STUDENT SUCCESS IN DEVELOPMENTAL MATH COURSES

Prepared for Imperial Valley College

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In the following report, Hanover Research reports the success rates for students in developmental math courses at Imperial Valley College and examines students' likelihood of successfully completing Math 119 after beginning in developmental courses.

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

This analysis identifies trends in the success of students who are enrolled in developmental math courses, including the points at which students in these courses may drop out of the developmental course sequence. To accomplish this, Hanover calculates the success rate for students passing each of the developmental math courses and generates a flowchart to visualize the patterns in course enrollment and passing.

This report is organized as follows:

- **Section I: Data and Methodology** discusses the data and the methodology Hanover used in the analysis.
- **Section II: Student Success Following Developmental Math Courses** presents and interprets the graphs for the analysis.

KEY FINDINGS

- **Math 61 is an important stage for students who are deciding whether to continue or not.** Students may fall off track after Math 61 for two reasons:
  - *Not passing Math 61.* The low pass rate for Math 61 indicates that many students are not able to move forward because they do not pass this course.
  - *Passing Math 61 but choosing not to move forward.* Even among those students who passed Math 61, nearly one-fourth chose not to continue to the next course in the sequence.

- **The course pass rate for Math 81 is one of the lowest rates in the new system.** The pass rate for Math 81 is about 70 percent, which is the second lowest pass rate in the new course system after Math 61.

- **The success rates in Math 119 are similar or better for students who start in the lower levels of the course sequence than those who start at higher levels.** As long as students work through all of the courses leading up to Math 119 and enroll in that course, their success rates are slightly higher than those of students who start from a higher level of the sequence in the new system. Success rates are no different from those of students who start from a higher level in the old system. This indicates that starting from a lower level of the course sequence does not reduce the chance of success for those who complete the sequence leading up to Math 119.

- **The Math 119 attempt rates for students who completed Math 90 or Math 91 are low.** More than half of the students who pass Math 90 or Math 91 choose not to continue taking Math 119 at IVC. This rate is lower than the attempt rate for the next course for any other math course examined.

- **The pass rate for each developmental math course in the new system is higher than for the corresponding course in the old system**. **In addition, the ultimate Math 119 success rates for students passing each developmental course are higher in the new system.** For students who succeeded in a specific developmental math course, the rates for them ultimately passing Math 119 are 3 to 8 percentage points higher in the new system than in the old system.

SECTION I: DATA AND METHODOLOGY

This section summarizes the data and methodology that Hanover used for this analysis of student success in developmental math courses at IVC.

To support the analysis, IVC provided Hanover with academic performance data for 15,341 students with unique student ID numbers. The dataset contains students' grade in the math courses they took in each academic year and term, as well as the number of times they attempted each course.

Hanover aggregated the dataset to the student-course level. In the aggregated data, for each student and each course, we generated the following information:

- **Course Grades.** We kept the grade students received in both their first and final attempt at the course. Except for some exceptions,[1] the final grade equals the highest grade if the student attempted the course multiple times. Therefore, we only used the first and the last grades in each course in the analysis.

- **Pass or Fail Status.** Using the course grade information, we calculated binary variables indicating whether the student passed the course on the first and the final attempts. For courses using grade points, we considered any grade higher than a "C" as passing and any grades lower than "C" and withdraw as failing. For courses only recording pass (P) and not pass (NP) status, we considered a "NP" grade or a withdrawal as failing. As there are only six records of either "Incomplete" or "Military Withdrawal," we dropped these observations.

- **Academic Period.** We generated the first and the last academic year and term the student took the course. The academic period covered by the dataset is from fall 2009-2010 to summer 2015-2016.

- **Attempt.** Using the attempt information, we generated indicators identifying whether the student took each of the developmental courses or not.

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[1] There are two types of cases where the last grade does not equal to the highest grade. First, there is only one observation that has a "A" grade in the first attempt and a "D" grade in the final attempt. We dropped this observation because it is counterintuitive and may represent a data error or an unusual situation that is not representative of students' usual experiences. Second, there are some cases where the student received a "D" in one or more of their first several attempts and an "F" in the final attempt. Although both "D" and "F" indicate failing grades, "D" is a higher score than "F." This case is not troublesome, as our interest is the passing rate instead of the exact grade the student received.

Figure 1.1 provides an overview of the number of students enrolled in each course (for the first time) across academic years.

