COMMUNITY COLLEGE COLLABORATIVE

ON

DEVELOPMENTAL MATHEMATICS

Presented at

NADE 25th Annual Conference

Louisville, Kentucky

March 17, 2001

Presented by:
Dr. Pansy Waycaster
Southwest Virginia Community College
Richlands, Virginia 24641
United States of America
(450)964-7559
pansy_waycaster@sw.cc.va.us
FAX: (540)964-7732

A recent report by The Institute for Higher Education Policy debunks (p. v) the misconceptions that remediation is too expensive and is an inappropriate function for colleges. Instead the report argues that remediation is a core function of higher education and a good investment for society as well as for colleges and universities. According to Jamie P. Merisotis, the institute's president, 'one of our concerns with the debate about college remediation…is that there really hasn't been a whole lot of factual discussion about what remediation is, how it works, and the impact proposed policy changes might have' (Remedial). David W. Breneman, Dean of the College of Education at the University of Virginia, said that "the report's findings mirrored those of a remedial-education study that he and another researcher published this summer" (Woodham). The Institute argues that as higher education strives to educate the populace, remediation will continue to be a core function of college and universities (p. 6) and proposes a set of strategies designed to reduce the need for remediation in higher education while also enhancing its effectiveness (p. v).

Background

The executive summary of the report presents information, which should be considered in any debate regarding developmental education. First the report argues (p. vi) that the "financial costs of remediation are modest and generally comparable to or lower than the costs of other academic programs" (p. vi). Remediation absorbs less than 1 percent—$1 billion of the $115 billion annual higher education budget (p. 12)—of expenditures, a relatively modest proportion. The report goes on to posit that even if "remedial education were terminated at every college and university in the country, it is unlikely that the money would be put to better use" (p. vi).

As for the appropriateness of remediation in college it must be noted that remediation is not just for recent high school graduates. Over one-quarter (27 percent) of entering freshmen in remedial courses were 30 years of age or older and only half (56 percent) of the students enrolled in remedial courses were freshmen (Institute, p. 9). In fact, remediation has been a function of colleges since early colonial days, beginning with Harvard college in the 17th Century when Greek and Latin tutors were provided. The need for remediation is no different today. A 1995 survey by the National Center for Education Statistics (NCES) found that 78 percent of higher educational institutions that enroll freshmen and 100 percent of public two-year institutions offered remedial courses (Institute, pp. v-vi). Twenty-nine percent, as compared to 30 percent in 1989, of first-time freshmen enrolled in at least one of these remedial courses, and freshmen were more likely to enroll in a remedial mathematics courses than in a remedial reading or writing course. In fact, a recent study of remediation by Maryland Higher Education Commission found that for students who completed college-preparatory courses in high school and immediately attended a community college, 40 percent needed math remediation (Institute, p. 8).

The Institute's report not only sanctions remediation as a core function of colleges, but also views remediation as a good investment for society and colleges. The alternatives to remediation can range from unemployment and low-wage jobs to welfare participation and incarceration--all of which are more expensive for society. A good remediation program can serve as a cost-effective investment. Students who are admitted to college and complete a remediation program go on to enroll in regular courses, pay tuition and participate in college activities, which partially offset the costs of providing remediation (p. viii). Furthermore, the long term social and economic benefits of going to college—increased tax revenues, greater productivity, reduced crime rates, increased quality of civic life—means that students who succeed as a result of remedial instruction in higher education also make their contribution to the public good.

A final concern of the Institute was that evaluation of remedial programs was minimal. Findings from their study of 116 two- and four-year colleges and universities found 'that only a small percentage conducted any systematic evaluation of their remedial education programs' (p. 10). Furthermore, the Southern Regional Education Board has raised the issue about the effectiveness of remedial programs by observing that "few states have exit standards for remedial courses" (Institute, p. 11). The report concludes by proposing strategies for the future—two mutually reinforcing goals (p. ix):

(1) Reducing the need for remediation in higher education and
(2) Improving the effectiveness of remedial education in higher education.

