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ABSTRACT

During the 1960's and 1970's, basic math programs were established at many two-year colleges after the influx of poorly prepared students, which resulted from a weakening of the exit criteria at the secondary level and of the entrance requirements at the postsecondary level. Though the success of these remedial programs is a matter of debate, depending on the standpoint and criteria adopted by those making the judgement, there are major ways of making these programs more effective. Some guidelines for increasing program effectiveness include: (1) providing an appropriate curriculum that focuses on the skills that will be needed in college and on the job; (2) ensuring that students who need help get it; (3) developing programs that respond to the special needs of the students; (4) providing each program with sufficient resources to carry out its work; and (5) protecting the integrity of the program and the college degree. Reducing the need for remedial math programs will involve broad policy decisions which might include raising entrance requirements in the two-year colleges, strengthening the math component of the secondary school curriculum, and allowing students to bypass basic computational skills by using calculators. (Author/HB)

REFLECTIONS ON BASIC MATH PROGRAMS IN THE TWO-YEAR COLLEGE

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Paper presented at the Sloan Foundation Conference on New Directions in Two-Year College Mathematics
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Dear Colleague,

Here's a copy of my paper Reflections on Basic Math Programs in the Two-Year College for our upcoming meeting. Happy reading!

Geoff Akst *ga*
Manhattan CC

ABSTRACT: During the 1960's and 70's, basic math programs were established at many two-year colleges. While a number of factors contributed to the influx of poorly prepared students, two points were paramount: the weakening of entrance requirements at the post-secondary level and of exit criteria at the secondary level. Just how well these remedial programs work is a matter of debate, depending in part on one's perspective. The basic skills instructor will look for content mastery; the instructor of a client course will demand carry over of the remedial content; and the college administration will focus on graduation and retention rates. From each of these points of view, there is room for debate.

There are five broad areas of concern in building an effective basic math program: (1) The curriculum must be appropriate. (2) Students who need help should get it. (3) The programs should be responsive to the special needs of its students. (4) The program must be provided with sufficient resources to carry out its work. (5) The integrity of the program and of the college degree should be protected.

How can the need for basic math programs in the two-year college be reduced? Possible strategies include: tightening admissions standards in the two-year college, raising exit standards in the high school (through requiring all students to pass a course in elementary algebra, through expanding the math content of assessment tests, etc.), encouraging more high school graduates to go on directly to college so that math skills do not become rusty, and through changing perceptions of the importance of conventional computational algorithms so that the need to teach arithmetic is eroded.

REFLECTIONS ON BASIC MATH PROGRAMS IN THE TWO-YEAR COLLEGE

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Each of the sections of this paper develops the theme of basic math programs in the two-year college (TYC) from a different perspective. The first section recalls some of the factors which contributed to the growth of these programs in the 1960's and 70's. The second addresses the question how well basic math programs, as they have developed, actually work. The third contains suggestions for making these programs work even better. And finally, the fourth section deals with strategies for self-destruction, that is, for changing the context in which we operate so that one day TYC basic math programs will no longer be necessary.

The Growing Need.

Not only is the problem of mathematics remediation in the two-year college (TYC) serious, but it is getting worse. National statistics tell the sad tale. In 1980 (the most recent year for which information is available), courses in basic mathematics -- arithmetic, elementary algebra, intermediate algebra and general mathematics -- accounted for nearly half the total TYC math enrollment, a good one-and-one-half times what the corresponding proportion had been in 1966.[1] Furthermore from 1966 to 1980, it was the group of very weakest students that grew most rapidly; as the TYC movement expanded, with their total math enrollment tripled, the registration in arithmetic exploded, zooming to eight times its former size. What is so disconcerting about this development is that arithmetic was the only math that many of these students seem to have studied in high school! For every TYC student who took calculus in 1980, there were three others taking arithmetic; for each student taking elementary statistics six were learning computational skills. In all, close to half a million TYC students in 1980 were registered in courses covering secondary or even primary school mathematics.