Figure 1.1: Enrollment in IVC Math courses by Academic Year of First Attempt
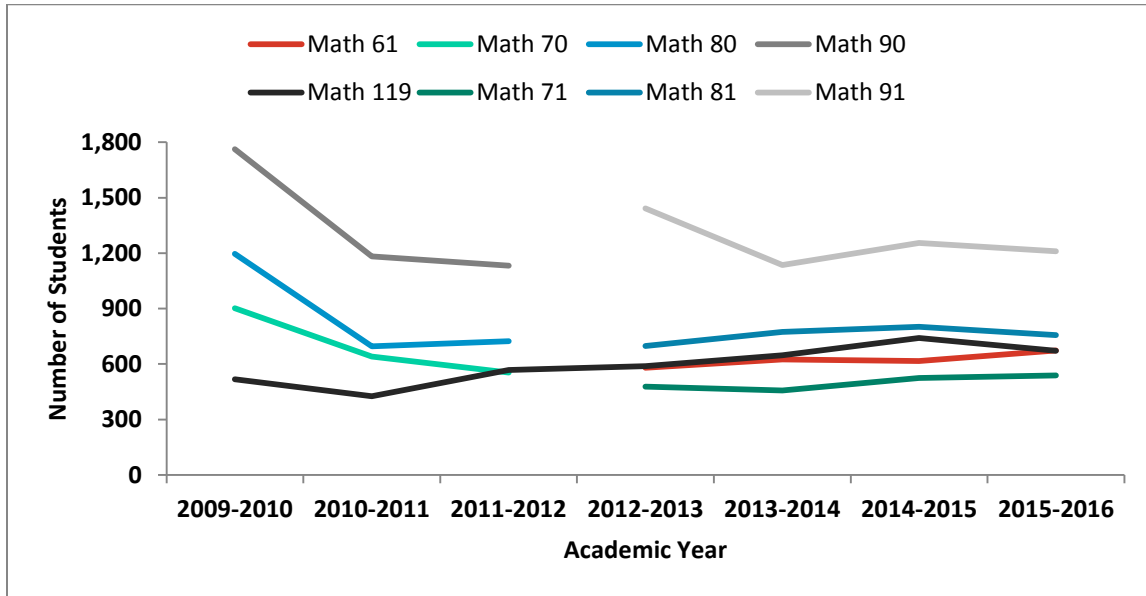
METHODOLOGY

Hanover conducts a series exploratory analyses to identify the point where students who enrolled in developmental math courses are dropping off. As IVC has two different math course systems (one before and one after the academic year 2012-2013), we include both course sequences in the analysis. We define the course sequence Math 70, Math 80, Math 90, and Math 119 before the beginning of the academic year 2012-2013 as the "old system," and the course sequence Math 61, Math 71, Math 81, Math 91, and Math 119 after the beginning of the academic year 2012-2013 as the "new system." We calculate the pass percentage (success rate) for Math 119 as well as other courses subject to different conditions.

MATH 119 PASS RATE

We first examine the group of students who took each math developmental course and also took Math 119. This analysis allows us to examine whether students' initial math level has any relationship with their success in Math 119. This analysis focuses exclusively on the Math 119 pass rate and not on attrition prior to attempting Math 119, so we would not necessarily expect Math 119 pass rates for students who took a lower level course to be lower than for students who took a higher level course, if the developmental courses are successfully addressing students' deficiencies in math.

In the calculation, we identify students who passed each developmental course and who also took Math 119. Then we calculate the success rate in Math 119 for this group of

students. When we identify students who pass, we first use the criteria based on the grade the student received in their first attempt. Then, as a robustness check, we conduct the same calculation using the grade the students received in their final attempt.

ULTIMATE MATH 119 SUCCESS RATE

We then relax the condition of taking Math 119 so that we can examine the whole group of students who took each specific developmental math course and track differences in success prior to enrolling in Math 119 in addition to success in Math 119 once students have enrolled. For each developmental course, we calculate two rates. First, we calculate the success rate for the developmental course by taking the ratio of the number of students who pass the course to the number of students who take the course. Second, we calculate the ultimate Math 119 success rate for students who passed the specific course by dividing the number of students who ultimately passed Math 119 by the number of students who passed the developmental course.

The second condition allows us to examine whether students who take particular developmental math courses have a better chance of ultimately succeeding in Math 119. Unlike the condition in the previous subsection, in this subsection students do not have to take Math 119 to be included. Therefore, the "non-success" category here includes both students who fail Math 119 and those who never attempt Math 119. We use the grade in the final attempt as the pass or fail criteria.

In addition, we add two additional conditions to the calculation of the ultimate Math 119 success rate to avoid potential biases:

- **Exclude students who do not have enough time to complete the full course sequence.** Because we do not have pass or fail information for Math 119 after the summer 2015-2016 academic term, students who took Math 91 in summer 2015-2016 would all be mistakenly labeled as unsuccessful if we did not adjust the calculation. Similarly, if students take the courses in sequence, students who took Math 81 in spring 2015-2016 also have not had a chance to take Math 119 yet. Moreover, although each academic year at IVC contains four academic terms, the majority of students take courses in the fall and spring terms. Therefore, when calculating whether students have had enough time to attempt Math 119, we treat each year as only having two academic terms, effectively assuming that students only take courses in fall and spring terms. We also build in one "buffer" term to allow for retaking a course or taking a term off from IVC.