The focus of attention in this study is the latter of these two charges—to improve the effectiveness of the developmental mathematics program at SWVCC. The report lists three strategies to improve the effectiveness of remedial education:

(1) Creating interinstitutional collaboration among colleges and universities in a state or system, allowing 'best practices' and ideas to be shared and replicated;
(2) Making remediation a comprehensive program that encompasses more than just tutoring and skills development; and
(3) Utilizing technology to enhance the teaching-learning process.

The first of these strategies—creating interinstitutional collaboration—is most consistent with the three charges made in 1998 by Dr. Arnold Oliver, Chancellor of the Virginia Community College System (VCCS), to the VCCS Developmental Studies Implementation Task Force:

(1) to develop common sytemwide guidelines for interpreting the results of the standardized test.

(2) to develop systemwide measurable objectives and exit criteria for developmental reading, writing, and mathematics.

(3) to make recommendations concerning performance indicators and assessment methods that can be implemented systemwide for the purpose of monitoring the success of these new procedures.

These charges require systemwide collaboration in standardized test interpretation, common objectives, exit criteria, and assessment methods for developmental courses. Such agreement should do much to standardize the treatment of developmental mathematics across the state system. All of the mathematics representatives serving on this Task Force are also members of VMATYC (the state affiliate of AMATYC—American Mathematical Association of Two-Year Colleges). Thus, the AMATYC Standards—*Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus*—served as a guide for mathematics decisions made by the Task Force. Fall semester, 2000, the Task Force recommendations will be implemented statewide. Major changes include common ASSET and COMPASS cutoff scores for placement into mathematics courses; mandatory placement into developmental mathematics classes, when appropriate, and common core exit exams for all three developmental mathematics courses—MTH 02, MTH 03, and MTH 04.

Sabbatical Study

The current collaborative study will complement the work of this Task Force by determining which teaching methodologies or practices work best to ensure success in preparing developmental mathematics students for college level mathematics courses. During spring, 2000 this researcher carried out a major collaborative among five community colleges in the VCCS—Virginia Community College System—to observe experienced instructors, gather data and extract the most effective ideas and teaching methods being utilized in the developmental mathematics classrooms for implementation into our own classrooms.

Ten instructors and fifteen developmental mathematics classrooms—Basic Arithmetic, Basic Algebra I, and Basic Algebra II—in five colleges were involved in the study. The researcher visited each classroom at least three times—at the beginning, middle, and end of the semester—to observe teaching methods and techniques as well as to gather attendance and student participation data. She also used this time to discuss details of the project and concerns for the class with the instructors. The primary variables under consideration in this study are: course credit hours, class size, attendance, student gender, teacher gender, class participation rates (questions and answers), method of instruction (lecture or individualized), success rates in developmental and subsequent college level mathematics courses, and retention and graduation rates for developmental students. The primary goal of the researcher is to isolate factors, which could positively impact the degree of success in developmental mathematics programs in two-year colleges.

Course Logistics

Table 1 below containing the classroom logistics of these different classes describes the setting for developmental classrooms in these five colleges.

Table 1 **Class Logistics for Developmental Mathematics**

CAMPUS	COURSE	TEACHER	HRS CREDIT	TEACH METHOD	NUMBER ENROLL	PASSING CRITERION
A	MTH 02	Female	5	LectureLab	20	70%
A	MTH 03	Male	5	LectureLab	24	70%
A	MTH 04	Male	5	LectureLab	18	70%
B	MTH 02	Male	3	LectureLab	12	70%
B	MTH 03	Male	5	LectureLab	22	70%
B	MTH 04	Male	5	LectureLab	30	70%
C	MTH 02	Male	3	LectureLab	18	70%
C	MTH 03	Female	5	LectureLab	21	70%
C	MTH 04	Female	5	LectureLab	16	70%
D	MTH 02	Female	5	Individual	22	85%
D	MTH 03	Female	5	Individual	24	75%
D	MTH 04	Female	5	Individual	22	75%
E	02,03,04	Female	5	Individual	19	80%
E	02,03,04	Female	5	Individual	22	80%

First, these three courses—Basic Arithmetic(MTH02), Basic Algebra I(MTH03), and Basic Algebra II(MTH04)—were, for the most part, offered for five hours credit. An earlier study (Waycaster, 1998) by this researcher revealed that the hours of credit given for developmental mathematics courses varied across the system. Since that time adjustments have been made in the credit hours for courses in at least two of the five colleges involved in this study, making them more consistent with other colleges in the system. At the time of this study, only two sections of MTH 02 were offered for three hours credit. All other courses were offered for five hours credit. The five-hour credit courses had a variety of class meeting patterns.

