Testing Our Assumptions:

The Role of First Course Grade and Course Level in Mathematics and English

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Abstract

Methods that provide an early indicator of factors that affect student persistence are important to colleges and universities. This quantitative research focused on the role of level of entry mathematics and English and also on grades earned in those classes as they relate to persistence after one year. The research showed that by far, the variable most predictive of first-time, full-time students enrolling one year later was earning a grade of "A" in English. Compared to those who did not pass their first English course, students who earned an "A" were three times more likely to persist. The variables which at least doubled the likelihood of persistence included earning an "A" or a "B" in mathematics, a "B" in English, and taking an English course beyond freshman English. While course level taken was significant, the course level effect paled compared with grades earned as a predictor. This effect – of grade earned being more important than course level – included remedial coursework in mathematics and English. In addition, obtaining a high grade in English was equally important for both STEM and non-STEM majors. Finally, students who took both mathematics and English courses their first year were more likely to persist than students who did not take both subjects.

Keywords: retention, persistence, mathematics, STEM, engineering, English, first year full time retention, GPA, freshmen, education, remediation, college, university

Predicting Retention

In the United States, institutions of higher learning are being held to ever-increasing demands for transparency in order to provide data to the public for use in choosing which college or university to attend (e.g. CHEA, 2013). The first version of college ratings will rely on data from federal administrative data systems (U.S. Dept. of Ed., 2015), including graduation rate measures obtained from the Integrated Postsecondary Education Data System (IPEDS). This has resulted in many professional accrediting bodies, such as ABET (the accrediting body for programs in computing, engineering, applied science and engineering technology) requiring immediate compliance with publicly posted annual student enrollment and graduation data on a per-program basis (ABET, 2013). The increased transparency has elevated the priority level for colleges and universities to improve undergraduate students' completion rates.

Despite decades of attention, the national percentage of first-time, full-time degree/certificate-seeking undergraduate students who began in public 4-year institutions in fall 2010 and who returned at the same institution the second year, ranges between 62% at the least selective institutions to 95% at the most selective institutions, with an overall retention level of about 79% (Aud, et al. 2013). Further, 59% of first-time, full-time undergraduate students at 4-year degree-granting institutions who began their pursuit of their bachelor's degree in 2005 completed the degree within 6 years at the institution where they began their studies (Aud, et al. 2013). With a proposed initial college rating system that is intended to identify institutions that are high-performing, low-performing and those in the middle (U.S. Department of Education, 2015), improved methods for predicting retention not only within an institution but also within an individual program are of increasing importance. In particular, institutions need methods that provide an early indicator of factors that influence student persistence. In addition, they need

information about where to focus their resources. This paper focuses on data that can be collected and reviewed on an annual or semi-annual basis and potentially used to make programmatic adjustments in instructional methods, staffing, and student support.

For universities that embrace access as a founding principle, there is a need to offer remedial level courses for students who may have followed a non-traditional path or who may be underprepared following high school. There are often prevailing assumptions that are made by many in higher education in terms of the preparation of students and its influence on retention and who will graduate. These prevailing assumptions include:

- Students who take remedial course work are less likely to return compared to students who do not need to take remedial course work. This assumption is considered to be particularly true for the area of mathematics, but this assumption is also applied to English.
- Particularly for engineering majors, but also for other heavily quantitative majors, students need to arrive at college "calculus-ready" if they are to be successful in obtaining their degrees.

As suggested by Pascarella (2006), there is a need to bring systematic inquiry to bear on the "rational myths" of higher education. While there is some evidence of truth behind the assumptions or "rational myths" outlined above, there is also a need to probe them. The following section reviews certain aspects of the remediation literature, with an emphasis on mathematics, English and grades obtained in those courses.

The importance of enhancing mathematics skills in high school so students can succeed in college is well established – e.g. Adelman (1999, 2004, 2006). Adelman (2004) noted that college dropouts were more likely to enroll in remedial reading and mathematics. Secondary school academic preparation certainly matters. Adelman (1999, 2006) showed that taking a

mathematics course in high school beyond algebra II dramatically improved persistence in college; each higher level of mathematics taken in high school corresponded to an increased percentage of students earning bachelor's degrees. Herzog (2005) found that the enrollment in remedial mathematics at the University of Nevada increased the probability of both dropping out and transferring out; however, he also showed that remedial English enrollees were *less* likely to leave due to their enrollment. Herzog (2005) attributes this to the fact that "unlike math, deficiency in English is more likely due to the soaring number of non-native speakers entering the institution, not simply a lack of sufficient preparation in high school" (p. 911). Interestingly, Herzog (2005) also found that after GPA, the strongest predictor of retention was performance in first year mathematics courses. In addition, Herzog (2005) noted that "the readiness to take on, and pass, math – a subject matter typically considered difficult and less popular for most students – showed up early in the analysis as a likely factor weighing on retention" (p. 911). This was confirmed by cross-tabulation which showed that freshmen who took no math at all during the first year were five times less likely to return in the second year.

