



## STEM GATEWAY RESEARCH BRIEFING

TITLE: **Stop, Shift or Graduate: Course Outcomes Lens**

Briefing Publication Date: 2/19/14

### RESEARCH QUESTION(S):

How do undergraduate STEM students perform in the core math & science gateway courses that lead into their STEM degrees?

**STUDY DESCRIPTION:** The STEM Gateway Program studied 1,503 first-time full-time freshmen students from the falls of 2005, 2006 and 2007 who initially stated they were interested in STEM degrees (see Table 1 below). These students indicated an interest in STEM majors when completing their admissions applications, or when visiting with academic advisors during their first semesters. At the time the data were pulled, these students fell into one of four student OUTCOME CATEGORIES:

- **SHIFTED:** Students who started with a STEM interest, but then switched to a non-STEM degree program at UNM
- **GRADUATED:** Students who started with a STEM interest and then graduated with a STEM bachelor's degree
- **STOPPED:** Students who started with a STEM interest, but then stopped attending UNM
- **ENROLLED:** Students who started with a STEM interest and were still enrolled in a STEM program at UNM in the fall of 2012

Total Number of Students	1503
Number of students in SHIFTED cohort	639
Number of students in GRADUATED cohort	334
Number of students in STOPPED cohort	444
Number of students in ENROLLED cohort	86

This study attempts to understand the impact of core gateway courses (courses that serve as gateway experiences to STEM degree programs) on STEM degree achievement. Each course was studied collectively, and was not broken out by section or instructor. Grade distribution patterns were collected only for students who fit the "Population Description / Definitions" section above. The following table provides a list of the courses studied:

<b>Table 2. STEM Gateway Courses</b>		
BIO	201	Molecular Cell Biology
BIO	202	Genetics
BIO	203	Ecology and Evolution
CHEM	121	General Chemistry I
CHEM	122	General Chemistry II
CHEM	123	General Chemistry I LAB
CHEM	124	General Chemistry II LAB
CHEM	301	Organic Chemistry
CHEM	302	Organic Chemistry
CHEM	303	Organic Chemistry LAB
CHEM	304	Organic Chemistry LAB
CS	152	Computer Programming Fundamentals
ECE	131	Program Fundamentals
ENVS	101	The Blue Planet
ENVS	102	The Blue Planet LAB
EPS	101	Intro Geology, How Earth Works
EPS	105	Physical Geology LAB
EPS	201	Earth History
MATH	107	Problems in College Algebra
MATH	110	Problems in Elementary Calculus
MATH	120	Intermediate Algebra
MATH	121	College Algebra
MATH	123	Trigonometry
MATH	150	Pre-Calculus Math
MATH	162	Calculus I
MATH	163	Calculus II
MATH	180	Elements of Calculus I
MATH	181	Elements of Calculus II
PHYC	151	General Physics
PHYC	151L	General Physics LAB
PHYC	152	General Physics
PHYC	152L	General Physics LAB
PHYC	157	Problems in General Physics
PHYC	158	Problems in General Physics
PHYC	160	General Physics
PHYC	160L	General Physics LAB
PHYC	161	General Physics
PHYC	161L	General Physics LAB
PHYC	167	Problems in General Physics
PHYC	168	Problems in General Physics

In studying these courses, we examined the following variables for each course:

- Number of students enrolled at 21 days into the semester (census dates)
- Number of students enrolled at the end of the semester
- Percentage of enrollments at the end of the semester resulting in the following grades or statuses (note, due to students attempting the same course more than once, the number of enrollments does not always equal the number of students):
  - “A” grade range
  - “B” grade range
  - “C” grade range
  - “D” grade range
  - “F” grade
  - W (withdraw)
  - I (Incomplete)
  - CR (credit)
  - NCR (no credit)
  - AU (audit)

When examining these grade distributions, we studied patterns for the following subgroups:

- Grouped by entry cohort (2005, 2006, 2007, and all three combined)
- Grouped by study category (Enrolled, Graduated, Shifted, Stopped)
- Grouped by ethnicity (as indicated by the student on their admissions application or subsequent enrollment forms)
- Grouped by family income level (as defined by Pell grant eligibility)
- Grouped by STEM major

In addition, this study also explores the impact of co-enrollment at Central New Mexico College (CNM). For each of the courses, we examined the grade distributions for UNM STEM students (as defined in the “Population Description / Definitions” section above) enrolled in equivalent courses at CNM.