•2 days per week for 2 hrs and 15 minutes each with a break
•3 days per week for 1 hour and 25 minutes each
•3 days per week—2 days for 2 hours each with a break, 1 day for 50 minutes
•4 days per week—2 days for 50 minutes each, 2 days for 75 minutes each
•5 days per week for 50 minutes each

Developmental courses are taught in the system at a funding ratio of 15:1 and usually with a maximum enrollment of 20-25 students, with the understanding that a few students will never attend class and/or withdraw during the first couple of weeks. Enrollment in these classes ranged from 12-24 with the exception of one MTH 04 class with 30 students. However, no more that 23 students were ever present during any observation day.

Usually from 56% to 81% of the students was in attendance, with the exception of one MTH 04 class that never saw 50% of its students present. Attendance dropped to single digits in several classes during my third visit near the end of the semester, which unfortunately is characteristic of many developmental mathematics classes. This attendance problem was most prevalent in the lecture courses with a break. A few students would simply not return from break for the second half of the class period. One of these colleges has decided to change its meeting times for fall, 2000 from one with a break to the 3 days per week for 1 hour and 25 minutes each day without a break in an attempt to resolve this problem.

As for gender makeup in the classes, female students outnumbered male students in six classes, and males outnumbered females in four classes—three of which were MTH 04. Females tend to outnumber males in MTH 02 and MTH 03 while males outnumber females in MTH 04. As for gender of teacher, there were six female instructors and six male instructors. Only experienced developmental mathematics faculty members were involved in this study. All but one instructor was full-time. This one part-time instructor was a retired high school teacher who had taught the same developmental mathematics course at the college for the last eight years.

The primary methods of instruction were lecture/lab and individualized (CAI--Computer Assisted Instruction). Three of the colleges use a lecture/lab format, one college is individualized with tutors assisting teachers, and one college offers all developmental courses in both a lecture and CAI mode. For this study only the CAI sections at this college were observed. All classes taught in a lecture/lab format at three of the colleges routinely reserved specified times during class for students to work individually and/or in groups with worksheets.

Participation Rates

One way to determine if students are engaged in learning is the degree of student participation i.e., the number of questions asked and answers given by the students during a lecture. So this question/answer data was gathered on nine of the classes in the three colleges which utilized the lecture/lab mode of instruction. Table 2 below presents this information.

Participation rates varied according to gender makeup of the class for the most part. In other words, if the class is predominantly male, then most of the student responses come from males and, likewise if the class is predominantly female, then most of the student responses come from females. Six classes were predominantly female and four classes were predominantly male. Consequently, as expected, the percentage columns for questions and answers reflect higher numbers for females when the class is predominantly female and higher numbers for males when the class is predominantly male, with two exceptions. First, MTH 03 at college B was predominantly female, yet on the first classroom visit, males gave 81% of the 36 answers. Second, MTH 04 at college C was predominantly male, but most of the questions (87%) and answers (62%) were initiated by females. Another variable, which may have influenced this deviation from the norm, is the gender of the teacher. The MTH 03 teacher was male and the MTH 04 teacher was female. Is it possible that math classrooms foster greater participation from students of the same gender as that of the teacher? Research (Waycaster, 1980) on gender and mathematics classes support this idea. Notice that in classes with males and females equally distributed, males more often dominate questions and answers. Research in the late 1970’s and early 1980”s involving mixed-sex developmental mathematics classes found that males dominated classroom discussions regardless of the gender makeup of the group. Data from the current study show that we have progressed a long way from this pattern of the 1970’s. In fact numerous questions and answers were offered in most of the classes observed, from both male and female students.

