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ABSTRACT

Drawing from literature on research, innovative programs, and association positions, this paper provides an overview of two-year college mathematics curricula, instruction, and faculty. Introductory material places the discussion in the context of changes that have taken place in the community college over the past 20 years, highlighting increases in part-time attendance, the enrollment of lower ability students, and the influx of minority and low-income students. The effects of these changes on the community college curriculum are analyzed with respect to the prevalence of remedial and introductory courses and the paucity of advanced courses; curriculum deficiencies; and testing and placement programs. Reports from individual colleges are reviewed next, providing information on developmental teaching methods, attempts to combat high attrition rates, math anxiety programs, and the operation of labs and centers. Next, the paper addresses the math competencies expected of entering freshmen and ways of assessing them. Focus is placed on the research of the Center for the Study of Community Colleges on the general education knowledge of two-year college students. An overview of recent changes in the instructional design of two-year college math classes is followed by a review of the research on the professional characteristics of two-year college math instructors. Finally, the future of mathematics is discussed, and recommendations concerning the professionalization of the faculty, curriculum reform, and the promotion of student understanding of the importance of math skills are presented. (AYC)

MATHEMATICS IN TODAY'S COMMUNITY COLLEGE

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In the past 20 years the American community college has been converted from a university preparation institution to a career and compensatory education center. Whereas the colleges formerly emphasized transfer studies and took pride in the number of students they attracted from high school and sent on to the universities, more recently they have developed a variety of career-oriented programs and have been forced to modify all their programs to accommodate the marginally literate students emanating from the secondary schools. The conversion was not absolute --- many students still use the colleges as a point of entry to baccalaureate studies -- but it did mark a shift in the institutions' central tendency.

This modification of function has affected the institution's people, processes, and programs. No aspect has been immune. Faculty have had to change teaching practices; the very number of pages they can expect students to read has plummeted. Career guidance has supplanted academic advisement. In most colleges, ten sections of remedial reading or writing are offered for every one section of English or American literature. And the part-time adult student seeking a course in basic skills or in job upgrading has become a familiar figure on campus.

Some analysts applaud the colleges' break with the tradition of the higher learning, viewing the changes as necessary for an institution that would serve a mass public. Others deplore the turn away from collegiate studies, feeling that the colleges thereby do a disservice to the students who look to them as the place to begin an education that will bring higher social and fiscal

rewards than those otherwise attainable. Regardless of one's position on the broader aspects of the changes, they should be examined by everyone involved with the colleges because they affect all, not least the instructors of mathematics, to whom this paper is addressed.

The 1,250 community colleges of America enroll more than one-third of all people engaged in formal post-secondary education. The colleges are large; 45 of them enroll more than 15,000 students each. In some states more than 80% of the people who begin college begin in a community college. This growth was occasioned by the increased percentage of people seeking post-secondary studies. Whereas at the turn of the century, less than 2% of the traditional college-age group was in college, by 1981 42% of the 18 to 24 year-olds were attending. The community colleges contributed to this growth by making access easier for people who in an earlier era would not have considered college-going: minority group and low-ability students, students from low-income families, students who wished to enter the workplace but found they needed an additional year or two of schooling in order to gain job preparation and a certificate enabling them to apply for employment in certain fields. The expansion of career education programs reflects this latter trend: in 1960 one-fourth of the community college students were enrolled in career programs; in 1970 the colleges awarded 43%, and in 1980, 62% of their degrees to career program graduates.

The colleges grew also by encouraging part-time attendance. In 1968 they enrolled 1.9 million degree credit students, 47% of whom were attending part-time. In 1982 they enrolled 4.9 million students, with 63% attending part-time. With the exception of New York and North Carolina, in the fourteen states with community college enrollments greater than 50,000, part-time students outnumbered the full-timers.

Students of lower ability have swelled community college enrollments. Most American colleges have some type of selectivity in admissions but more than half the community colleges allow students to attend if they are of a minimum age (usually 18) and/or they present a high school diploma. Only around one-fourth of them ask the students to provide ability test scores and few, if any, use the students' high school grade point average as a criterion for admission. This has resulted in a high proportion of students with poor prior academic records attending community colleges. Whereas 62% of the full-time students entering all post-secondary institutions in 1983 were from the top 40% of their high school class, only 47% of that group entered a community college.

