Comparing Success Rates of Developmental Math Students

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Abstract
The authors detail the surprising findings of their study of the success rates of students enrolled in developmental mathematics courses, examining the effects of the change from three to five credit hours and of implementing an exit exam.

Developmental mathematics students are generally students who are at risk of dropping out of school because of various factors. Many are nontraditional students who have jobs and families; others are traditional students who lack the skills needed to succeed in the college environment. Math anxiety, fear, and intimidation often affect developmental math students, who tend to be afraid of technology, math, and college in general.

In February 2000, the Virginia Community College System Developmental Education Implementation Task Force published recommendations for developmental courses throughout the state. In Report No. 2, *Best Practices to Ensure Quality of the Developmental Education Teaching-Learning Environment*, the Task Force recommended mandatory and correct placement by using multiple measures such as Lassi, Compass, writing samples, and high school transcripts. Other recommendations included a limit of two enrollments in the same remedial course and successful completion of developmental courses before any courses having a prerequisite were taken. Likewise, the Task Force recommended system-wide measurable objectives and exit criteria.

For developmental math courses, the Task Force emphasized practical applications, modeling real-life experiences, oral and written communication concerning the language of algebra, logic of procedures, and interpretation of results. They also encouraged the use of graphing utilities and a function approach.

A Question of Credits

In the Fall of 1998 – prior to the creation of this Task Force and the release of its findings – Southwest Virginia Community College (SwVCC) began offering all developmental math courses for five credit hours. Developmental courses at SwVCC include Basic Math (02), Algebra I (03), and Algebra II (04). The intent was to give developmental math students more time to cover approximately the same amount of material they had previously covered in the three-credit math courses. By slowing instruction, we hoped that more developmental students would be successful in the developmental math courses.

In 2003, after five years of offering the courses for five credits, we decided to research the results. We compiled ten years of data (five years before the courses were offered for five credits and five years after they were offered for five credits). We looked at the number of developmental students (on-campus and off-campus) who received grades of Satisfactory (S), Unsatisfactory (U)/Re-enroll(R), Withdrawal (W), and Audit (A)/ Incomplete (I).

The data included fifteen semesters from Fall 1993 to Summer 1998 when the courses were offered for three credits, and fifteen semesters from Fall 1998 to Summer 2003 when the courses were offered for five credits. Math 04 had been offered for four credits on-campus for two semesters (Fall 1997 and Spring 1998), so that data was collapsed into the three-credit data. The total number of students enrolled during this study in Math 02 was 1029 for three credits and 1019 for five credits; Math 03 had 1917 for three credits and 1433 for five credits; and Math 04 had 544 for three credits and 465 for five credits. Enrollment decreased when credits were changed from three to five.

An independent t-test was run on the mean number of students enrolled in all three developmental courses. Math 02, Math 03, and Math 04 were collapsed into a single group and three credits were compared to five credits by grade categories.

Table 1: Mean Number of Students in All Three Courses (Math 02, Math 03, Math 04), Collapsed and Compared for Three and Five Credits by Grade Categories

Grade Categories	n	Mean	SD	t	p
Satisfactory (S)					
3 credits	45	41.78	30.483	1.277	.205
5 credits	45	34.22	25.413		
Unsatisfactory (U) Re-enroll I					
3 credits	45	23.20	21.726	.211	.833
5 credits	45	22.27	20.198		
Withdrawals (W)					
3 credits	45	11.42	9.985	2.184	.032
5 credits	45	7.53	6.560		
Audit (A) Incomplete (I)					
3 credits	45	.93	1.304	.776	.440
5 credits	45	.73	1.136		

Table 1 indicates that Withdrawals decreased significantly (p = .032) from a mean of 11.42 to a mean of 7.53 when Math 02, 03, and 04 were collapsed into a single group and offered for five credits instead of three. There were no significant changes noted in the other three grade categories. These data indicate that three-credit courses are just as effective in training developmental math students as five-credit courses.

The Effect of Exit Exams

In compliance with the recommendations of the VCCS Developmental Education Implementation Task Force, SwVCC began administering exit exams to all developmental math students in the Fall of 2000.