Table 2 **Participation Rates During Lectures in Developmental Math Classes**

Site	Course	Teacher Gender	Student Gender	Attend	Male	Female	Ques-tion	Male	Female	Answer	Male	Female
A	MTH02	F	F	15	20%	80%	65	5%	95%	126	9%	91%
A	MTH02	F	F	12	17%	83%				103	8%	92%
A	MTH02	F	F	6	17%	83%				81	4%	96%
A	MTH03	M		14	50%	50%	23	87%	13%	59	54%	46%
A	MTH03	M		13	46%	54%				130	45%	55%
A	MTH03	M		14	50%	50%				81	47%	53%
A	MTH04	M	M	8	75%	25%	30	87%	13%	126	74%	26%
A	MTH04	M	M	4	100%	0%				176	100%	0%
A	MTH04	M	M	4	75%	25%				126	77%	23%
B	MTH02	M	F	9	33%	67%	25	4%	96%	60	20%	80%
B	MTH02	M	F	8	12.5%	87.5%				56	0%	100%
B	MTH02	M	F	7	0%	100%				69	0%	100%
B	MTH03	M	F	17	35%	65%	5	20%	80%	36	81%	19%
B	MTH03	M	F	9	11%	89%				38	0%	100%
B	MTH03	M	F	9	22%	78%				53	2%	98%
B	MTH04	M		23	39%	61%	3	67%	33%	56	27%	73%
B	MTH04	M		18	61%	39%				8	83%	17%
B	MTH04	M		14	43%	57%				46	67%	35%
C	MTH02	M	F	16	44%	56%	29	3%	97%	119	53%	47%
C	MTH02	M	F	12	42%	58%				120	38%	62%
C	MTH02	M	F	12	42%	58%				136	54%	46%
C	MTH03	F	F	18	17%	83%	8	25%	75%	48	40%	60%
C	MTH03	F	F	14	7%	93%						
C	MTH03	F	F	13	8%	92%				30	13%	87%
C	MTH04	F	M	13	69%	31%	23	13%	87%	57	54%	46%
C	MTH04	F	M	15	60%	40%				81	37%	63%
C	MTH04	F	M	7	57%	43%				28	7%	93%

Findings and Recommendations

Table 3 below contains enrollments and grade distributions over a seven year period for Basic Arithmetic (MTH 02), Basic Algebra I (MTH 03), and Basic Algebra II (MTH 04) for the five colleges in the study.

Table 3 **Success Rates for Developmental Mathematics Classes**
Summer, 1993—Spring, 2000

	Basic Arithmetic MTH 02			**Basic Algebra I MTH 03**			**Basic Algebra II MTH 04**		
Site	**Total**	**Pass**	**% Pass**	**Total**	**Pass**	**% Pass**	**Total**	**Pass**	**% Pass**
A	**1321**	**652**	**49%**	**2391**	**1294**	**54%**	**696**	**446**	**64%**
B	**1915**	**970**	**51%**	**2859**	**829**	**29%**	**1175**	**459**	**39%**
C	**743**	**448**	**60%**	**997**	**531**	**53%**	**742**	**395**	**53%**
D	**958**	**401**	**42%**	**2422**	**1204**	**50%**	**1536**	**791**	**51%**
E	**224**	**93**	**42%**	**1319**	**485**	**37%**	**685**	**357**	**52%**

Passing percentages ranged from 29% to 64% across the colleges. Student enrollment for these seven years also varied from 224 to 2859 for any given developmental mathematics course. A closer look at these enrollment numbers and success rates reveals some noteworthy data and raise some interesting questions. First, MTH 03 routinely enroll the highest numbers of students in all five colleges. The highest success rates (60%, 54% and 64%) occurred in MTH 02 at college C, MTH 03 at college A, and MTH 04 at college A respectively. Roueche and Roueche (1993) declared a 61-70% successful completion rate in developmental courses as adequate. Ten of the fifteen math groups saw almost 50% or better success rates. Two of the five colleges (A and C) attained $\geq$ 50% success rates in all three courses.