Budny, LeBold, and Bjedov (1998) conducted a study of over 35,000 Purdue University freshman engineering majors across a 28-year period between 1966 and 1993. Their study suggests that first semester grade point average (GPA) is a much better predictor of the likelihood of retention and ultimate graduation within engineering than entering student information (e.g. student's math SAT score). Budny, et al. (1998) showed that for Purdue freshmen the higher the first semester GPA, the higher the retention. Other authors have shown a relationship between students' academic performance and 1-year retentions. Whalen, Saunders and Shelley (2010) showed that students with higher GPAs at the end of their first college year were significantly more likely to return compared with students with lower GPAs. Budny, et al.

(1998) went on to examine the grade in a first-year students' first mathematics course as a predictor of the likelihood of retention.

The following section reviews some of the literature on postsecondary remediation with an emphasis on persistence and degree completion. Adelman (2006) noted that the remediation did not make a strategic difference in degree completion. Adelman's study also revealed the importance of earning postsecondary credits in college-level mathematics within the first two years of enrollment in postsecondary education in terms of ultimate degree attainment. Bahr (2008) studied remediation in mathematics in community college, addressing more than 85,000 freshmen enrolled in 107 community colleges and the relationship of remediation to long-term academic attainment (credential completion and transfer). Bahr's study found that students who remediate successfully (achieve college-level math skill) exhibit long-term academic attainment that is comparable to that of students who achieve college-level math skill without the need for remedial assistance. Bahr (2008) in addition reviewed other studies conducted on the efficacy of remediation and draws attention to two other large-scale, comprehensive multi-institutional studies of note. The first study is Bettinger and Long (2004) and their examination of the effects of math remediation on students at four-year colleges. They found that after accounting for selection, students who complete remediation are less likely to drop out, suggesting that the courses increase persistence among underprepared students. The second study is Attewell et al. (2006), who report that entrants to two-year colleges who took remedial classes are not associated with lower chances of academic success. The study found that two-year college students who successfully passed remedial coursework in reading were about 11% more likely to earn a degree (associate's or bachelor's) than academically equivalent students who did not take remediation.

Studies of Boise State University students have highlighted the role of first semester GPA and admissions test scores in retention. A study by Belcheir (2005) of fall 2003 first-time-in-college students found that the best predictor of returning one year later was first semester GPA. First semester GPA was best predicted by admissions index scores, implying that better prepared students are more likely to return. In addition, higher first semester GPAs were associated with enrollment in ENGL 101 (the first college-level writing course) and MATH 25 (a remedial math course). Enrollment in MATH 108 (a pre-college algebra course) was associated with lower GPAs, perhaps in part because so many students were failing this course, directly contributing to a low GPA. A similar study of fall 2005 students (Belcheir, 2006) found that first semester GPA was the only variable needed to predict retention, though enrollment in a developmental mathematics course also was negatively related to retention when simple relationships were studied.

A study of Boise State University mechanical engineering graduates by Gardner, Pyke, Belcheir, and Schrader, 2007 was conducted to assess the range of entry-level math preparedness among mechanical engineering bachelor of science graduates to guide program development efforts. Surprisingly, less than 25% of the 2004 mechanical engineering graduates commenced their studies in calculus 1 or higher, and many students who received their degrees began in pre-college algebra courses. The findings of Belcheir (2005) and Gardner (2007) led to testing the hypothesis that the performance of engineering students in their first mathematics class was more highly correlated to persistence than the level of mathematics at which they began their college studies. The prediction model included grade in first math course, enrollment in elementary algebra (MATH 25), intermediate algebra (MATH 108), college algebra (MATH 143), or calculus (MATH 170) along with the demographic variables of gender, ethnicity (white/ not

white), whether or not the student knew which branch of engineering s/he wished to pursue, and age. Results showed that the model that included only first mathematics grade and ethnicity provided the best prediction of retention one year later. Stated differently, starting engineering "calculus ready" is not as valuable a predictor of retention one year later as compared with first grade in any mathematics class. One possible reason for this may result from the increased self-efficacy that results from doing well in the mathematics class; students with higher math self-efficacy are more likely to view difficult tasks as something to be mastered than something to be avoided (Bandura, 1977). One practical take-away from this finding is to carefully advise students with borderline ACT/SAT scores. Such students can, for example, take review courses, or online review courses in mathematics prior to the start of classes (e.g. Callahan & Garzolini (2015)), or even retake the immediately lower level mathematics class (recommended for students who took a year away from math in their culminating year of high school).