This inadequate preparation of incoming students is not a problem confined to TYC's or to mathematics. Verbal skills of entering TYC students have declined as well [2], and four-year institutions, even the most selective, have also begun to complain about the academic preparation of entering freshmen.[3] How are we to explain this dislocation in our educational system? The non-selective entrance criteria of the proliferating TYC's and of other open-admissions institutions was, of course, an aggravating factor. Relaxing college admissions standards weakened the incentive for high school students to apply themselves, and many grew confident of finding a niche in college no matter what their level of preparation. It is hardly surprising then that since the late 60's, the proportion of students following the preparatory track dropped sharply, and the less stringent "general" track became dominant.[4] Curriculum makers in the high school, under the pressure of student activism and liberated by diffuse college standards, allowed students to take fewer demanding courses such as algebra and geometry

Akst/2

and to substitute electives like "personal development" courses. Across the curriculum, grade inflation and social promotion also contributed to declining expectations. Furthermore, an analysis of high school transcripts from around the country suggests that this phenomenon was more severe in mathematics than in any other discipline.[4]

As standards slipped in the 60's and 70's, the percentage of students whom the high schools graduated increased, climbing from 60% to 75%.[5] More and more students were in a position to go on to college, and in those two decades, the proportion of the college-age population actually attending college rose from 1/5 to 1/3.[6] Of course, many of the weaker high school graduates headed straight for the open-admissions institutions -- not only students who had failed to develop their capabilities but others of low academic potential who would not have been able to pursue a degree under earlier stringent conditions even had they applied themselves.

There may have been other less tangible societal pressures behind the slipping skills of incoming college students. Many observers noted signs of slackening discipline in the home and on the street which could well have impinged on student motivation and performance. A generation of television babies was growing up, weaned less on David Copperfield than on Star Trek; the tradition of spending time interacting with books, conversing, and doing homework seems to have been in decline. Outside the home, heightened political unrest channelled the time and energy of many students away from academic pursuits. But the two factors first noted -- the reduction of entrance requirements at the post-

Akst/3

secondary level and the weakening of secondary school exit requirements -- were most directly responsible for today's huge remedial enrollment. This causal relationship is important to keep in mind if the process is ever to be reversed.

How Well is the Need Being Met?

Given that TYC basic math programs have grown into sizable enterprises requiring the allocation of hotly contested college resources, the question is, do they work? The answer is an unequivocal Yes!, Maybe!, and No! What makes the evaluation of these programs so subjective is not just a matter of having to decide whether a glass of water is half-filled or half-empty; the more fundamental issue is which glass to look at. The problem is that the perception of the goals and expectations of a basic math program depends in large measure on the viewer's responsibilities and interests.

At one extreme, the faculty in the trenches -- those teaching basic mathematics -- will likely feel that their work is successful to the extent that students learn the remedial topics thoroughly and then pass their course. By contrast, instructors of client courses -- courses which cover freshman math, science, technology, health, business, etc. -- will be more concerned with the retention and carry over of the remedial content. Of course, the two groups of faculty may overlap to some extent, and it is amusing to see how my own feelings change as I shift roles from arithmetic to statistics teacher, condemning the low standards I employed earlier in giving a marginal student the benefit of the doubt. There is also the view from the seventh floor, to use the slang at my institution. Deans and presidents consider special programs such as mathematics remediation to be interventionist strategies; from their point of view, these programs succeed or fail depending on the extent to which they increase the number of students the college will retain or graduate.

All three perspectives are legitimate, and none can be ignored in any serious attempt to gauge program effectiveness.