College Level Courses

Table 4 below lists the college level courses taken immediately after successful completion of the corresponding developmental mathematics course. For each college level course the number of developmental and nondevelopmental students enrolled are noted as well as the passing percentage.

Table 4 **Success Rate for College Level Mathematics Courses**
Fall, 1993—Spring, 2000

Site	Student	02 $\rightarrow$ 120		02 $\rightarrow$ 126		02 $\rightarrow$ 141		03 $\rightarrow$ 115		03 $\rightarrow$ 126		03 $\rightarrow$ 151		03 $\rightarrow$ 163		04 $\rightarrow$ 115		04 $\rightarrow$ 151		04 $\rightarrow$ 163	
		N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
A	dev	14	43			16	50	12	75	164	78	177	79	66	55			26	77	57	63
A	reg	268	69			225	71	84	54	306	80	945	77	747	66			945	77	747	66
B	dev			10	50	111	66	18	83	95	77							18	89	59	56
B	reg			283	69	339	76	85	59	294	68							99	61	552	65
C	dev					88	66			51	84	17	76					29	83	47	51
C	reg					691	70			303	81	295	64					295	64	346	49
D	dev	75	60					39	59			57	63	17	35	25	72	35	63	133	50
D	reg	750	74					179	48			686	54	692	45	180	47	685	54	693	45
E	dev	22	77															16	75	25	68
E	reg	770	80															180	82	632	70

MTH 02—Basic Arithmetic
MTH 03—Basic Algebra I
MTH 04—Intermediate Algebra
Dev--developmental student

MTH 120—Introduction to Mathematics
MTH 126—Math for Allied Health
MTH 141—Business Math
reg—regular , nondevelopmental student

MTH 115—Technical Math
MTH 151—Math for Liberal Arts
MTH 163—Precalculus

Several observations are noteworthy. First, there were mixed results for students in colleges A, B, and D tracked from MTH 02 to their first college level mathematics course. For the 02 $\longrightarrow$ 120 sequence, student in college A did not reach an adequate success level (43%), whereas students in colleges D and E, both with an individualized instruction format, attained high levels of success (60% and 77% respectively) which were close to the success rates of nondevelopmental students in this course. But note that colleges D and E had lower success rates than college A in the Basic Arithmetic course. One possible explanation is that colleges D and E require higher passing criterions, making developmental students better prepared for college level mathematics courses. A similar pattern occurs for the 02 $\longrightarrow$ 141 sequence. (Note that MTH 120 and MTH 141 are virtually the same course.) Students in college A achieved a lower success rate (50%) than students in colleges B and C (66% each). But this time all three colleges used a lecture format, so a higher passing criterion for developmental courses cannot explain the difference. Since college A has inadequate success levels in both MTH 120 and MTH 141, a closer look at content coverage and passing criteria in both MTH 02 as well as MTH 120 and MTH 141 at that college seems appropriate. A second consideration may be to change the prerequisite for MTH 120 and MTH 141 to include one unit of high school algebra.

Even though the prerequisite for MTH 126 is only one unit of mathematics , college B was the only college having students to enroll in MTH 126 immediately after successfully completing MTH 02. These students attained a 50% success rate in MTH 126, much lower than the success rates (77%, 78%, and 84%) for developmental students who first successfully completed MTH 03. In fact the success rates of these MTH 03 students were comparable or better than the success rates of nondevelopmental students taking MTH 126. Thus, these observations suggest that good advise to students in the Allied Health Program is to first complete MTH 03 before enrolling in MTH 126.