The current study questions the commonly held assumptions outlined earlier and builds on the Gardner (2007) study in several ways. Instead of limiting the study only to engineering majors, the current study includes all new freshmen and compares science, technology, engineering and math (STEM) majors and non-STEM majors. Instead of focusing only on mathematics, the current study adds English courses and grades. The current study also corrects a potential flaw in the previous research design. Enrollment in mathematics courses was modeled at a "yes/no" or "0/1" level of measurement, while the single variable of math grade was on a scale of 0-4 where 0="F" and 4="A." Because the measure level differed for courses and grades and because scales with more values have an advantage in reaching statistical significance, the current study uses the same level of measurement for both grades and courses. That is; all variables in this study are based on a "0/1" scale. For example, a student who earned a "B" in

their first math course has a "0" for the "A in Math" variable, a "1" in the "B in math" variable, and a "0" for all other math grades. Students who received grades of "D," "F," or "W" are all grouped together and coded as a "1."

The study addresses the following questions:

1. When predicting retention after one year, which provides *a better indicator* of who will be retained: the level of English and mathematics in which students first enroll or the grade that they receive in those courses?
2. Which is more important in predicting retention, English grades and/or courses or mathematics grades and/or courses?
3. Is the relationship similar for both STEM and non-STEM majors? For example, do mathematics courses and/or grades play a more significant role for STEM majors while English courses and/or grades are more significantly related to retention for non-STEM majors?

Method

Description of Sample

The 8,265 students who formed the basis of the analysis were first-time-in-college students who first enrolled full-time at Boise State University, a metropolitan university in Idaho, in the fall of 2007, 2008, 2009, or 2010 seeking a bachelor's degree. The group was reduced to 5,848 students (or 71% of the original group) who took both an English and math course during their first year at the university. The number was further reduced to 5,650 when a few students taking low enrollment math courses were eliminated from the analysis. The average age of the group indicated that most were just out of high school (M=19.19, SD=3.04). The majority were

female (53.4%) and white non-Hispanic (79.2%). Most students (n=4,511) were classified as non-STEM majors, while about 20% (n=1,139) were STEM majors. For the purposes of this study, students will the following majors were classified as STEM students: Biology, Chemistry, Civil Engineering, Computer Science, Electrical Engineering, Geology, Geophysics, Mathematics, Materials Science, Mechanical Engineering, and Physics.

Variables Included in the Study

Four variables were monitored in this study: first math class taken, first English class taken, first math grade earned and first English grade earned, see Table 1. The enrollment in math and English courses occurred during the student's first year of enrollment or as a college-level course in the last year of high school. This information was used to develop a series of 0/1 variables where "1" indicated a "yes" and "0" indicated a "no." For example, a student who obtained a "B" in "ENGL 101" would have a "1" for an English grade of "B" and "0" for all other English grades as well as a "1" for ENGL 101 and "0" for other English courses. In addition, students' majors were categorized as being a STEM or non-STEM. Retention was measured after one year, see Table 1.

Table 1.

Variables included in the study by STEM status for first-time full-time students who first enrolled in fall 2007, 2008, 2009, or 2010

