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Results of a Placement System for the First College Mathematics Course

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RESULTS OF A PLACEMENT SYSTEM FOR THE FIRST COLLEGE MATHEMATICS COURSE

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ABSTRACT

The success or lack of success in the first college mathematics course that students attempt has a significant impact on students' future academic progress. Lack of success in mathematics and English can (a) lead to a student changing his or her major, (b) delay the student's progress toward graduation, and (c) decrease the likelihood that the student will be retained at the college the next year. Due to the importance of student success in the first college mathematics course, many colleges and universities have turned to mathematics placement systems to help ensure that students in STEM majors are likely to succeed in their first mathematics course. The results of these placement systems, however, are largely unknown. This study analyzed the results of a mathematics placement system using five years of data, which were obtained from 10,484 students enrolled in six mathematics courses. The placement system places students in level 1, 2, 3, and 4 courses based on nationally normed standardized tests in mathematics as well as high school GPAs. The success rates (grade A, B, or C) for students placed in levels 1, 2, 3, and 4 were 59.06%, 88.57%, 86.13%, and 88.28% respectively. In addition, the DFW (grade D, F, or W) rates for College Algebra and Calculus I are at or below the DFW rates from national data.

Keywords: mathematics education, success rate, DFW rate, failing rate, mathematics placement, placement level, high school GPA, VSU math index, ALEX placement exam

INTRODUCTION

The first college mathematics course that students take varies depending on the student as well as depending on the admissions policy and entry-level expectations of the college or university that the student is attending. Most students in the United States enroll in an introductory before-calculus course, such as College Algebra or Precalculus, or in Calculus I as their first college mathematics course (Blair et al. 2018). Research in undergraduate mathematics education indicates that students struggle in these first-experience college mathematics courses. A variety of studies indicate that the DFW (grade D, F, or W) rate for Calculus I ranges from 22% to 57%, depending on the institutions and types of institutions included in the study (Bressoud 2015; Pyrdrowskil 2013). Masters universities, which are the peer group of our institution, Valdosta State University, have a 37.1% DFW rate in Calculus I (Bressoud 2015). Across the United States, approximately

50% of College Algebra students do not successfully complete the course with a grade of A, B, or C (Saxe and Braddy 2015).

The success or lack of success in the first college mathematics course that students attempt has a significant impact on their future academic progress. Lack of success can delay the student's progress toward graduation and decrease the likelihood that the student will be retained at the college in the upcoming year (Saxe and Braddy 2015). In addition, particularly in the case of calculus, lack of success can cause students to transfer out of their STEM major (Hensel 2008).

Due to the importance of student success in the first college mathematics course, many colleges and universities have implemented mathematics placement systems. The intent of the placement systems is to accurately place each student in their first mathematics course to facilitate their likelihood of success, while at the same time striving to ensure the student is not overly prepared for their first course (Medhanie 2012). Colleges and universities use a variety of placement methods to place students in their first course, but most use indicators from past performance in high school, typically grades; nationally normed achievement exams, typically the ACT or SAT; and placement tests, which may be developed externally, such as ACCUPLACER, or internally by the mathematics department (Medhanie 2012).

The results of these placement systems, however, are largely unknown. This study analyzed the results of a mathematics placement system using five years of data, fall 2013 to spring 2018, which includes 10484 students enrolled in six mathematics courses.

THE MATHEMATICS PLACEMENT SYSTEM

Beginning with fall 2013 enrollment, Valdosta State University (VSU) implemented a mathematics placement system in order to ensure that students are properly prepared for their first college mathematics course. Students are allowed to enroll in mathematics courses based on (a) successful completion of the prerequisite course, (b) their VSU math index (VMI), or (c) their ALEKS placement exam score.

Based on admissions data, almost all students admitted to the university are assigned a placement level based on the VSU math index. Students without a VMI are default-assigned to the lowest level of mathematics courses, which is placement level 1. Students who desire a higher placement level than obtained from the VMI may choose to take the ALEKS online placement exam. See Table I for the entry-level mathematics courses associated with each of the four placement levels, 1, 2, 3, and 4.

The registration system allows students to register for any course listed at their placement level as in Table II. Students choose which course to take based on their major, core curriculum requirements, and their personal preference.