Students in colleges A, B, and D taking Technical Math (MTH 115) immediately after successfully completing Basic Algebra I outperformed their nondevelopmental counterparts in this college level course. However, those students taking MTH 04 before MTH 115 in college D had higher success rates (72% versus 59%) in this college level course. Even though MTH 04 is the prerequisite for MTH 115, it appears that students taking MTH 115 immediately after successfully completing MTH 03 are achieving higher success rates in this course than their nondevelopmental classmates. Then why should MTH 04 be required to enroll in the MTH 115-116 sequence? The course description for MTH 115-116 in the Student Handbook (1999-2000) provides the rationale for the MTH 04 prerequisite. Topics listed for coverage in this sequence of courses include: exponential and logarithmic functions, trigonometry, analytic geometry and complex numbers. MTH 04 provides a much stronger foundation for studying these topics than MTH 03. Further research to determine success rates in MTH 116—the second course in this sequence--for MTH 03 and MTH 04 students would provide valuable additional tracking information on this Technical Math sequence.

This scenario is repeated when tracking students from MTH 03 and MTH 04 into Liberal Arts Math (MTH 151). Students in colleges A, C, and D proceeding into MTH 151 immediately after successfully completing MTH 03 attain higher levels of success (79%, 76%, and 63% respectively) than their nondevelopmental counterparts. All five colleges had students who successfully completed MTH 04 before enrolling in MTH 151. These students had comparable or a little higher success rates in MTH 151. So why should students take MTH 04 before enrolling in the MTH 151-152 sequence? Returning to the Student Handbook (1999-2000), the topics covered in MTH 152—the second course in the sequence—include: combinatorics, probability, statistics and algebraic systems. Here again, MTH 04 gives a better preparation for these topics. Tracking research on MTH 152 for MTH 03 and MTH 04 students may provide insights and possible answers as to the need for MTH 04 as a prerequisite.

Tracking to Precalculus (MTH 163) from MTH 03 and MTH 04 backgrounds produces more clean cut results. Students taking MTH 163 immediately following successful completion of MTH 03 in colleges A and D achieved 55% and 35% success rates respectively. Students in all five colleges who successfully completed MTH 04 before taking MTH 163 achieved $\geq$ 50% levels of success in this college level course. Furthermore, all but one college (B) saw the developmental MTH 04 students with comparable or higher success rates than their nondevelopmental counterparts. And, the students at colleges A and D who successfully completed MTH 04 before taking MTH 163 achieved comparable or higher success levels in the college level course. Thus, the rationale for recommending successful completion of MTH 04 before enrolling in MTH 163 is certainly justified by the findings in this research.

Retention Rates

Table 5 below lists the retention percentages for developmental and nondevelopmental students for the five colleges over a three-year period from fall, 1997 through spring, 2000.

Table 5 **Retention Rates for Developmental and Nondevelopmental Math Students**

Site	Dev/ Reg	Fall, 1997	Spr, 1998	Fall, 1998	Spr, 1999	Fall, 1999	Spr, 2000
		N	**%**	**N**	**%**	**N**	**%**
A	**Dev**	175	80.6	131	79.4	116	65.5
A	**Reg**	781	47.9	827	50.7	939	46.1
B	**Dev**	344	61.9	324	64.2	279	64.5
B	**Reg**	652	61.7	614	55.5	664	61.9
C	**Dev**	117	73.5	173	74.0	172	78.5
C	**Reg**	630	46.8	822	42.1	780	53.2
D	**Dev**	271	79.3	322	79.5	316	72.5
D	**Reg**	1004	52.5	1014	53.9	1048	51.1
E	**Dev**	62	67.7	75	78.7	48	77.1
E	**Reg**	817	42.4	747	51.0	843	51.6

First, retention rates for developmental students range from 61.9% to 80.6% across the five colleges for this time period. One college(B) stand out in that it has one of the highest enrollments in developmental mathematics classes, yet the lowest retention rates for developmental students. However, these 'lowest' retention rates for developmental students were still all higher than the retention rates for nondevelopmental students across all five colleges. Specifically, the retention rates for nondevelopmental students ranged from 42.1% to 61.9% for this time period. Note that the lowest rate of retention for developmental students (61.9%) is the same as the highest retention rate for nondevelopmental students. In other words, for the three-year period from 1997-2000, retention rates for developmental mathematics students were almost 19 percentage points higher than the retention rates for nondevelopmental students. What accounts for this? Developmental faculty would argue that the extra attention—in counseling, advising, teaching, and monitoring progress—as well as smaller classes contribute greatly to this higher level of retention for developmental mathematics students. This research gives support to their argument. The only college (B) having a developmental class enrollment over 25 is the same college with the lowest developmental retention rates. Thus, smaller class size and special attention through advisement may be a key to retaining developmental students.