The exams were developed by SwVCC faculty and given and graded by two instructors. The exams cover the core material from each course and contain twenty-five problems each. If students do not have a minimum score of 70 percent on the exam, they have a second chance to pass the course by retaking the exam. If they do not pass on the second try, they must re-enroll for the course or take a diagnostic test (Asset, Compass, or Readiness) in order to be placed in a higher math course.

After three years of administering the exit exam, we compared student grades during these three years with those grades from the three years before we started requiring the exam. Independent t-tests were run on the number of students who received grades of Satisfactory (S), Unsatisfactory (U)/Re-enroll (R), Withdrawals (W), and Audit (A)/Incomplete (I). All together, we compared nine semesters from Fall 1997 to Summer 2000 (before the exit exam was implemented) and nine semesters from Fall 2000 to Summer 2003 (after the exit exam was in place). We found that enrollment increased after the exit exam was introduced, but noted that mandatory placement also came into effect at this time. Math 02 increased from 453 to 719 students; Math 03 increased from 780 to 993; and Math 03 rose from 230 to 313.

After running a t-test on the mean number of students enrolled in all three courses before and after the exit exam, we found no significant difference in the success rates of the students.

Table 2: Mean Number of Students in All Three Courses (Math 02, Math 03, Math 04) Collapsed and Compared Before and After the Exit Exam by Grade Categories

Grade Categories	n	Mean	SD	t	p
Satisfactory (S)					
Before exit exam	27	31.33	26.351	-.999	.323
After exit exam	27	38.63	27.323		
Unsatisfactory (U) Re-enroll I					
Before exit exam	27	15.00	14.315	-2.444	.018
After exit exam	27	27.41	22.159		
Withdrawals (W)					
Before exit exam	27	7.63	6.968	-.216	.830
After exit exam	27	8.04	6.892		
Audit (A) Incomplete (I)					
Before exit exam	27	.48	1.051	-1.287	.204
After exit exam	27	.85	1.064		

The data in Table 2 indicate a significant increase (p = .018) in the number of students receiving an Unsatisfactory/Re-enroll grade following the implementation of the exit exam. This could be interpreted to mean that more stringent expectations were expected for a Satisfactory completion of the course, thereby resulting in more Unsatisfactory/Re-enroll grades. None of the other grade categories differed significantly at the .05 level of probability.

Comparing On Campus to Off Campus

We also compared on-campus students with off-campus students for nine semesters before the exit exam was implemented (Fall 1997 through Summer 2000) and for nine semesters after it was in place (Fall 2000 through Summer 2003). Tables 3 and 4 show the results of the Chi Square statistics that were run on the number of on-campus and off-campus students enrolled in Math 02. They compare the students before and after the exit exam by grade categories.

Table 3: A Comparison of Math 02 On-Campus Students Before and After the Exit Exam by Grade Categories

Grade Categories	Before Exit Exam		After Exit Exam	
	n	%	n	%

Satisfactory	191	50.8%	246	49.9%
Unsatisfactory, Re-enroll	116	30.9%	190	38.5%
Withdrawal	66	17.6%	52	10.5%
Audit, Incomplete	3	.8%	5	1.0%
Total	376	100.0%	493	100.0%

Chi Square = 11.433; 3 df; p= .010

As Table 3 shows, a Chi Square of 11.433 with 3 df was significant at an alpha level of .010, indicating significant differences in grade categories of on-campus students following the implementation of the exit exam. The percentage of students successfully completing Math 02 fell slightly from 50.8% to 49.9%. The percentage of Unsatisfactory/Re-enroll completions rose from 30.9% to 38.5%, and the number of Withdrawals fell from 17.6% to 10.5%. The inference is that the exit exam had negligible effect on the number of successful completions; however, it did lead to more unsuccessful grades and fewer withdrawals for Math 02 on-campus students.