	Non-STEM major (n=4,511)		STEM major (n=1,139)		Total (N=5,650)	
Variables included	N	Percent of non-STEM	N	Percent of STEM	N	Percent of total
English grade: A	2002	44.4%	519	45.6%	2521	44.6%
English grade: B	1152	25.5%	277	20.6%	1429	25.3%
English grade: C	889	19.7%	198	17.4%	1087	19.2%
English grade: D/F/W	468	10.4%	145	12.7%	613	10.9%
Total:	4511		1139		5650	
Developmental English	537	11.9%	103	9.0%	640	11.3%
ENGL 101	2839	62.9%	650	57.1%	3489	61.8%
ENGL 102	1025	22.7%	343	30.1%	1368	24.2%
English course beyond 102	110	2.4%	43	3.8%	153	2.7%
Total:	4511		1139		5650	
Math grade: A	828	18.4%	256	22.5%	1084	19.2%
Math grade: B	1136	25.2%	283	24.9%	1419	25.1%
Math grade: C	961	21.3%	252	22.1%	1213	21.5%
Math grade: D/F/W	1586	35.2%	348	30.6%	1934	34.2%
Total:	4511		1139		5650	
Elementary Algebra	968	21.5%	119	10.5%	1087	19.2%
Intermediate Algebra	1316	29.2%	231	20.3%	1547	27.4%
Basic core math course to fulfill university math requirements	811	18.0%	33	2.9%	844	14.9%
College Algebra/ Analytic Trigonometry -- Prerequisite to Calculus I	1228	27.2%	415	36.4%	1643	29.1%
Calculus I or higher	188	4.2%	341	29.9%	529	9.4%
Total:	4511		1139		5650	
Retention after one year	3196	70.9%	861	75.6%	4057	71.8%

Statistical Analysis

Logistic regression was employed using the Statistical Analysis System (SAS) to develop a model to predict retention one year later. As a first step, all variables were included in the model along with the interactions between STEM membership and all grades and courses. When no interaction terms reached statistical significance using α=.05, the model was again run but without the interaction terms. The significance of the model was assessed using the Likelihood Ratio. An approximation to R^2 was calculated using the suggestion of Menard (1995) to regress the predicted probability of being retained for each student against the actual outcome (0=not retained, 1=retained).

The model compared those receiving an "A", "B", or "C" to those who were unsuccessful in the course who obtained a "D/F/W". Mathematics courses were coded so that comparisons were made to those enrolled in Calculus I or higher numbered course. English courses were coded so that comparisons were made to those enrolled in English 101. In other words, the regression model included the following variables for grades—"A in English", "B in English", "C in English", "A in Math", "B in Math", "C in Math"—and the following variables for courses—developmental English, English beyond 101, elementary algebra, intermediate algebra, basic core math course, college algebra and trig. Because the "D/F/W" grades, Calculus I or higher and English 101 variables were not included in the model, students with these courses and grades became the de facto comparisons.

Results

Table 2 displays the simple relationships between English grades and courses and mathematics grades and courses to retention one year later. The biggest difference in one-year retention rate was found for English grades where only 31% of students who received a "D, F or W" in their first English course were still enrolled one year later compared to 83% of those who

received an "A". For mathematics grades, the range was 55% retained one year later for those with a "D, F, or W" compared to 85% for those receiving an "A" in their first math course. Students enrolled in developmental English had a 66% retention rate compared to 85% of those taking an elective course beyond English 102 (the second freshman English course). For mathematics courses, the lowest retention rate (67%) was found for students enrolled in elementary algebra (MATH 25) compared to 84% retention for students taking calculus I or higher as their first mathematics course.

Table 2.

Proportion retained after one year based on STEM major, course level, and grade for first-time full-time students who first enrolled in fall 2007, 2008, 2009, or 2010 (N=5,650)

		STEM		
		Non-STEM major	STEM major	Total
English grade combined	A	.82	.87	.83
	B	.73	.80	.74
	C	.58	.64	.60
	D/F/W	.30	.34	.31
First English Course	Developmental English or ESL	.65	.72	.66
	ENGL 101	.69	.74	.70
	ENGL 102	.76	.78	.77
	English course beyond 102	.85	.83	.84
Math grades combined	A	.84	.87	.85
	B	.80	.87	.81
	C	.76	.81	.77
	D/F/W	.55	.54	.55
First Math Course	Elementary Algebra	.66	.72	.67
	Intermediate Algebra	.71	.66	.70
	Basic Core Math Class	.72	.67	.71
	College Algebra / Trig	.73	.74	.73
	Calculus I or higher	.82	.85	.84

English and mathematics grades along with first course levels were then employed to predict retention one year later. The relationship of courses and grades to retention was similar for both STEM and non-STEM majors (i.e., none of the interaction terms to assess whether the grades or courses variables had a different relationship for STEM and non-STEM majors was statistically significant) so interaction terms were removed from the model. The set of variables consisting of mathematics and English courses and grades along with STEM status provided a significant prediction of retention after one year (Likelihood Ratio Chi-square(14, N=5650) = 609.83, $p<.0001$). The R^2 from the regression of the predicted probability of returning against actual events was .11.