Graduation Rates

Table 6 below lists the numbers and percentages of community college graduates since 1993-94 who took developmental coursework as part of their studies.

Table 6 **Community College Graduates Who Have Taken Developmental Courses Fall, 1993—Spring, 2000**

Campus	**1993-94**		**1994-95**		**1995-96**		**1996-97**		**1997-98**		**1998-99**	
	# Dev	%Dev	# Dev	%Dev	# Dev	%Dev	# Dev	%Dev	# Dev	%Dev	# Dev	%Dev
A	223	40.4	245	44.1	230	43.6	222	43.7	225	43.5	250	40.7
B	135	53.8	135	53.4	158	53.6	206	53.8	182	52.6	197	53.0
C	89	30.4	82	30.1	77	35.8	88	32.7	86	32.8	76	35.3
D	162	44.0	205	53.8	150	46.0	134	45.0	129	41.2	147	45.7
E	153	45.5	157	45.6	145	40.7	157	42.1	135	38.4	121	38.7
$\sum$	1800	42.3	1806	45.6	1720	44.2	1831	44.1	1790	42.3	1836	43.1

The totals report that over 40% of the graduates from the five community colleges in this study have taken some developmental coursework in their program of studies. This is an impressive statistic, which supports the argument that developmental students do progress to complete their program or degree and do indeed graduate. In fact for one college (B) a **majority** of its graduates took developmental work.

Conclusion

This major study involving five community colleges has resulted in several suggestions for developmental mathematics programs and recommendations for additional research. Course logistics reveal that even though most of the courses carried five hours of credit, there were several different scenarios for meeting times during the week. With such a variety, colleges may choose the pattern which best meets the needs of their students and promotes good attendance habits. Developmental mathematics instructors need to be aware of the gender dynamic routinely at work in the classroom and strive to involve the minority gender in discussions on content. Teachers need to remember that teacher gender also can influence participation from students and work to include both males and females in questions and answers. Checking class attendance regularly and knowing students' names are details, which convey to students that the teacher is concerned about them and their success in class. Every developmental math teacher in all five colleges took class attendance at the beginning of class at every class observation.

Ten of the fifteen developmental mathematics classes had success rates $\geq$ 50%, yet five classes had success rates lower than 50%. The two colleges using individualized instruction had inadequate success rates in both Basic Arithmetic classes and one Basic Algebra I class, and one lecture college had low success rates in both Basic Algebra I and Basic Algebra II. This data is evidence that one mode of instruction is not a panacea for all students, and suggest that colleges offer at least two modes of instruction for developmental mathematics courses, if at all possible. Such an alternative is a welcome alternative for students.

Tracking developmental students into college level classes produced some interesting findings and implications for future research. Students proceeding from Basic Arithmetic (MTH 02) to college level mathematics courses had mixed results, but for the most part students succeeded in Intro and Business Math courses (MTH 120 and 141). One lecture college had low success rates in these college level courses which suggests a closer examination of their content coverage and passing criteria for both Basic Arithmetic and the college level courses. Students who enrolled in Technical Math immediately after successfully completing Basic Algebra I fared well in this college mathematics course, outperforming the nondevelopmental students in the same course, but not performing quite as well as students who first completed Basic Algebra II. Although most students succeeded in Technical Math with only a Basic Algebra I background, this researcher argues that the real need for mastery of Basic Algebra II before enrolling in this sequence is apparent in the content coverage for the second course in this sequence (MTH 116). Hence the VCCS guidelines appropriately list MTH 04 as a prerequisite for this sequence. Tracking research is recommended for this sequence to determine the success rates for students in MTH 115-116 with MTH 03 versus MTH 04 backgrounds. A similar pattern occurs when tracking developmental students into the Liberal Arts sequence (MTH 151-152). Students with only a MTH 03 background again outperformed their nondevelopmental counterparts in MTH 151, as do developmental students with a MTH 04 background. Yet MTH 04 remains as a prerequisite for Liberal Arts Math since its real value appears in the second course in this sequence (MTH 152). Additional tracking of developmental students through this sequence is also recommended. Tracking developmental students into Precalculus (MTH 163) is much more clean cut. All students who first completed MTH 04 before taking MTH 163 succeeded at $\geq$ 50%. Furthermore, all colleges but one outperformed their nondevelopmental classmates. Students from two colleges enrolled in MTH 163 immediately after MTH 03, and attained lower success rates. Additional research on this sequence to monitor success rates in MTH 164 (Trigonometry) for students with a MTH 03 versus MTH 04 background is warranted.