Finally, this study also explores course repeater patterns. For each course, the following information is reported:

- Number of students who repeated the course at least once
- Percentage of these students who passed on their first attempt (but still repeated the course anyway)
- Percentage of these students who passed on their second attempt
- Number of students who repeated the course at least twice
- Percentage of these students who passed on their third or final attempt

## FINDINGS

*The following implications and recommendations are not comprehensive. They are provided only to stimulate discussion. They reflect only the views of the STEM Gateway program.*

### **FINDING 1: INDIVIDUAL STEM GATEWAY COURSE IMPACT ON STEM GRADUATION**

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The average percentage of STEM-interested students in STEM gateway courses who eventually earned STEM bachelor's degrees was 36 %. However, some courses are connected to lower STEM graduation rates.

<b>SUBJECT</b>	<b>NUMBER</b>	<b>Number of Enrollments</b>	<b>Percent of Enrollments Eventually Resulting in STEM GRADUATE</b>
ENVS	101	229	7%
MATH	120	426	8%
EPS	101	189	12%
MATH	121	635	13%
CHEM	123	156	16%
MATH	150	518	17%
MATH	123	405	22%
MATH	180	406	27%
CHEM	124	169	32%
MATH	162	426	35%

<b>Table 4. STEM Gateway Courses with the HIGHEST NUMBER of Enrollments NOT Resulting in Graduation</b> <i>(courses that appear in both Tables 3 and 4 highlighted)</i>			
<b>SUBJECT</b>	<b>NUMBER</b>	<b>Number of Enrollments</b>	<b>Number of Enrollments Eventually NOT Resulting in STEM GRADUATE</b>
MATH	121	635	507
CHEM	121	804	442
MATH	150	518	367
MATH	120	426	364
MATH	180	406	271
MATH	123	405	257
CHEM	122	560	249
MATH	162	426	201
ENVS	101	229	197
BIO	201	383	194

<b>Table 5. STEM Gateway Courses with the HIGHEST PERCENTAGE of Enrollments Resulting in Stop (drop out)</b> <i>(courses that appear in all Tables 3 - 5 highlighted)</i>			
<b>SUBJECT</b>	<b>NUMBER</b>	<b>Number of Enrollments</b>	<b>Percent of Enrollments Eventually Resulting in STOP</b>
MATH	150	518	26%
MATH	120	426	26%
MATH	123	405	24%
MATH	121	635	22%
CHEM	123	156	21%
EPS	101	189	20%
MATH	162	426	18%
CHEM	121	804	17%
ENVS	101	229	15%
MATH	163	382	15%

<b>Table 6. STEM Gateway Courses with the HIGHEST NUMBER of Enrollments Resulting in Stop (drop out)</b> <i>(courses that appear in all Tables 3 - 6 highlighted)</i>			
<b>SUBJECT</b>	<b>NUMBER</b>	<b>Number of Enrollments</b>	<b>Number of Enrollments Eventually Resulting in STOP</b>
CHEM	121	804	140
MATH	121	635	139
MATH	150	518	136
MATH	120	426	110
MATH	123	405	98
CHEM	122	560	80
MATH	162	426	75
MATH	163	382	57
MATH	180	406	52
BIO	201	383	51

The courses in Tables 3 – 6 are those that are *least likely* to lead to STEM graduation for STEM-interested students. They are dominated by pre-calculus mathematics courses.

On one hand, it appears that few STEM-interested students who enroll in pre-calculus courses go on to earn STEM bachelor’s degrees. However, there is more to this story. When we look at students who began at UNM as first-time freshman and who earned STEM bachelor’s degrees during the 2010-2011 academic year, we see that many successful STEM students completed pre-calculus courses at UNM (see Table 7).