Table 3 displays the regression results for the model. Of the 14 variables included in the model, 12 were statistically significant. The only variables that were not statistically significant were (1) enrollment in developmental English (instead of ENGL 101) and (2) whether or not the student was a STEM major.

Table 3.

Final logistic regression equation for predicting retention one year later based on English and Math courses taken, grades received, and STEM major for first-time full-time students who first enrolled in fall 2007, 2008, 2009, or 2010 (N=5,650)

Parameter	Estimate	Standard error	Wald Chi-square	Significance Level	Odds ratio Point estimate*
Intercept	0.16	0.15	1.10	0.2942	--
Elementary Algebra	-0.55	0.16	12.43	0.0004	0.577 (1.733)
Intermediate Algebra	-0.53	0.15	12.93	0.0003	0.590 (1.695)
Basic core math course to fulfill university math requirements	-0.51	0.16	10.21	0.0014	0.603 (1.658)
College Algebra/ Analytic Trigonometry -- Prerequisite to Calculus I	-0.38	0.14	7.25	0.0071	0.681 (1.468)

Math grade: A	0.94	0.10	90.57	<.0001	2.572
Math grade: B	0.82	0.09	85.14	<.0001	2.278
Math grade: C	0.6531	0.09	54.89	<.0001	1.921
Developmental English	0.19	0.13	1.92	0.1664	NS
ENGL 102	0.21	0.08	6.68	0.0098	1.230
English course beyond 102	0.73	0.24	9.00	0.0027	2.076
English grade: A	1.19	0.08	216.31	<.0001	3.292
English grade: B	0.90	0.10	87.55	<.0001	2.469
English grade: C	0.49	0.12	17.52	<.0001	1.635
STEM major	0.08	0.09	0.95	0.3306	NS

Note: Codings are set up so that grade comparisons are to those obtaining D, F, or W. Math course comparisons are to Calculus I or higher numbered course. English course comparisons are to ENGL 101, the traditional first course that students take in the sequence.

*When the odds ratio was less than 1, the inverted odds ratio is provided to aid in understanding and comparisons, e.g, translating the MATH 25 odds ratio from 0.577 to 1.733 should be interpreted at students who did NOT take MATH 25, were 1.7 times more likely to be retained.

The variable that was most predictive of students being retained one year later was receiving an "A" in English, see Table 3. This result can be interpreted as showing that compared with those who received a (D, F or W) in their first English course, students who received an "A" were 3.3 times more likely to be retained. The variables which were likely to at least double the likelihood of being retained, as shown by an odds ratio of at least 2.0, included an "A" in math (2.6 times), a "B" in English (2.5 times), a "B" in math (2.3 times), and taking an English course beyond ENGL 102 (2.1 times). Using the size of the odds ratios to indicate the strength of the variables in predicting retention, we note that the top three odds ratios are all associated with grades (A in English, A in Math, B in English) rather than course level. Thus, while level of the course taken was significant, the effects paled compared to grades earned in the course.

A follow-up comparison (see Table 4) shows that students who took both mathematics and English courses their first year were more likely to be retained compared with those who did not. Students who enrolled in both math and English also had higher first semester GPAs

compared to the other groups. Additional research in the characteristics of this group and the reasons behind their lack of enrollment in these basic courses and the relation to retention would be useful.

Table 4.

Retention and first semester GPA of students enrolling in both math and English compared to those who did not for first-time full-time students who first enrolled in fall 2007, 2008, 2009, or 2010 (N=5,650)

Course enrollment	N in group	Percent of total group	First term GPA*	Percent retained after 1 year**
Took both Math and English	5848	70.8	2.69	71.0%
Took only English	1504	18.2	2.56	63.4%
Took only Math	515	6.2	2.51	59.1%
Took neither	398	4.8	1.76	42.5%

*F(3,8261)=97.20, p<.0001, Dunnett's ***t*** for post-hoc comparisons using the "took both" group as the control.
** χ^2 (3, N=8,265) = 204.69, p<.0001

Discussion

One of the questions asked in this study was whether the level of the English and mathematics courses taken during students' first year or the grades they obtained in those courses were better indicators of retention one year later. Results clearly indicate that grades are much more important than the actual course level that the student first took when predicting retention one year later. In particular, obtaining a grade of "A" in English is most predictive of continued enrollment compared to any other measure, with an odds ratio of 3.3. The second highest odds ratio is approximately the same for obtaining a grade of "A" in mathematics (2.6) and obtaining

a “B” in English (2.5). Thus – grades in English and mathematics are very important predictors of first-year student retention. This is consistent with findings by other researchers who have shown a clear association of first-year academic success, as measured by GPA with retention (e.g. Whalen (2009), Herzog (2005)).