From the remedial faculty point of view, measures of success in the basic math course tend to involve two types of data: final exam scores and final course grades. Happily, analysis of either can generally be relied on to yield positive results. Final exam scores, for example, virtually always turn out to be significantly higher than initial placement test scores, often by several standard deviations or more. Such large gains, however, may be deceptive. For one thing, design and statistical biases tend to inflate the gain beyond its true value; for another, genuine learning may be due to factors other than course participation.[7] As for course grades, between 1/2 and 3/4 of starting students in a typical basic math course pass.[8] Sometimes passing rates are significantly higher -- in summer session say, when the population is self-selected, or in sections with particularly effective instructors. Some basic skills courses will have lower passing rates, of course, because the students are unusually weak, the pedagogy is faulty, or too much material has been crammed into the course. It is important to bear in mind, however, that even when the passing rate is as high as 3/4 per course, the passing rate in the course sequence may still be discouraging, say 1/2 for arithmetic and elementary algebra, or 2/5 for the three-tier sequence from arithmetic to intermediate algebra. In fact, a recent survey of TYC's around the country found that about 40 to 50% of students starting basic math programs satisfy all their basic math obligations.[9]

How well do remediated students do in client courses? The best evidence is that about half of the students exiting from basic math programs go on to succeed (get C or above) in college-level math courses.[9] Is 50% good enough? Well, that figure is very likely lower than the success rate for exempted students, but higher than what it would have been had the remediated students not taken and passed basic math courses. Again, is the glass half-empty or half-full?

From the administrator's perspective, retention and graduation rates are key statistics in evaluating basic skills programs. At some TYC's, students who satisfy their basic math obligations are retained at a higher rate than those originally exempted [10] -- a respectable standard to meet; yet even here, the overall graduation rate may be disappointing, and one scans the "faces" at commencement spotting only an occasional student who started out in arithmetic. A recent study at CUNY's nine TYC's reports that only a third of all entering students eventually graduate -- only a fourth of those who come in with low high school averages. (By contrast, the graduation rate for CUNY's four-year college students, who generally enter with stronger academic skills and with more financial security, is a full half.[11]) One-third also seems to be a quick-and-dirty approximation for the TYC graduation rate on the national level as well; each year, TYC's around the country award only about 350,000 associate degrees [11] even though for each of the past ten years, they admitted one to one-and-a-half million first-time students.[6]

A pessimistic interpretation of such data is that basic skills programs as a whole are not compensating sufficiently for the deficiencies which incoming students bring to the TYC experience, and that the cost to the taxpayer, the TYC, and the student -- in terms of time, resources or money -- is simply unacceptable. The optimist will point out that TYC's prepare many of their non-graduating students for transfer to the four-year college of their choice, to advance on the job, to meet personal goals which may have nothing to do with graduating, or possibly to master enough skills which will enrich their lives and increase the contribution which they make to society.

Given that the picture is mixed, where does that leave us? The answer lies with some healthy realism. For one thing, to expect TYC's or basic skills programs to be responsible for ensuring that weak students overtake those who are stronger may not be reasonable. By seeking out the lowest achieving students, basic skills courses are in effect programming themselves for partial success at best. The main point is that TYC's, if they are to survive, must meet as well as they can the needs of the students they are able to attract. And rather than dwelling on what is probably an inherent limitation of the effectiveness of basic skills programs, it is more productive for those of us working in these programs to search for ways either to improve the services which we deliver to our students or to modify the conditions which originally contributed to mathematically handicapped students entering the TYC's.

Strategies for Meeting the Need.

It is to the first of these concerns that we now turn: how can TYC basic math programs be improved? At the risk of sounding overly prescriptive, I've distilled from my experience observing numerous programs a list of five broad guidelines which might serve as points of departure for increasing program effectiveness. Of course, there is more than one way to carve a turkey, and several readers may wish to meet me later to take issue with one point or another.

(1) The curriculum must be appropriate.

The curriculum should be chosen frugally, keeping in mind the program's propaedeutic function: preparation for specific followup courses, for passing a competency test, etc. Due to the pressure of time, non-essential topics must be kept to a minimum. Topics should be developed heuristically, with the acquisition of skills stressed. As to the calculator question, it is critical that arithmetic courses continue to cover conventional algorithms, but that they also teach the use of the calculator (estimation, constants, memory, scientific notation, etc.). This duality is essential for preparing students for situations at school or on the job which they are likely to encounter, some requiring the use of calculators and others forbidding it. Instruction and testing should emphasize applications and word problems, with many examples taken from followup courses, so as to promote carry over.