<b>Table 7. Percentage of STEM Bachelor’s Degree Earners at UNM who Completed MATH 120 and MATH 121</b>		
<b>Population of students from first-time full-time freshman cohorts</b>	<b>Completed MATH 120 at UNM</b>	<b>Completed MATH 121 at UNM</b>
All STEM Degree Recipients	19%	41%
All Engineering Degree Recipients	10%	21%
All Arts & Sciences STEM Degree Recipients	23%	52%
Arts & Sciences: Biology Degree Recipients Only	28%	57%
Arts & Sciences: STEM Degree Recipients other than Biology	12%	40%

These data illustrate that pre-calculus math courses serve two simultaneous roles: (1) crucial building block to STEM degrees, and (2) screening mechanism that pushes many students away from STEM.

**FINDING 2: COURSE CATEGORIES WITH LOW INCIDENCE OF STUDENTS GRADUATING WITH STEM DEGREES**

Just as with individual courses, some course categories were connected to high and low success rates (see Table 8).

<b>SUBJECT</b>	<b>Number of Enroll</b>	<b>Number of GRAD</b>	<b>Number of SHIFT</b>	<b>Number of STOP</b>	<b>PCT of Enroll who Grad</b>	<b>PCT of Enroll who Shift</b>	<b>PCT of Enroll who Stop</b>
All Courses	9540	3475	3558	1470	36%	37%	15%
All Math Courses	3440	854	1523	693	25%	44%	20%
All Pre-Calc Math	2044	309	1047	492	15%	51%	24%
All 100 Level Courses	7510	2451	2943	1288	33%	39%	17%
All <151 Level Courses	4359	1016	2016	878	23%	47%	20%
All 151-199 Level Courses	3151	1435	927	410	46%	29%	13%
All 200+ Level Courses	2030	1024	615	182	50%	30%	9%

As seen in Table 8, once students enter into their 200 level gateway courses, their chances of graduating with STEM bachelor’s degrees are much higher than the average (36%). Gateway courses at the 151-199 level are slightly less likely to graduate STEM students than courses at the 200+ level, but are still more likely than the average.

The categories that are least likely to graduate STEM are pre-calculus mathematics courses (15%), followed by gateway courses below the 151 level (23%), and then followed by all math gateway courses (25%).

These data appear to indicate that students are screened out of STEM very early in their careers at UNM. Again, pre-calculus mathematics seems to play the largest role in this screening out process.

### FINDING 3: COURSES WITH HIGH NUMBER OF REPEAT ENROLLMENTS

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Of gateway courses with enrollments over 100, Table 9 shows which are most likely to be repeated by UNM STEM students.

<b>COURSE</b>	<b>PERCENT OF ENROLLMENTS THAT ARE REPEATS</b>
CHEM 301	23%
MATH 123	18%
MATH 162	17%
CHEM 302	17%
MATH 163	17%
MATH 150	16%
MATH 121	15%
MATH 180	16%

### FINDING 4: THE IMPACT OF “A” RANGE GRADES ON STEM GRADUATION

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The “UNM Killer Course List” from Fall 2011 includes eighty two courses with high enrollments and low student pass rates. STEM Gateway studied the grade distribution patterns for the following sixteen STEM-based courses on this list: MATH 120, 121, 123, 150, 162, 163, 180, 181; ENVS 101; CHEM 121, 122, 301, 302; BIOL 201, 202; PHYC 160. Taken together, these courses represent a sizable portion of the gateway courses that STEM students complete en route to their degrees.

	<b>Passing (A,B,C) Percentage for GRADUATED</b>	<b>Passing Percentage for SHIFTED</b>	<b>Passing Percentage for STOPPED</b>
<b>Averages from courses in this subset</b>	86%	65% (21 points lower than GRADUATED)	54% (32 points lower than GRADUATED)

From the table above we clearly see that students who pass their STEM killer courses are more likely to graduate than those who do not. However, a closer examination of grade distributions points to a more specific observation.