In addition, obtaining a high grade in English is equally important for both STEM and non-STEM majors. Because STEM majors typically must take more math courses and their major is more quantitative compared to most non-STEM majors, many have felt that performance in math courses was more important than performance in English for STEM majors. The equal importance of obtaining a high grade in English for both STEM and non-STEM majors in terms of predicting retention one year later is a key finding.

Another key finding is that the grade earned in mathematics is more predictive of continued enrollment compared with the level of mathematics course taken. Although students who enter at a mathematics level of calculus I or higher are more likely to continue than students beginning at levels below calculus I, of the two factors – course taken, or grade earned – the strongest predictor of retention is grade earned. A related finding is shown by Budny et al., 1998, who presented a comparison of the average sixth semester retention rates for Purdue students for the years 1981 through 1993 versus the grades obtained in one of the three first-semester mathematics courses (precalculus, calculus I, or calculus II). Budny (1998) reported that this comparison showed that students who earn an A in precalculus in their first mathematics course have approximately the same retention rate as students who earn a B in calculus I in their first mathematics course; and that this in turn is approximately the same retention rate as students who earn a C in calculus II as their first mathematics course. Budny (1998) emphasized the importance of correct placement in a first mathematics course to optimize success in that course.

Another important point noted by Budny was that the cohort of students who earned an A or B in precalculus had average SAT scores that were over 100 points lower than the cohort of students who earned a C in calculus II, yet they had the same retention rates. Bahr (2008) in his report on mathematics remediation among community college students, showed that remediation is equally efficacious in its effect on academic outcomes across levels of initial math deficiency. That is, students who successfully remediate at lower levels of remedial mathematics classes are equally likely to complete college as students who remediate at higher levels of remedial mathematics classes. Thus, these studies support our finding that academic success in mathematics is an important factor when predicting retention.

While mathematics momentum from high school is important and the level of math attainment in high school does affect the probability a student will earn their bachelor's degree (Adelman, 2006), this study provides additional important information about the role of the student and the importance of their academic performance in entry-level coursework. As students transition to college, they gain independent control over their effort and quality of effort in first-year college coursework. Communicating the importance of strong academic performance to students and to their faculty as it relates to their future degree completion is critical. The message of students being the principal actor who is ultimately responsible for their academic success has been eloquently stated by others, e.g. Adelman (2006).

These findings may help inform administrative resource allocation decisions, particularly given the emphasis on university accountability (CHEA, 2013). Placement in the appropriate level mathematics and English courses, combined with excellent instruction and student support services is critical. These findings support implementing strategies to assure correct placement, devoting adequate resources for tutoring, learning assistance, and supplemental instruction; and

providing professional development for instructors in evidence-based instructional practices to promote an optimized learning experience. None of these measures, however, ensure that students will earn an A or B in the corresponding English and mathematics courses. The recent work of Marsh (2014), which shows that academic support expenditures (faculty development, course design and instructional technology) are statistically significant predictors of student retention are particularly helpful in conjunction with these findings, suggesting strategic investment in first-year instructional development in mathematics and English may improve student retention.

In summary, the assumption that students are less likely to successfully graduate with a STEM degree if they do not begin college ready for calculus must be tempered with clear communication about the importance of achievement of success in entry level coursework, which is highly predictive for student retention. With the critical shortage of STEM professionals in the nation, we operate under a national imperative to increase the throughput of STEM students (PCAST, 2012). Increasing student persistence is one way to accomplish this, and this study provides additional information about the importance of academic success in first-year coursework as it concerns student retention.

Limitations of the study

This study was limited to a single metropolitan university in the Northwest and to the first-time full-time freshmen who enrolled there over a four-year period between fall 2007 and fall 2010. Different results may be obtained at other institutions or with other student groups, (part-time students). In addition, modifications to the math curriculum at this university have been occurring since fall 2011, so future studies may find different results due to curricular changes.

The study was limited to students who had taken both an English course and a math course during their first year of enrollment. While the group of interest included 71% of the first-time full-time freshmen, 29% were eliminated from the study due to lack of enrollment in one or both areas.

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