ASSIGNING THE PLACEMENT LEVEL BASED ON THE VSU MATH INDEX

In order to place students using available admissions data, all students are assigned a placement level of 1, 2, 3, or 4 based on their high school grade point average (HS-GPA) and the mathematics portion of the test required for admissions (SAT-math or ACT-math). The HS-GPA scores are grouped into four categories: 1, 2, 3, and 4 as in Table III. In addition, the SAT-math scores are grouped into four categories as in Table IV. ACT-math scores are converted to equivalent SAT-math scores as in Table IV, then the SAT/ACT-math scores are grouped into four categories: 1, 2, 3, and 4 as in Table V.

Table I. Placement levels

Course	Prerequisites	Placement level	ALEKS placement exam score
MATH 1101 Math Modeling	None	1	0–55
MATH 1111 College Algebra	None	1	0–55
MATH 1112 Trigonometry	MATH 1111 with C or better	2	56–65
MATH 1261 Survey of Calculus	MATH 1111 or MATH 1101 with C or better	2	56–65
MATH 1113 Precalculus	MATH 1112 with C or better	3	66–75
MATH 2261 Calculus I	MATH 1112 or MATH 1113 with C or better	4	76–100

Table II. Mathematics courses allowed by placement level

Placement level	Allowed mathematics courses
1	MATH 1101, 1111
2	MATH 1101, 1111, 1112, 1261
3	MATH 1101, 1111, 1112, 1261, 1113
4	MATH 1101, 1111, 1112, 1261, 1113, 2261

Table III. High school GPA categories

	HS-GPA	
Category	Low	High
1	3.41	4.00
2	3.04	3.40
3	2.69	3.03
4	0.00	2.68

Table IV. ACT-math to SAT-math conversion table

ACT-math	10	11	12	13	14	15	16	17	18	19	20	21	22	23
SAT-math	280	320	360	370	400	420	450	470	490	510	520	540	550	570
ACT-math	24	25	26	27	28	29	30	31	32	33	34	35	36	
SAT-math	580	600	620	640	660	690	710	730	750	760	780	790	800	

Table V. SAT-math score categories

	SAT-math	
Category	Low	High
1	561	800
2	521	560
3	491	520
4	0	490

The four categories of high school GPAs and four categories of standardized test scores are crossed to give sixteen categories. With data gathering and analysis conducted by the Office of Institutional Research, we studied the success (grade of A, B, or C) and non-success (withdrew or grade of D or F) of students in each of the entry-level mathematics courses for each of the sixteen categories. From these success/non-success rates, we determined which level of courses (level 1, 2, 3, or 4) a student in each category was likely to pass and assigned the appropriate course level for the VMI-based placement level as in Table VI.

Table VI. Math placement level based on VMI

HS GPA	SAT-math	Placement level	Math courses
1	1	4	MATH 2261
1	2	3	MATH 1113
1	3	2	MATH 1112 or 1261
1	4	1	MATH 1101 or 1111
2	1	2	MATH 1112 or 1261
2	2	1	MATH 1101 or 1111
2	3	1	MATH 1101 or 1111
2	4	1	MATH 1101 or 1111
3	1	1	MATH 1101 or 1111
3	2	1	MATH 1101 or 1111
3	3	1	MATH 1101 or 1111
3	4	1	MATH 1101 or 1111
4	1	1	MATH 1101 or 1111
4	2	1	MATH 1101 or 1111
4	3	1	MATH 1101 or 1111
4	4	1	MATH 1101 or 1111

ASSIGNING THE PLACEMENT LEVEL BASED ON THE ALEKS PLACEMENT EXAM

While almost all students have a placement level determined by the VMI, some students have incomplete admissions data. These students are given a default placement of level 1, yet some of these students may think they are ready for higher level mathematics than College Algebra. For example, international students are sometimes given a default placement of level 1 due to missing ACT/SAT-math scores, but may consider themselves ready for higher level math. Similarly, STEM majors with a level 1 placement may want to start in Precalculus, but their placement level does not allow a student to enroll in

Precalculus. When students are not satisfied with their placement level, they may choose to take the ALEKS placement exam.