The colleges have also attracted sizeable proportions of the ethnic minorities and similarly high proportions of students from low-income families. By 1980 the colleges were enrolling nearly 40% of the ethnic minority students involved in American higher education and more than half the minorities beginning college began in a community college. The distribution of family income similarly showed a tilt toward low-income students: 54% of all first-time, full-time students entering college were from families with an annual income of less than $35,000, but 74% of the community college matriculants fell into that category (Astin and others, 1983).

These characteristic of community colleges--lower ability students, students wishing to find employment after only a short period of study, part-time attendees, students who come from families with a tradition of college going--have marked both the curriculum and the faculty. The curriculum in most traditionally organized schools has the appearance of a ladder. Each course builds on the one prerequisite to it and all are presumed to be part of a sequence resulting

in a degree or diploma that evidences certain knowledge and competencies. The community colleges have broken away from that sequence. By far the majority of their enrollments are in introductory courses for which there is no prerequisite: English 1, Psychology 1, History 1, and so on. Relatively few students are enrolled in advanced or second level courses. As an example, an enrollment count undertaken in 1980 in five of the largest community college districts in the country revealed the following patterns: in the humanities there were no students in remedial courses, but 85% of the enrollment was in introductory courses or courses for which there was no prerequisite. The pattern for other disciplines was comparable: social sciences, 79% in introductory courses; sciences, 5% remedial, 65% introductory: mathematics, 60% remedial, 25% introductory; composition, 35% remedial, 50% introductory. (The only exception was in the fine and performing arts which had no remedial classes, 60% introductory, 40% advanced). The curriculum in those institutions had become grade 13 plus remedial studies, with only a nod toward advanced work. These patterns are reflected in the transfer rate which shows less than 5% of the students entering community colleges nationwide completing two years there and then transfering to a senior institution. What transfer does occur often takes place after the first year when the student, having made a satisfactory record in a set of introductory courses, transfers to a neighboring senior institution for the sophmore and subsequent years. (Cohen and Brawer, 1982).

The effect of these shifts on mathematics can be traced because the literature about mathematics in the community colleges is better developed than the literature regarding other academic fields taught in those institutions. Mathematics is a well-defined curriculum area and it accounts for a higher percentage of community college effort than any discipline other than English composition, reading, and literature. A National Science Foundation-sponsored study done in

1969 found mathematics accounting for 24% of the two-year college enrollments in science and social science. (Beckwith, 1980, page 5). Among the associations directing papers toward people teaching and planning mathematics in the community colleges is the Committee on the Undergraduate Program in Mathematics, a standing committee of the Mathematics Association of America. Major sources of information also include such journals as the Mathematics Association of Two-Year Colleges Journal and the Two-Year College Mathematics Journal.

Many of the reports coming from the Committee on the Undergraduate Program in Mathematics in the 1960s and 1970s related to what the group perceived as deficiencies in the curriculum in two-year colleges. They reported on the need for additional courses in calculus, linear algebra, and other advanced levels of mathematics and on the preparation of instructors in mathematics. However, more recently, such concern for the upper reaches of mathematics in two-year colleges has given way to consideration of mathematics for general education or the severely underprepared student. The monograph entitled Science Education In Two-Year Colleges: Mathematics (Beckwith, 1980) reviewed several studies of mathematics in general education, including one done in the early 1970s that formed two-thirds of the mathematics departments offering a course specifically designated for general education.