<b>Table 11. Comparing GRADUATED to SHIFTED and STOPPED</b>									
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>F</b>	<b>WD</b>	<b>CR</b>	<b>NCR</b>	<b>ABC</b>
Graduated	38	33	16	4	1	7	2	0	86
Shifted	15	26	24	11	5	16	2	2	65
<i>Difference</i>	23	7	-8	-7	-4	-9	0	-2	21
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>F</b>	<b>WD</b>	<b>CR</b>	<b>NCR</b>	<b>ABC</b>
Graduated	38	33	16	4	1	7	2	0	86
Stopped	11	23	21	13	9	22	1	2	54
<i>Difference</i>	27	10	-5	-9	-9	-15	1	-2	32

When comparing GRADUATED students to SHIFTED and STOPPED students, we find that largest grade difference is in the “A” range. Indeed, while nearly 38% of GRADUATED students earned “A”s in these courses, only 15% of SHIFTED students and 11% of STOPPED students did so.

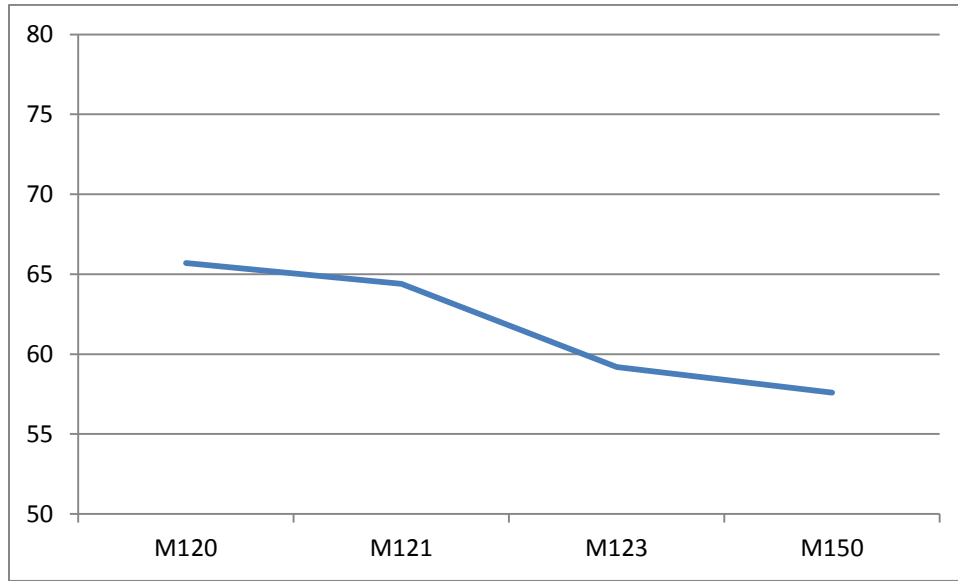
While the emphasis at most universities is on empowering students to pass their courses, for STEM students at UNM the emphasis should be placed on earning “A” grades. Programs and services should be designed to help students appreciate the distinction between “A” grades and “passing” grades, and to help them achieve at the highest level. Indeed, “A” grade achievement should be considered as a key performance indicator for UNM’s STEM improvement goals.

**Finding 5: Pre-calculus mathematics and student achievement for traditionally underrepresented students**

The following table shows grade distribution patterns for enrollments in our population for four primary pre-calculus math courses: Intermediate Algebra (MATH 120), College Algebra (MATH 121), Trigonometry (MATH 123) and Pre-Calculus Mathematics (MATH 150).

<b>Table 12. Grade Distribution Patterns for Pre-Calculus Math Courses</b>			
<b>Course</b>	<b>Enrollment at the end of semester</b>	<b>Percent of enrollment earning “A” range grade</b>	<b>Percent of enrollment earning CR or “C” grade or higher (Success Percent)</b>
MATH 120	426	15	66
MATH 121	635	13	64
MATH 123	405	15	59
MATH 150	518	13	58