ALEKS is a web-based, artificially intelligent assessment and learning system published by McGraw-Hill. Some universities use the ALEKS software for mathematics placement. Through consultation with the ALEKS representative, we set the placement exam cut scores for placement into level 1, 2, 3, or 4 based on existing national data as in Table I.

In order to take the placement exam, students purchase a six-week license. They can take the placement exam up to three times. They are allowed up to 24 hours to complete each exam attempt and must wait 24 hours to start the next exam attempt. Each placement exam attempt serves as a diagnostic assessment, which determines the students' strengths and weaknesses and provides appropriate individualized online tutorials to improve their skills. The placement exam is not proctored. Students are asked to follow the VSU honor code and not receive outside help when taking the placement exam.

Upon completion of the online placement exam, students immediately receive their score, and the score is automatically transferred on a daily basis to the university's registration system. If the student's ALEKS placement level is higher than the existing placement level, then the placement level is automatically changed within the registration system.

DATA ANALYSIS

In assessing the math placement, two variables were used, the MATH_PLACEMENT and PASS_DFW. The MATH_PLACEMENT has levels 1, 2, 3, and 4 and the PASS_DFW has two labels, PASS (successful grade of A, B, or C) and DFW (grade D, F, or withdrew). DFW is coded 0 and PASS is coded 1. The Office of Institutional Research provided the data on these two variables over a five-year period from fall 2013 to fall 2018.

The data was analyzed using cross tables and presented in the form of a graph. Figures 1 and 2 show the MATH_PLACEMENT (levels: 1, 2, 3, 4) and PASS_DFW (levels: 0–DFW, 1-Passed with C or higher) using the number of students in Figure 1 and the percentage of students in Figure 2. The asterisk means the student did not have a VMI level.

From Figure 2, students with VMI placement level 1 registering for Math 1101 or Math 1111 have a DFW rate of 40.94% (3019 out of 7374), while the students with VMI placement levels 2, 3, and, 4 have a DFW rate 11.43%, 13.87%, and 11.72%, respectively. Figure 2 demonstrates that the VMI placement process is successful in assigning the students the correct VMI level. Figure 1 shows that 3019 students with VMI placement level 1 have a grade D, F, or W. This large group of students need extra support in order to be successful.

Figures 3 and 4 sort the students who were successful (PASS_DFW = 1) and not successful (PASS_DFW = 0) by MATH_PLACEMENT level (1, 2, 3, 4) using the number of students in Figure 3 and the percentage of students in Figure 4.

