prealgebra and Elementary Algebra) are housed in the Division of Transitional Studies which currently is an admitting unit for students who do not meet the admission standards of degree granting units. The students served by the Division are considered high risk.

Students are initially placed into mathematics courses based on their ACT math sub-test score. Students may challenge the original math placement by taking the Mathematics Placement Series provided by the Mathematical Association of America (MAA). Of the

three branches of the crossroads: the foundation, which includes developmental mathematics, technical programs, and general education mathematics for math-intensive, liberal arts, or teacher programs. The *Crossroads* has been endorsed by many state, regional, and national organizations, including the National Association for Developmental Education (NADE) which is the only national organization representing all facets of developmental education including a very active mathematics group. Members of the NADE mathematics group (Math SPIN) were on the AMATYC task force and writing teams.

Most of the fundamental changes in mathematics education recommended by the *Crossroads* make use of advances in learning theory that are widely accepted as effective learning tools in other disciplines. Collaborative learning, discovery learning, problem solving, and use of technology are recurring themes in the *Crossroads*.

Implementation Strategy

The University of Louisville developmental mathematics program is currently using materials developed in collaboration with Pacific Crest which is an educational consulting, publishing and technology company whose goal is to "Improve educational effectiveness through Process Education." The cornerstones of Process Education are cooperative learning, discovery-based learning, problem-based learning, journal writing, and self-assessment. The obvious match in pedagogy inspired the developmental mathematics unit to investigate ways to incorporate the changes in curriculum recommended by the *Crossroads* using Process Education. The Process Education model uses collaborative groups, usually teams of four or five students, and computers as an integral part of the curriculum.

The first concern for changing the curriculum and pedagogy was faculty development. Training of 15-20 part-time instructors who were very traditional in their approach to mathematics education seemed a monumental task. Initially the program director and one full-time instructor received training at a Pacific Crest Teaching Institute. Following that training they piloted a section of developmental mathematics, Prealgebra, to

ELEMENTARY ALGEBRA (MATH 099)

	'94F	'95S	'95F	'96S	'96F (L)	'96F (P)	'97S (L)	'97S (P)
% Pass	61.6	54.7	60.4	48.0	64.4	72.0	53.4	72.0
% Completion	53.3	45.7	51.2	39.8	55.3	64.3	45.9	56.0
Total Students	810	534	787	477	441	359	222	298

New Performance Measures

The program changes have been closely monitored and evaluated. The increase in pass rate, though promising, is not a sufficient measure of success. One measure that the University is required to report to the state Commission on Higher Education, in addition to the current pass rate (CPR), is the pass rate of developmental mathematics students in their first college level mathematics course. The future pass rate (FPR) is calculated within four semesters of the original developmental course. For example, students in developmental mathematics in the spring semester of 1995 would have until spring of 1997 to complete a college level mathematics course. The accountability measure can be condensed to the following formula: $CPR_D + FPR_D \geq CPR_A + FPR_A$, where D = developmental students, and A = all students. That is, students who go through the developmental mathematics program must meet or out-perform their better-prepared peers when they exit the program. Results from this state-mandated formula will be available in November of 1997 for Fall 1995.

Results

The results of the program changes have been very interesting. While student performance is getting better, the instructors are also becoming better facilitators. As the instructors gain confidence in the teaching methods that are new to them, student performance should continue to increase. The new methods have the participating instructors much more involved with student outcomes and success. They are much more aware of the opportunity to get the students actively involved in their own learning process. One of the major obstacles to students' success is daily attendance. Since the new format

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