**Figure 1. Success Pct for Pre-calculus Math**

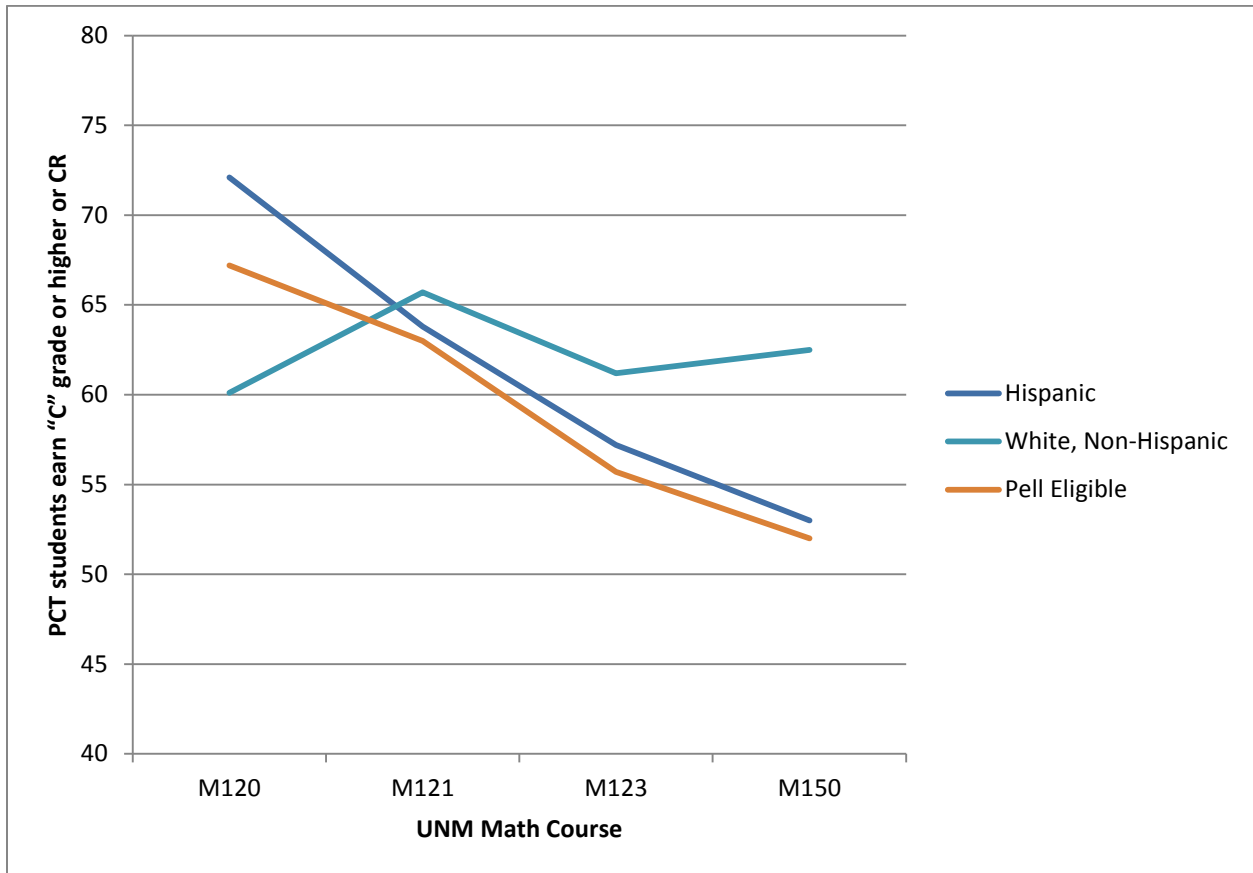


Interestingly, this trend differs when looking at Hispanic and Pell-Eligible students compared to White Non-Hispanic students. While white students maintain relatively constant success rates throughout the pre-calculus sequence, success percentages for Hispanic and Pell-Eligible students decline as they progress through the courses.