Studies of remedial mathematics have included nationwide surveys on teaching techniques, faculty qualifications, time spent on various aspects of mathematics, and related issues of general concern. Chang (1983) found elementary algebra offered in 82% of the remedial courses; arithmetic in 68%; and intermediate algebra in 53%. Most of the colleges surveyed did not offer credit for remedial courses. Nearly all the colleges provided tutorial services

for the students and, in just under half the cases, the remedial students finished their developmental programs within one semester; just over half of them went on to complete at least one college-level mathematics course. Beckwith reported a nationwide study, done by the Center for the Study of Community Colleges under National Science Foundation auspices, which revealed that 97% of the colleges offered introductory and intermediate mathematics, 86% offered some advanced study, and 67% offered applied or technology related mathematics. Well over half the course offerings were at the introductory or intermediate level, including courses in pre-algebra; introductory algebra; geometry; intermediate algebra and trigonometry; college algebra and trigonometry; and all developmental or remedial courses. The literature on remedial education in mathematics revolves around questions of definition, placement of students, granting of credit, course content, and effective instructional practices. Beckwith reviewed a 1975 study which found that nearly all two-year colleges offered courses in developmental mathematics. At that time less than half the colleges required a placement examination and, in those that did, few mandated that students take a remedial course. That was the era when the students were to be given the right to fail, a procedure and value system that has changed notably in the past few years. Now, a rapidly increasing number of two-year colleges are returning to the 1950s pattern of mandated placement tests and course placements in English and mathematics.

Many reports from individual colleges are also available. Developmental mathematics at Lower Columbia College (Washington) was described in a report indicating the various ways that students might complete the mathematical requirements through courses offered in laboratory and classroom. As in many other colleges, the high attrition rates in developmental mathematics were combated by extensive placement testing, math anxiety workshops, and several levels of review courses (Crepin, 1981). Math avoidance was revealed in a

study of students' course-taking patterns in a large urban community college district in which a high percent of the students who had noted an interest in science-related careers had completed no mathematics courses even after having completed more than thirty units of college work (Friedlander, 1981).

Information about the operation of laboratories and centers that teach basic mathematics is prevalent. Mitchell (1980) reported on the operations of the Mathematics Center at Pima College, indicating that its 20 to 25 staff served 400 to 500 students. It had a lead faculty member or coordinator responsible for employing and scheduling instructors, assistants, and tutors; training the staff; establishing record keeping systems; developing curriculum; managing the preparation of materials; determining grades; and "serving as the instructor on duty several hours each week (p. 43)." The Center had a differentiated staff with other fully certified instructors, clerical assistants, and peer tutors. Problems at the Center included computing faculty work load and training peer tutors. The Mathematics Learning Center at Cerritos College was examined from the standpoint of its financial base. The Center was cost-efficient because its course sections were large and because it employed paraprofessional personnel to maintain student records. The author recommended keeping the staff lean and insuring that students understand the Center's policies (Baley, 1981). Some of the reports of the mathematics centers and laboratories describe the special services offered for students with various types of deficiencies in mathematics understanding (Habib, 1981; Yawin, 1981; Rotman, 1982). Others focus more intently on the organization and operation of the laboratories themselves (Emerson, 1978; Fast, 1980; Palow, 1979).

Some work has been done recently on competencies expected of entering freshmen, with particular attention to tests that would place students in

mathematics courses in which they had a reasonable chance of succeeding. Many of the questions swirling around student placement have to do with the relative merits of homemade placement tests and tests that are prepared and distributed by a national agency. Several articles on faculty with dissatisfaction nationally-normed tests have been published. Wood (1980) reports the switch from the ACT mathematics placement test to an instrument developed at the University of Houston, Downtown Campus, more than fifteen years ago. The college used that 50-minute test to shunt students scoring below seventy percent to a course reviewing algebra. Notable results in retention and achievement were effected.

A minimum level of mathematic literacy for all college-level students was specified in the 1981 annual report of the American Mathematical Association of Two-Year Colleges Developmental Mathematics Curriculum Committee (Dyer, 1981). In several states the community colleges have been cooperating with the universities and secondary schools in announcing competencies expected. The Academic Senates of the California community colleges, the California State University, and the University of California addressed a statement to parents, teachers, counselors, and administrators of high school students indicating the requisite competencies in algebra, arithmetic, geometry, and advanced mathematics that students should demonstrate in preparation for college (Statements..., 1982). Miami-Dade Community College (Florida) prepared a booklet for distribution to junior high school and high school students in its service area indicating expected competencies in mathematics and English usage. Community colleges elsewhere have undertaken similar projects.