Table 4: A Comparison of Math 02 Off-Campus Students Before and After the Exit Exam by Grade Categories

Grade Categories	**Before Exit Exam**		**After Exit Exam**	
	n	**%**	**n**	**%**
Satisfactory	57	74.0%	133	58.8%
Unsatisfactory, Re-enroll	15	19.5%	71	31.4%
Withdrawal	5	6.5%	17	7.5%
Audit, Incomplete	0	.0%	5	2.2%
Total	77	100.0%	226	100.0%

Chi Square = 6.779; 3 df; p = .079

The data in Table 4 do not indicate a significant difference (Chi Square = 6.779; 3 df; p = .079) in grade categories before and after the exit exam for Math 02 off-campus students. However, there was a strong tendency for the percentage of Satisfactory completions to decrease (74.0% to 58.8%). There was also a tendency for the number of Unsatisfactory/Re-enroll completions to increase (19.5% to 31.4%). The interpretation of these findings is that the exit exam had a tendency to lower the number of successful completions and to increase the number of unsuccessful grades for the Math 02 off-campus students.

The following Chi Square statistics in Tables 5 and 6 compare the number of on-campus and off-campus students enrolled in Math 03. They compare the students before and after the implementation of the exit exam by grade categories.

Table 5: A Comparison of Math 03 On-Campus Students Before and After the Exit Exam by Grade Categories

Grade Categories	Before Exit Exam		After Exit Exam	
	n	%	n	%
Satisfactory	231	45.9%	338	52.1%
Unsatisfactory, Re-enroll	180	35.8%	209	32.2%
Withdrawal	84	16.7%	94	14.5%
Audit, Incomplete	8	1.6%	8	1.2%
Total	503	100.0%	649	100.0%

Chi Square = 4.412; 3 df; p = .220

The data in Table 5 do not indicate a significant difference in grade categories before and after the implementation of the exit exam for on-campus Math 03 students. The Chi Square of 4.412 with 3 df and a probability of .220 was not significant at an alpha level of .05. The interpretation of these findings is that the exit exam had no significant effect on the Math 03 on-campus students. All categories remained approximately the same before and after the exit exam.

Table 6: A Comparison of Math 03 Off-Campus Students Before and After the Exit Exam by Grade Categories

Grade Categories	Before Exit Exam		After Exit Exam	
	n	%	n	%
Satisfactory	214	77.3%	171	48.9%
Unsatisfactory, Re-enroll	42	15.2%	149	42.6%
Withdrawal	18	6.5%	29	8.3%
Audit, Incomplete	3	1.1%	1	.3%
Total	277	100.0%	350	100.0%

Chi Square = 60.642; 3 df; p<.0001

In Table 6 the Chi Square = 60.642; 3 df; p < .0001 indicates some very strong differences in grade categories for off-campus Math 03 students before and after the implementation of the exit exam. The percentage of successful completions fell from 77.3% to 48.9% and the number of Unsatisfactory/Re-enroll grades rose from 15.2% to 42.6%. Withdrawals and Audit/Incomplete grade categories were only slightly affected. The conclusion is that the exit exam brought about a significant drop in the number of successful completions for off-campus Math 03 students.

Tables 7 and 8 compare the number of on-campus and off-campus Math 04 students. The Chi Square tests compare the students by grade categories before and after the exit exam was implemented.

Table 7: A Comparison of Math 04 On-Campus Students Before and After the Exit Exam by Grade Categories

Grade Categories	Before Exit Exam		After Exit Exam	
	n	%	n	%
Satisfactory	75	55.1%	123	56.2%
Unsatisfactory, Re-enroll	38	27.9%	70	32.0%
Withdrawal	22	16.2%	24	11.0%
Audit, Incomplete	1	.7%	2	.9%
Total	136	100.0%	219	100.0%

Chi Square = 2.256; 3 df; p = .521

In Table 7 no significant differences (Chi Square = 2.256; 3 df; p = .521) were present over the four grade categories for on-campus Math 04 students. The interpretation of these findings is that the exit exam made no difference in grade categories for Math 04 students.

Table 8: A Comparison of Math 04 Off-Campus Students Before and After the Exit Exam by Grade Categories

Grade Categories	Before Exit Exam		After Exit Exam	
	n	%	n	%
Satisfactory	78	76.5%	43	44.8%
Unsatisfactory, Re-enroll	14	13.7%	43	44.8%
Withdrawal	10	9.8%	10	10.4%
Total	102	100.0%	96	100.0%

Chi Square = 24.719; 2 df; p < .0001

Significant differences were noted in Table 8 in grade categories, following the administration of the exit exam for off-campus Math 04 students, as evidenced by a Chi Square of 24.719 with 2 df and a probability less than .0001. The data indicate a drop from 76.5% to 44.8% in the Satisfactory grade category and an increase from 13.7% to 44.8% within the Unsatisfactory/Re-enroll grade category. The Withdrawal grade category remained approximately the same with a 9.8% before the exam and a 10.4% after the exam. The inference is that the exit exam led to a decline in the Satisfactory grade category and to an increase in the Unsatisfactory/Re-enroll grade category for off-

campus Math 04 students.