**Table 13. Grade Distribution Patterns for Pre-Calculus Math Courses, by Ethnicity and Pell-Eligibility**

Course	Enrollment at the end of semester	Percent of enrollment earning "A" range grade	Pct of enrollment earning CR or "C" grade or higher (Success Percent)
<b>Hispanic Students</b>			
MATH 120	188	15	72
MATH 121	252	10	64
MATH 123	131	13	57
MATH 150	184	12	53
<b>Students Pell-Eligible During Their First Semesters at UNM</b>			
MATH 120	136	17	67
MATH 121	198	14	63
MATH 123	92	13	56
MATH 150	126	8	52
<b>White, Non-Hispanic Students</b>			
MATH 120	145	23	60
MATH 121	328	14	66
MATH 123	198	18	61
MATH 150	231	15	63

**Figure 2. Success Pct for Pre-Calculus Math, by Ethnicity and Pell-Eligibility**



## IMPLICATIONS

The following implications and recommendations are not comprehensive. They are provided only to stimulate discussion. They reflect only the views of the STEM Gateway program.

### IMPLICATION 1: STUDENTS ARE STRUGGLING TO GET THROUGH THE PRE-CALCULUS SEQUENCE

All roads lead to pre-calculus mathematics. Of all first-time freshmen, only 6% enroll in calculus or beyond during their first semesters. Twenty-eight percent do not enroll in any math or ISM course, and the remaining 65% enroll in a pre-calculus or ISM course during their first semesters.

Yet pre-calculus mathematics courses have topped UNM's Course Outcomes chart (traditionally referred to as the "killer course list") for years.

	MATH 120	MATH 121	MATH 123	MATH 150
Spring 2013	69% 1 <sup>st</sup> on the list	41% 12 <sup>th</sup> on the list	53% 2 <sup>nd</sup> on the list	52% 3 <sup>rd</sup> on the list
Fall 2012	43% 8 <sup>th</sup> on the list	39% 10 <sup>th</sup> on the list	57% 1 <sup>st</sup> on the list	51% 2 <sup>nd</sup> on the list
Spring 2012	47% 5 <sup>th</sup> on the list	52% 3 <sup>rd</sup> on the list	51% 4 <sup>th</sup> on the list	68% 1 <sup>st</sup> on the list
Fall 2011	55% 3 <sup>rd</sup> on the list	43% 6 <sup>th</sup> on the list	51% 4 <sup>th</sup> on the list	64% 1 <sup>st</sup> on the list

Source: UNM Office of Institutional Analytics

	MATH 120	MATH 121	MATH 123	MATH 150
Spring 2013	704 1 <sup>st</sup> on the list	438 2 <sup>nd</sup> on the list	251 6 <sup>th</sup> on the list	195 11 <sup>th</sup> on the list
Fall 2012	581 2 <sup>nd</sup> on the list	584 1 <sup>st</sup> on the list	246 10 <sup>th</sup> on the list	262 8 <sup>th</sup> on the list
Spring 2012	506 1 <sup>st</sup> on the list	475 2 <sup>nd</sup> on the list	217 12 <sup>th</sup> on the list	238 10 <sup>th</sup> on the list
Fall 2011	747 1 <sup>st</sup> on the list	596 2 <sup>nd</sup> on the list	193 14 <sup>th</sup> on the list	295 9 <sup>th</sup> on the list

Source: UNM Office of Institutional Analytics

The current UNM MALL (Math Learning Lab) model for MATH 101, 102 and 103 (formerly MATH 120) represents a significant effort to improve student success rates in Intermediate Algebra.

**Recommendations:** The MALL project represents a solid start at reforming pre-calculus mathematics at UNM. Additional steps should be taken to (1) more fully research the scope and types of challenges posed by the status quo, and (2) develop and implement improvements among in pre-calculus advising, placement, degree pathways alignment, curriculum, instruction and/or academic support. In addition, emphasis should be placed on improving the pre-calculus experience for traditionally under-represented student populations.

## **IMPLICATION 2: STUDENTS SHOULD UNDERSTAND THE VALUE OF MASTERY IN THEIR STEM GATEWAY COURSES**

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The phrase “C’s earn degrees” can still be heard at UNM. Indeed, in some disciplines this may be the case. But STEM disciplines usually build upon the foundation knowledge and study skills taught in STEM gateway courses. For instance, it is difficult to succeed in MATH 121 if you did not master MATH 120. It is then even more difficult to succeed in MATH 150, and then later in CHEM 121. Simply passing these courses does not appear to suffice.

**Recommendation:** Working through advisors and instructors, stress to students the value of mastery over completion or passing.