(2) Students who need help should get it.

A placement test should be given to all entering students, and used to identify which of them lack the competencies they need. A test has the advantage over the high school record of providing uniform, recent information on what students know. Sample questions from the exam should be sent to incoming freshmen before they are tested to encourage review. The exam should cover the same content as the basic math courses; the expediency of using SAT or ACT admissions test scores for placement is contr[illegible] to the purposes and design of these tests. Many basic math stud[illegible] overestimate the math they know or remember, and a student lacking proficiency should be strongly advised to take or assigned to a basic math course. A mechanism should be in place at registration to check that the student in fact enrolls. Of course, test scores like other predictors of achievement are imperfect, and any students who feel that their designated courses are inappropriate should be allowed to request a hearing or a retesting.

(3) The programs should be responsive to the special needs of its students.

The curriculum should be organized into a course sequence sufficiently flexible so as to provide students in different situations with a reasonable chance to succeed as quickly as possible; an intensive arithmetic course should be available for the weakest student, a briefer arithmetic course for the marginally deficient who only needs a quick review, a separate course in elementary algebra for the student who knows only

Akst/9

arithmetic, etc. Sections should be offered at times convenient to students, many of whom hold jobs and have family responsibilities. Courses must meet a sufficient number of contact hours a week -- at least four -- so as to allow practice in class. Where courses are self-paced, a calendar of minimum progress should be set to reduce the chances of procrastination. Even if the dominant mode of instruction is traditional lecture-recitation, individual student needs should be addressed outside the classroom by tutoring, CAI, etc. Instructors should be knowledgeable in alternative approaches to each topic, and attempt to gauge and to build on each student's previous mathematical experience. Many basic math students have poor study skills, so that the choice of textbook ought to take into account not only curricular fit but also such factors as quality of writing, readability level, and the extent to which skills are constantly being reinforced throughout by means of review exercises integrated with new material.

(4) The program must be provided with sufficient resources to carry out its work.

Unfortunately, many basic math programs do not have enough sections to accommodate all students designated as remedial. The college must allocate resources to provide the program with sufficient staffing and space. Enrollments in traditionally taught sections should be limited to 25 so as to allow for individual attention. The majority of sections should be taught by full-time math faculty who also teach non-remedial courses so as to maximize the continuity between remedial and non-remedial mathematics. The Math Lab must offer enough tutoring to meet student needs. Lab staffing should be funded in such a way as to provide continuity of employment to key personnel, not the practice on many campuses. As an alternative for instruction or drillwork which some students will prefer, microcomputers, video setups and other instructional technology should be made available in the Math Lab.

(5) The integrity of the program and of the college degree should be protected.

If the remedial requirement is to have teeth, each basic math course should have firm exit standards including a uniform final exam comparable to the corresponding placement subtest. This is especially important when one course leads to another in a sequence, or where part-time faculty, in whom one may not have the same degree of confidence as full-timers, predominate. Students should be required to demonstrate mastery of major topics (mastery learning), because of the cumulative nature of the curriculum. At registration into client courses, including freshman mathematics, science, etc., students who have not fulfilled their remedial obligations should be screened out if these courses are to be taught at the college level; this may be a serious bone of contention where the jobs of physics faculty, for example, are at stake. Awarding degree credit for arithmetic or elementary algebra weakens the degree and should be avoided, although granting credit for such courses toward either full-time student

Akst/11

status or for financial aid may be essential to enable the student to attend college.