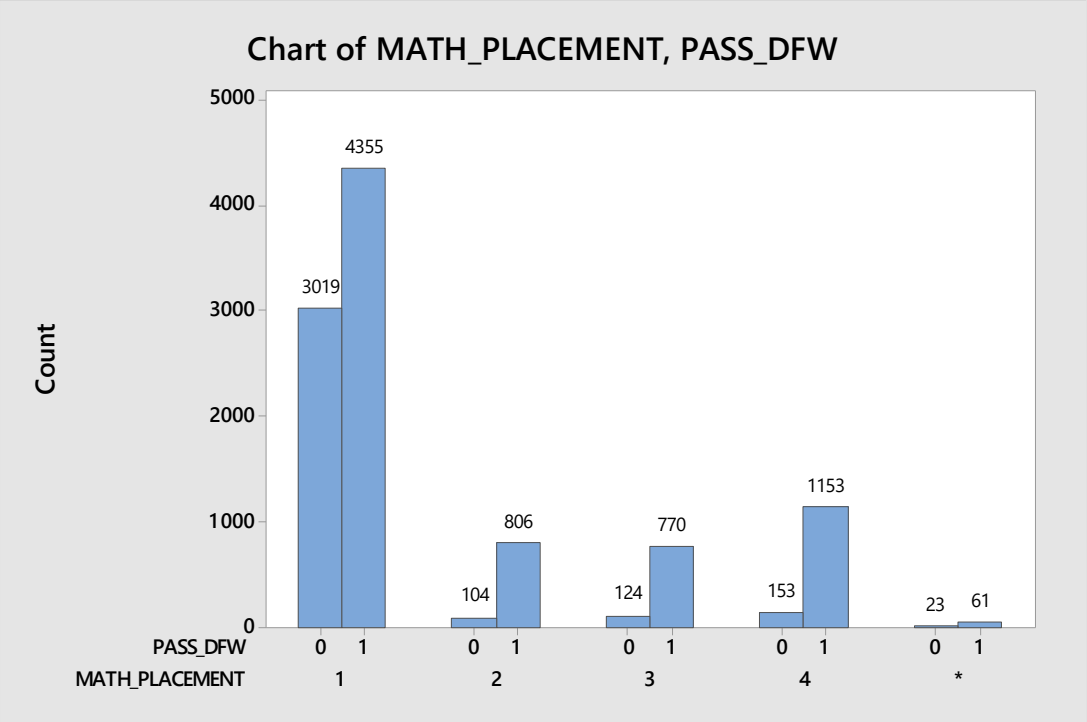

Figure 1. MATH_PLACEMENT vs PASS_DFW using number of students. * indicates students without a VMI level.

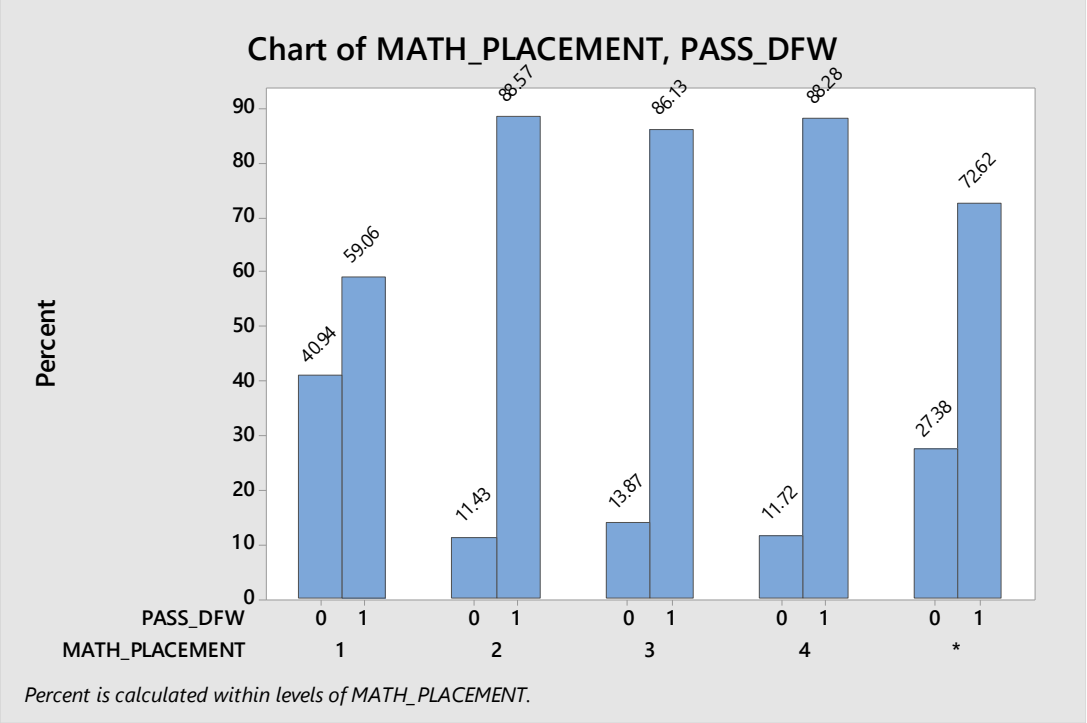

Figure 2. MATH_PLACEMENT versus PASS_DFW using percentage of students. * indicates students without a VMI level.