Despite these pronouncements the question of how much students know is studied only rarely. As a way of getting information about absolute levels of student knowledge, the National Assessment of Educational Progress has for

more than fifteen years administered items in science, social science, and mathematics to samples of nine year-olds, thirteen year-olds, and seventeen year-olds. Building on this idea of assessing student knowledge in an absolute rather than a relative sense, the Center for the Study of Community Colleges designed an instrument to survey community college students in the humanities, sciences, social sciences, mathematics, and English usage. Many of the items in this General Academic Assessment were provided by the National Assessment of Educational Progress with other items borrowed from Educational Testing Service or provided by various community colleges. The test included 53 items in mathematics spread over five forms; the scores were converted to ten point scales. In addition the Center collected such background items about the students as age, number of college credits earned, occupational aspirations, number of courses taken in each liberal arts area, self-assessment of academic skills, and primary reason for attending college.

The test was administered to around 8,000 students in the community colleges of Los Angeles, Miami, St. Louis, and Chicago. The sample was generated by picking every Nth academic transfer-credit class from the 1983-1984 schedules. Excluded from sampling were remedial classes, occupational classes that did not carry transfer credit, and adult education or community service courses. The class section was used as the unit of sampling because it is the most feasible way of administering a survey to a random sample of community college students.

The results were as expected. Students who had completed more total college units, who anticipated receiving an associate degree by June 1984, who were in college to transfer and/or to prepare for a career in the advanced professions or technologies, or who had completed more math courses scored higher. But the highest correlation of all was between the mathematics scores and the question,

"Compared to other students at this college how would you rate your ability to use algebra to solve problems?" Students were given a choice of rating themselves; poor, fair, good, or excellent. Scores on the mathematics scale ranged from below four for the students who rated themselves as poor to above six for those who said they were excellent (Riley, 1984).

The future of mathematics in the community colleges will see some modification, more in instructional design than in course content. The computer and hand-held calculator have already changed patterns of drill and demonstration. Advances in those technologies will continue to make inroads on traditional instruction. Enrollments will remain high because mathematics is a service course to numerous technologies and career programs. A 1977-1978 survey found 449,000 students taking mathematics classes in community colleges nationwide. And that figure does not include those who were enrolled in remedial sections offered through mathematics laboratories. The number was the highest for enrollments in any academic area within the sciences, social sciences, or humanities. Contrast that figure with 335,000 enrollments in history, 255,000 in political science, and 225,000 in psychology. Or, put another way, contrast it with the 73,000 students studying chemistry or the 35,000 enrolled in physics courses. (Cohen and Brawer, 1982, p.289)

Changes in the mode of presenting concepts and drill in mathematics depend in large measure on the way the instructors perceive their role. Education is a labor-intensive enterprise; will the faculty continue demanding small classes? Nationwide, classes in mathematics are smaller than classes in the other sciences and social sciences: 28 vs. 32, on average. Of the scheduled mathematics classes in six of the largest districts, 21% had fewer than 20 students; 56% between 20 and 30; and 23% more than 30. Yet 35% of the instructors said their classes would be more effective if they had fewer students.

Based on the literature there seems to be a split between instruction in remedial mathematics and college level mathematics as great as the gulf between the teaching of English composition and English literature. The publications on remedial mathematics speak of laboratory experiences, tests, grades, auto-instructional programs, and ways of staffing the laboratories to make them more efficient. The articles on college-level mathematics discuss games, proofs, problem-solving strategies, theorems, and the unfortunately labeled concept, math anxiety. This split is revealed in the articles carried in The Two-Year College Mathematics Journal in which, for the four years beginning in 1980, there were tips on teaching, mathematics concepts for classroom use, mathematics games, and a few articles on mathematics avoidance. There was an occasional article on merging mathematics with other fields, as for example, "Integrating Writing into the Mathematics Curriculum," (Goldberg, 1983), and a few reports of classroom experience, for example one involving basic mathematics and women in which the investigator found that women in all-female section of a basic algebra class did better than women in mixed sex classes (Brunson, 1983). But most of the papers were distinctly addressed to instructors of advanced classes, whereas the ERIC system and the journals especially slanted toward remedial studies in mathematics and English usage carry papers describing the operations of learning laboratories.