Summary of Results

When comparing the five years before five credits were introduced with the five years after, and after collapsing Math 02, Math 03, and Math 04 into a single group, results indicated no significant difference in Satisfactory or Unsatisfactory rates. The only significant difference (p= .032) was that withdrawals decreased for all three courses after the courses were offered for five credits (Table 1).

After comparing the three years before and the three years after the exit exam was implemented, results showed no significant difference in Satisfactory rates for Math 02, Math 03, and Math 04 students. A significant difference (p = .018) was found in the Unsatisfactory rates after implementing the exit exam when all three courses were collapsed into a single group (Table 2).

When comparing on-campus students with off-campus students for the three years before administering the exit exam and the three years after, we found that the exit exam brought about a significant decline in the Satisfactory category and a significant increase in the Unsatisfactory/Re-enroll category for off-campus Math 03 and Math 04 students (Tables 6 and 8). The exit exam had little effect on the Math 03 and Math 04 on-campus students (Tables 5 and 7). Withdrawals decreased for Math 03 and Math 04 on-campus, but increased for these courses off-campus after the exit exam began (Tables 5-8).

Math 02 on-campus students showed a highly significant difference (p = .010) in grade categories after the exit exam began. Although the exit exam had little effect on the number of successful completions, it did lead to significantly more unsuccessful grades and fewer withdrawals for Math 02 on-campus students (Table 3). Math 02 off-campus students showed a strong tendency toward an Unsatisfactory rate after the exit exam was in place, but the difference was not significant. Withdrawals increased slightly for Math 02 Off-Campus students after the exit exam began (Tables 4).

Conclusions and Recommendations

There was no significant difference found in the success rates of any of the developmental courses after they were offered for five credits. This indicates that three- credit courses are just as effective as five-credit courses for developmental math students.

As a result of this study, SwVCC has decided to return to offering all developmental math courses for three credits. The VCCS curriculum guide indicates the developmental math courses can be offered from one to five credits, but this may need to be revised. After all, the cost to students for a five-credit course is much greater than a three-credit course, scheduling a five-credit course is more difficult because the length of each class often eliminates another class, and the effectiveness of the two classes seems to be equal.

When comparing the success rates of all three courses for all students before and after the exit exam, results showed no significant difference in success although success did increase modestly after the exit exam was in place. The results also indicated a significant difference in the unsuccessful rates, which increased when all three courses were collapsed into a single group. This finding could imply that higher expectations after the exam was implemented resulted in more unsuccessful grades.

The results of the on-campus and off-campus research indicated that the exit exam has made little difference in the success rate of Math 03 and Math 04 on-campus students, but has made a significant difference in the Unsatisfactory rate of off-campus students. The Math 02 exit exam has made a significant increase in the Unsatisfactory rate of on-campus students and a strong tendency toward an Unsatisfactory rate for off-campus students, although not significant. Both on-campus and off-campus results show a decrease in Satisfactory rates for Math 02 after the exit exam began. After examining the results, we recommend the exit exam continue to be given both on-campus and off-campus to all developmental students at SwVCC. This study also supports the Task Force recommendation of requiring exit criteria for all developmental math courses, both on-campus and off-campus.

We also recommend that this study be replicated by other community colleges that offer a variety of credits for developmental math courses and that administer an exit exam to developmental math students. We are interested to see if such replications would also indicate that three-credit developmental math courses are just as effective as five-credit courses, and that exit exams can be beneficial to developmental math students and should be continued.

Note: The authors would like to thank Dr. Ed Smith, Institutional Research Officer at Southwest Virginia Community College, for supplying the data needed to conduct this study.

Reference

Recommendations from the VCCS Developmental Education Implementation Task Force. (2000*). Best practices to ensure quality of the developmental education teaching-learning environment,* Report No. 2.

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