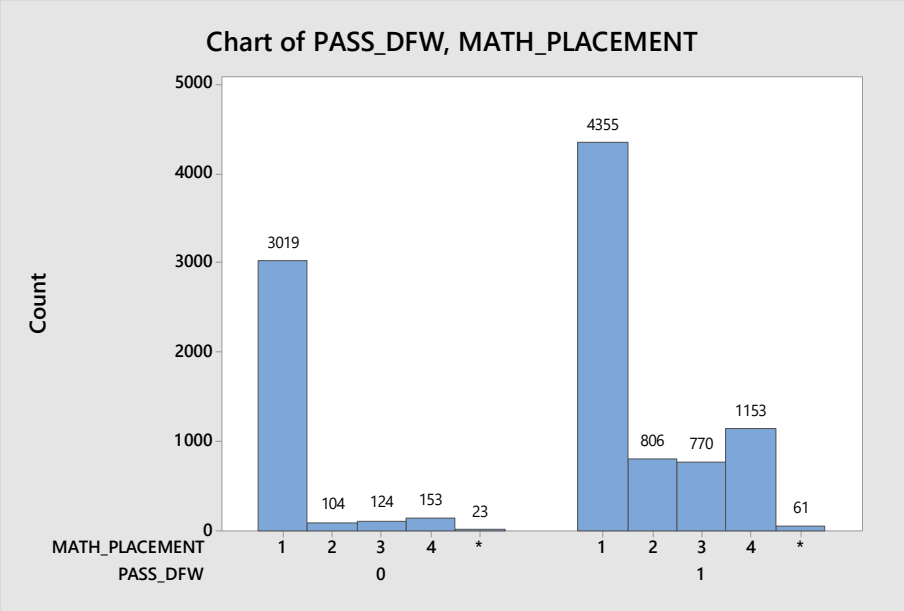

Figure 3. PASS_DFW vs MATH_PLACEMENT using number of students. * indicates students without a VMI level.

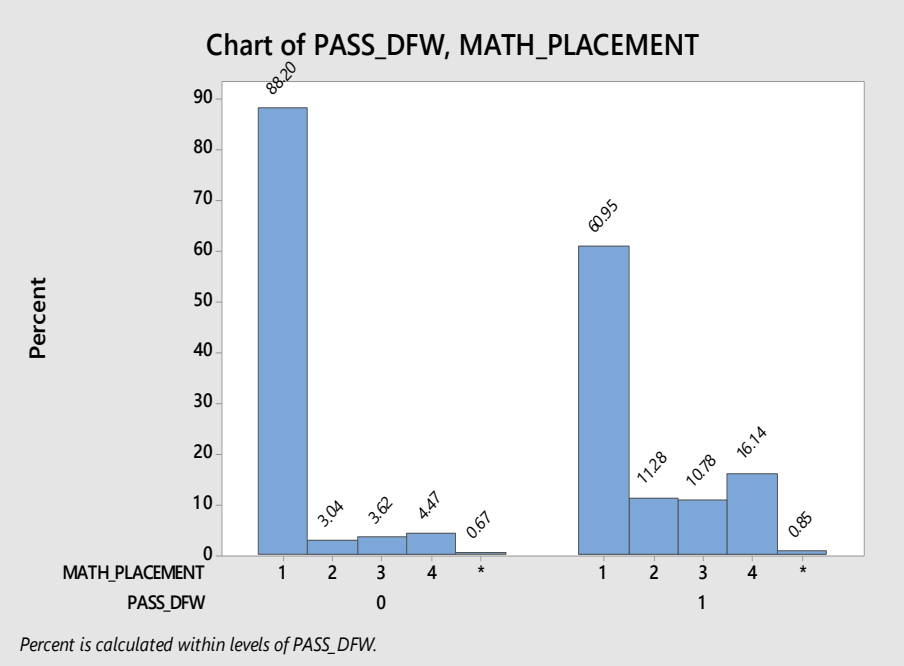

Figure 4. PASS_DFW vs MATH_PLACEMENT using percentage of students. * indicates students without a VMI level.

Figure 4 shows that 88.2% (or 3019) of the students with D, F, or W have a VMI level 1 and the remaining 11.8% (or 404) of the students have a VMI level 2 or higher. Again it is clear that the students placing in VMI level 1 need extra support in order to be successful.

Figure 5 is between COURSE_NUMBER (levels: 1101, 1111, 1112, 1113, 1261, and 2261) and PASS_DFW (levels: 0–DFW, 1-Passed with C or higher). Figure 5 shows that the DFW rate in Math 1101 is 31.91%, Math 1111 is 32.19%, Math 1112 is 34.76%, Math 1113 is 28.28%, Math 1261 is 43.76%, and Math 2261 is 34.41%. The DFW rates are very much the same indicating that the students are placing correctly in their first mathematics course. The Math 1111 College Algebra DFW rate (32.19%) is well below the DFW rate across the United States (50%). In addition, the Math 2261 Calculus I DFW rate (34.41%) is comparable to, if not below, the DFW rate of similar master's universities in the United States (37.1%).