The major differences between remedial and college-level mathematics seem to be in the pattern of presentation (laboratory vs. classroom) and in the staffing (a lead instructor supervising a corps of aides vs. a lone instructor in a classroom). Further differences appeared in the Center for the Study of Community Colleges' national surveys. Instructors of remedial classes indicated they spent less time in lecture (36% vs. 49%). They were less likely to

administer ABCDF grades (52% vs. 76%). As a group they tended to be younger, with less teaching experience, but much more likely to rely on tutors (60% vs. 48%) and paraprofessional aides (27% vs. 12%) for teaching assistance and more likely to use test-scoring facilities (23% vs. 13%). These differences suggest that the instructors of remedial classes are perforce leading in the development of a professional faculty peculiarly suited for the community college.

Community college instructors in general differ from their senior institution counterparts in demographic characteristics, attitudes, and values. The community college faculty teaching transfer-credit courses typically hold the Master's degree, and the instructors of occupational subjects tend to be certified on the basis of their experience within the trades that they teach. Members of both groups have relatively high teaching loads, with the instructors of transfer courses teaching from 13 to 16 hours per week or four or five classes with around 30 students in each. The occupational program faculty often teach longer hours since they are involved in clinics and laboratories.

The faculty tend not to be members of academic disciplinary associations. As an example, less than 7% of the people teaching history belong to the American Historical Association and similar figures pertain for community college faculty membership in the American Philosophical Association, the American Sociological Association, and so on. Where associations have been formed with the intent particularly to involve community college instructors, the membership ratio is much higher. The Community College Humanities Association has developed into a thriving national group over the past five years and the American Mathematical Association of Two-Year Colleges is directed toward its disciplinary affiliates.

Are the faculty satisfied with their working conditions? Until the 1960s the local secondary schools were the largest single source of community college

instructors. For those who moved from a secondary school to a community college, faculty satisfaction was high because they had entered a higher status position and enjoyed a reduced teaching load. The less satisfied instructors tended to be the younger ones coming in directly from graduate school. Still, the faculty continually pleads for better qualified students, smaller classes, and more time off. In one large, urban community college district recently, the faculty bargaining unit negotiated a teaching load reduced from 15 to 12 hours per week. In return they relinquished all sabbatical leaves, instructional development grants, and travel funds. They saw lower teaching loads as more crucial to their professional well being and personal satisfaction than the perquisites that faculty historically have indicated as being essential for their professional currency.

This sheds light on the question of professional status. Some commentators have reasoned that the community college is best served by a group of instructors with minimal allegiance to a profession. They contend that professionalism leads to a form of cosmopolitanism that ill-suits a community-centered institution, that once faculty members find common cause with their counterparts in other institutions they lose their loyalty to their own colleges. This argument stems from a view of professionalism among university faculties that has ill-suited teaching in the senior institutions, where, as faculty allegiance turned more to research, scholarship, and academic disciplinary concerns, interest in teaching waned.

However, that argument suggests that a professionalized community college faculty would necessarily take a form similar to that taken by the university faculty. It need not. It could develop in a different direction entirely, tending neither toward the esoterica of the disciplines nor toward research and scholarship on disciplinary concerns. The community college faculty

disciplinary affiliaton is too weak, the institutions' demands for scholarship are practically non-existent, and the teaching loads are too heavy for that form of professionalism to occur.

A professionalized community college faculty might well organize itself around the discipline of instruction. The faculty is already engaged in course modification, the production of reproducible teaching media, and a variety of related activities centered on translating knowledge into more understandable forms. They have had to take that direction because of the paucity of self-directed learners in their classrooms. A corps of professionalized instructors would well suit the community college. They could reform curriculum, devise entry and exit examinations for their students, manage groups of paraprofessional aides and instructional assistants, prepare reproducible instructional media, and exhibit the other essential components of people practicing the discipline of instruction. A professionalized community college instructor would be a manager of student learning. It is likely that the instructors most nearly acting like such practitioners currently are involved with learning laboratories that have taken over much of the remedial instruction.