Finally, the research data on retention rates and graduation rates speak to the real purpose of developmental programs in community colleges. The three year cohort study reveals that retention rates (61.9%--80.6%) for developmental students is about 19 percentage points higher than retention rates for nondevelopmental students. In fact, across the five colleges, the lowest rate of retention for developmental students (61.9%) is identical to the highest retention rate for nondevelopmental students. Thus, with higher retention rates as one of the goal for community colleges, developmental educators must continue giving strong support in the counseling, advising, and teaching of these students. The high percentage (40%) of graduates with developmental background found in this study also give added support to the extra assistance provided to developmental students. Results of this study validate the efforts of faculty and staff in these open-door community colleges to bring underprepared students to an academic level which allows them to compete with regular college students.

References

Bartholomay, Ann C (2000, February 3). "Recommendations from the VCCS Developmental Education Implementation Task Force: Report No.1: Standards for developmental Education in the Virginia Community College System".

Bartholomay, Ann C (2000, February 3). "Recommendations from the VCCS Developmental Education Implementation Task Force: Report No.2: Best Practices to Ensure Quality of the Developmental Education Teaching-Learning Environment".

Crossroads in American Mathematics: Standards for Introductory College Mathematics Before Calculus. American Mathematical Association of Two-Year Colleges. 1995.

Hodges, Dawn Zoller (1998). "Evaluating Placement and Developmental Studies Programs at a Technical Institute: Using ACT's Underprepared Student Follow-up Report". Community College Review, 26(2), 57-66.

O'Brien, Colleen. "New National Report: College Remedial Education Threatened by Inaccurate Information, 'Conjecture'; Report Says Remediation Is a Core Function Of Colleges". Press Release. December 1, 1998.

Remedial classes not always sign of bad education, study says. (1998, December 13). Bristol Herald Courier.

Roueche, J.E. & Roueche, S.D. (1993). *Between a rock and a hard place: The at-risk student in the open-door college. Washington D.C:* Community College Press.

Smith, Ed (2000, January). *VCCS Research Report Series: VCCS Students: Who? What? Where, how and When?* Richmond, VA. Academic Services and Research.

Sydow, Debbie L. "VCCS Professional Development: A Summary of the Report Prepared by the Professional Development Task Force". April, 1993.

SVCC 1999-2000 Catalog and Student Handbook—The New Millennium Edition, SWVCC. Richlands, VA.

The Institute For Higher Education Policy. College Remediation: What It Is What It Costs What's at Stake. Washington, DC: December, 1998.

Virginia Community College System (1996). *Policy Manual*, Richmond, VA: VCCS.

Waycaster, Elizabeth Pansy (1980). *The Relationship Between Achievement of Women in An All-Female Basic Algebra Class and the Achievement of Women in Mixed-Sex Classes.* Doctoral Dissertation, Indiana University, Bloomington, IN.

Waycaster, Pansy. (1998, Spring). "Students Should Spend Sufficient Time on Developmental Mathematics". *Inquiry: The Journal of the Virginia Community Colleges*, 2:1,26-31.

Woodhams, Fred. (1998, December 2) "Report Finds Misperceptions About Costs, Beneficiaries of Remedial Education". *The Chronicle of Higher Education: Today's News.*