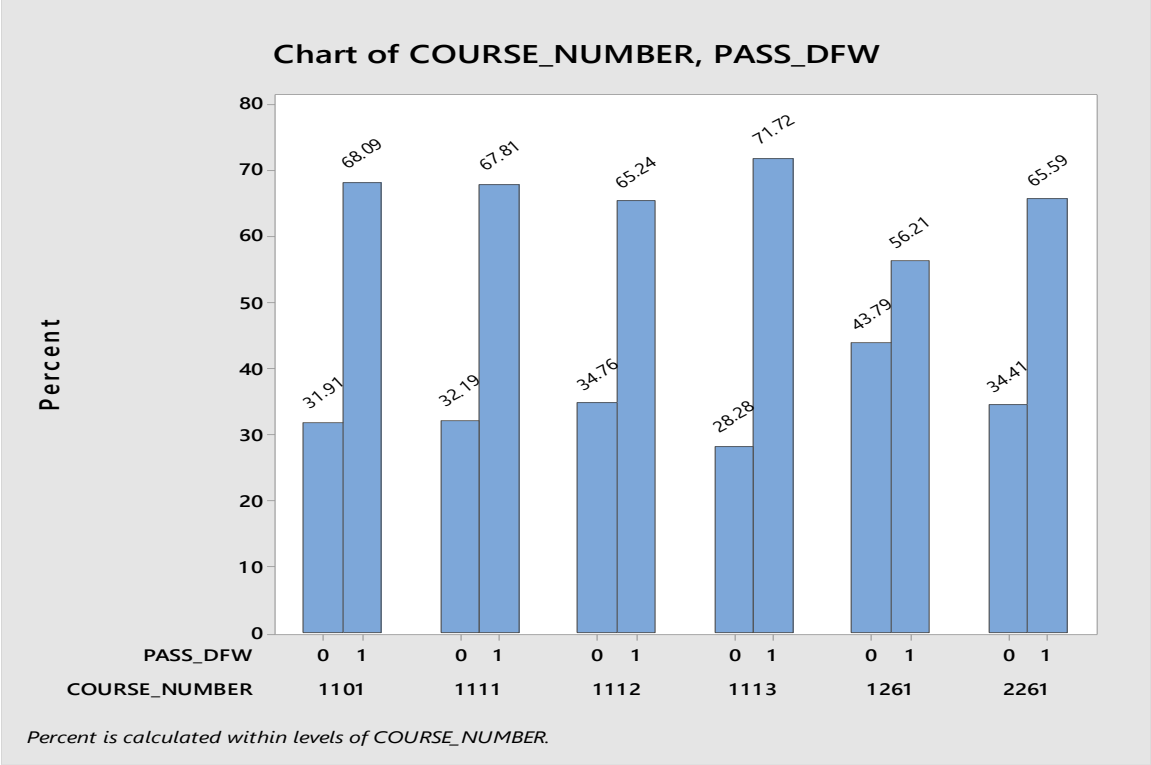

Figure 5. COURSE_NUMBER vs PASS_DFW using percentage of students.

CONCLUSION

From Figure 2, the success rate (grade A, B, or C) for students placed in levels 1, 2, 3, and 4 are 59.06%, 88.57%, 86.13%, and 88.28% respectively. The results show that the mathematics placement system at Valdosta State University is placing the students correctly in their first college mathematics course. Figure 5 shows that the DFW rates for the entry-level courses are similar, indicating that the students are being correctly placed. Also, comparing the DFW rates for College Algebra (32.19%) and Calculus I (34.41%) with national data (College Algebra 50%, Calculus I 37.1%) provides further evidence that the students are being correctly placed.

Figures 1 and 2 also demonstrate that a high number (3019) and percentage (40.94%) of students with a level 1 placement were not successful (grade D, F, or W). Figure 4 shows that these 3019 students represent 88.2% of all students with a D, F, or W in the entry-

level courses. While this study clearly indicates the placement system is working well, it also shows that the students with a level 1 placement need more support to be successful.

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