Many two-year college instructors have so professionalized themselves, but that concentration on the discipline of instruction has not yet become the hallmark of a group of instructors sufficiently large to have it seem the central tendency of the 200,000 people teaching in the nation's community colleges. The relatively heavy teaching loads take their toll, and as long as instructors insist on smaller and fewer classes, instruction remains a labor-intensive, high-cost enterprise. Fortunately for the development of community college teaching as a profession, many instructors in remedial mathematics have taken the lead in developing learning laboratories and in pursuing instruction through

differentiated staffing.

Few mathematics teachers enjoy presiding over students doing drills in the classrooms, but neither should they want to turn the laboratories over to less qualified staff. They are faced with becoming managers of learning which involves them in designing placement tests, analyzing the results of instruction, defining objectives, monitoring procedures, reviewing programs, developing competency tests, and conducting follow-up studies of students who transfer or who enter the work place. They can do that or risk being shunted to the corners of the community college where they would find the occasional serious student of mathematics who would enter a career in one of the advanced technologies or who would transfer to the university and major in science. Too few of the community college students fit those categories to warrant a sizeable staff teaching mathematics beyond the level of college algebra.

The experience of other disciplines whose practitioners insisted on teaching only the majors in their area or the students who were serious about their studies is instructive. In some colleges the instructors in specialized areas in the humanities recognized that there were not enough serious students to warrant their attention and they began making liaisons with other disciplines. Thus the philosophy instructors involved themselves with people in the health and business fields and developed courses in Medical Ethics, Business Ethics, Logic for Computers, and similar cross-disciplinary activities. The literature instructors, acting in cooperation with instructors from other disciplines in the humanities, developed interdisciplinary courses combining literature with history, philosophy, art appreciation, and religion. They demonstrated the value of those courses, made them required for all degree candidates, ensured that students would write within the contexts of those courses, and built them

into the fabric of the institution. In one 13,000-student community college in Florida, the humanities staff teaches sixty sections a year of an interdisciplinary humanities course. The course is required for students in all programs, including the occupational certificate areas.

Some mathematics instructors have taken similar steps. Davis (1980) studied the level of cooperation between mathematics and occupational technical faculty in designing and presenting mathematics courses for students in occupational programs. He found that these cooperative relationships were more likely to be developed where there was a high quality of informal communication among the staff, a process for development and review of content in the courses, and where the mathematics department took responsibility for initiating such course liaisons.

The future of mathematics in the community colleges will see it concerned for the next several years at least with remedying the defects in mathematics preparation revealed by students graduating from high school. If recent curriculum reforms in the secondary schools have the desired effect, by the end of the decade, the press for remedial studies in community colleges may have been lightened. At that time the attention of the mathematics curriculum planners will of necessity turn increasingly to ways of merging the study of m thematics so that it becomes suited both for the liberally educated person and for the person intending upon immediate employment. This is essential because most students coming to community colleges want to be prepared for immediate employment but at the same time, they do not want to forgo their options for continued study. Furthermore, a person is both a worker and a citizen of the community and needs preparation in applied mathematics and in the broader concepts of mathematics that help the person as

citizen to understand developments in science and technology outside the career field itself. And the career programs themselves have increasingly become feeders to the senior institutions. Many of the credits earned in the two-year college occupational programs are acceptable for transfer.

Any such curricular reformation should take place in the community colleges themselves. There is no external agency organized for the purpose of revising collegiate studies in a manner that would better fit the colleges. The practitioners who have organized the mathematics laboratories, who are familiar with community college students and the internal politics of curricular reform, will have to undertake these changes in the direction of mathematics courses sufficiently broad and concentrated to satisfy the peculiarities of the institution in which they work.

Learning mathematics depends on an ability to imagine the future. Why manipulate those apparently sterile symbols? The student must appreciate the power of those symbols to effect technology, invention, the advance of knowledge in the sciences, the quality of life itself. This suggests a set of modules to be presented in conjunction with all formal mathematics classes and as part of the learning process in the mathematics laboratories. These short segments would be directed toward moving students away from a sole concentration on the symbolic language itself, toward understanding the power of that language. Basic mathematics is as much a service course to students in all programs as is basic English usage. The professionalized community college instructors would ensure that it was so presented.

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