Conclusions: Reducing the Need

Having reviewed the rise of TYC basic math programs, the extent to which they are effective, and some suggestions for building successful programs, I cannot help but wonder if the need for such programs will ever be reduced, and if so, under what circumstances this can be brought about. The underlying question, of course, is how the level of mathematical preparation of students entering TYC's can be raised. Fortunately, there are a number of scenarios which might lead to that delightful prospect.

In the first of these scenarios, the one which which will be opposed by those of us who believe in open-admissions for reasons of social equity and mobility, TYC's might adopt restrictive admissions criteria. Such a development is not unthinkable. Tight funding has already caused a national trend among many public state univerities to toughen their entrance requirements and to get out of the remediation business.[13] Will this trend extend to the TYC? One possibility is that TYC's, for the very economic or political reasons that motivated the senior institutions, will move in the same direction. Another is that an even larger portion of weak students will be shunted to TYC's diverted from the increasingly exclusive four-year institutions.

In fact, some TYC's have already begun to move in the direction of toughening admissions standards.[14] Many others could conceivably choose this option in about a decade when there will be a turn-around in the demographic curve, and the number of eighteen-year-olds will begin to climb steadily [6]; at that time, it will be less risky for an institution to shrink or shift its target population.

In the second scenario for reducing the need for TYC math remediation, the high schools could begin to graduate students with stronger math skills. These days, the states seem to be tripping over one another in efforts to strengthen the exit standards of their high schools.[13] Such efforts reflect intense public and governmental dissatisfaction with the condition of the educational system, particularly the failure of the high school diploma to signify readiness either to enter the job market or to study at the postsecondary level. This commitment to strengthen the high school curriculum could lead, at least in some states or districts, to an across-the-board requirement that students in all tracks pass a course in elementary algebra. There are already efforts in this direction, efforts which all of us in the mathematics community need to support. For example, a National Academy of Sciences panel of business and education leaders recently noted that students who start work after high school need to master virtually the same basic academic skills as

Akst/13

college-bound students, and recommended that all high-school students be required to take elementary algebra.[15] Likewise, the National Commission on Excellence has suggested that high schools require all students to take a minimum of three years of mathematics.[16]

Another approach to strengthening the de facto secondary math curriculum is through assessment programs. Many states and school districts already give their high school students competency tests which they must pass in order to earn a regular diploma. The mathematical content covered on these tests is generally restricted to elementary computational skills, often as applied to daily-life situations. In time, the competency tests already in place should improve the computational skills which students bring to the TYC, reducing the arithmetic component of basic math programs. Extending the test content to include a good deal of elementary algebra would be a boon for the TYC.

Persuasion might succeed where coercion fails. A selling job could coax high school students into taking more solid mathematics either to prepare for future employment [17], or to avoid future remedial obligations.[18]

Strategies might be developed which encourage high school students to learn and retain more of the mathematics which they study. Tapping the potential of microcomputers may one day allow students to explore concepts and to reinforce skills in ways not now dreamed of. The degree to which math skills are reinforced in other high school courses could be the focus of an arithmetic- or an algebra-across-the-curriculum movement. However, any attempt to raise the quality of math instruction in the high schools will involve finding ways to reverse the shortage of qualified, certified teachers, an effort to which the TYC's could conceivably contribute.

In the third scenario, students would be persuaded to matriculate in college right after graduating from high school, reducing the extent to which skills grow rusty. The state of the economy and the availability of financial aid could be key factors in discouraging students from taking a break between high school and college. However even if such efforts were wildly successful, the TYC's would still have to reckon with the needs of its older freshmen. At many TYC's, this population is already substantial in size; for example, a good fourth of the regular admittees at CUNY's TYC's enter at age 25 or above.[19]

In the final scenario for the contraction of TYC basic math programs, ignorance of traditional paper-and-pencil arithmetic could become less of a handicap for incoming students. Public perception of the importance of conventional computational algorithms might, in time, erode to the point that weak students could simply be handed a calculator without suffering any stigma from their machine-dependence. Basic mathematics would then focus on calculator-based skills, algebra and problem-solving.

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