  Specifically, we exclude students taking each developmental course in the following periods:
  o **Math 61:** spring 2013-2014 or later
  o **Math 71:** fall 2014-2015 or later
  o **Math 81:** spring 2014-2015 or later
  o **Math 91:** fall 2015-2016 or later

- **Exclude students who take more than two years to finish the course sequence.** By the structure of the dataset, the lower level courses in the sequence will have a systematically lower ultimate Math 119 success rate than the higher level courses. For two students starting in different stages of the developmental math sequence at the same time, the student in the higher level course will have a better chance to succeed in Math 119 because they will have fewer courses in the sequence to complete, so they will have more time to retake the courses if they fail. In addition, students in earlier cohorts would have a better ultimate success rate for similar reasons; because they have had more time to reach and complete Math 119, they would effectively have a built-in margin for retaking courses that students in more recent cohorts would not. This could be especially problematic when comparing the old developmental math sequence to the new sequence.

  To avoid this bias, we examine whether students successfully complete Math 119 within a fixed period after beginning their developmental coursework, rather than leaving the completion period open-ended. This places all students on equal footing when making comparisons in success rates. If students take courses only in the fall and spring terms and take one course per term, the entire developmental sequence would not take longer than two years. Therefore, to avoid this bias, we require students to complete Math 119 within the following time periods for each developmental course (counting them as "unsuccessful" if they complete Math 119 after this cutoff point):

  o **Math 61:** 2.5 years (10 terms)
  o **Math 70 and 71:** Two years (eight terms)
  o **Math 80 and 81:** 1.5 years (six terms)
  o **Math 90 and 91:** One year (four terms)

  These time limits will allow students to be counted as "successful" in Math 119 if they complete the developmental sequence at a rate of two courses per year (one course per semester if students take courses only in the fall and spring), with one extra term built in as a buffer (in addition to the buffer provided by the option of taking courses in the winter or summer terms).

COURSE FLOWCHART FOR DEVELOPMENTAL MATH COURSES

We also create a flowchart to represent the success rate at each stage of the developmental course sequence. The flowchart allows us to investigate the points where a large percentage of students drop out of the developmental sequence. As we observe similar outcomes using pass criteria based on the first attempt and the final attempt, we only report the outcomes using students' grade in their final attempt.

In the flowchart, we calculate the following three rates:

- **Overall pass rate for the course:** We calculate the percentage of students who passed the course out of the total number of students who took the course.

- **Pass rate of the course for students who took the previous course in the sequence:** In this calculation, we focus on students who succeeded in the previous developmental course. We calculate the percentage of students in this group who pass the course. Comparing this rate with the overall pass rate provides a sense of whether students with lower initial placements are as successful in each course as those who placed directly into the sequence.

- **Attempt rate for the next course in the sequence for students who succeed in the course:** We calculate the percentage of students who passed each developmental course who then chose to take the next level course in the sequence. To allow students enough time to take the course at the next stage, we exclude students who take the course in the academic year 2015-2016 (four terms) because many of these students may not have had a chance to enroll in the next course in the sequence yet.

SECTION II: STUDENT SUCCESS FOLLOWING DEVELOPMENTAL MATH COURSES

MATH 119 PASS RATE

Figure 2.1 presents the success rate in Math 119 for students who passed each developmental math course. The figure illustrates the following insights:

- **In the new system, students who took the lower level courses and progressed to Math 119 have a higher pass rate than those who took the higher level courses.** The higher success rate for students who took the lower level course in the sequence indicates that students can be in an advantageous position if they take courses from the lower levels of the sequence, as long as they do eventually make it all the way to Math 119. While some of students skipped several courses in the sequence, the majority of students in this analysis who make it to Math 119 follow every step of the course sequence along the way. Regardless of the path they choose, as long as they make to Math 119, students who start from a lower level course on average show an equal or higher chance of passing Math 119.

- **In the old system, students who took the lower level courses and progress to Math 119 have similar passing rates as students who took the higher level courses.** Although students who took lower level courses in the old system do not show higher passing rates in Math 119 like students in the new system, students starting from a lower level course can be equally successful as those starting from a higher level course if they make it to Math 119.

- **Taken together, these results indicate that the key issue for students in lower-level developmental courses is attrition during the developmental sequence,** which is examined in more detail in subsequent sections of this report. If these students make it to Math 119, their pass rate is in line with other students' pass rates.

- **The final attempt success rate is higher than the first attempt, by 12 to 15 percentage points under the old system and by 7 to 10 percentage points under the new system.** While the overall trends for rates using both criteria are the same, the absolute rates using the final attempt are higher than those using the first attempt. This indicates that students can make progress by taking courses multiple times. This also illustrates the importance of limiting the time allowed to complete the whole course sequence to two years when calculating the ultimate success rate in Math 119 in subsequent sections of the report; many students do attempt courses multiple times, and failing to account for the amount of time required to complete the sequence would bias any comparisons between old and new courses.

Figure 2.1: Math 119 Pass Rate for Students Who Passed Each Developmental Math Courses
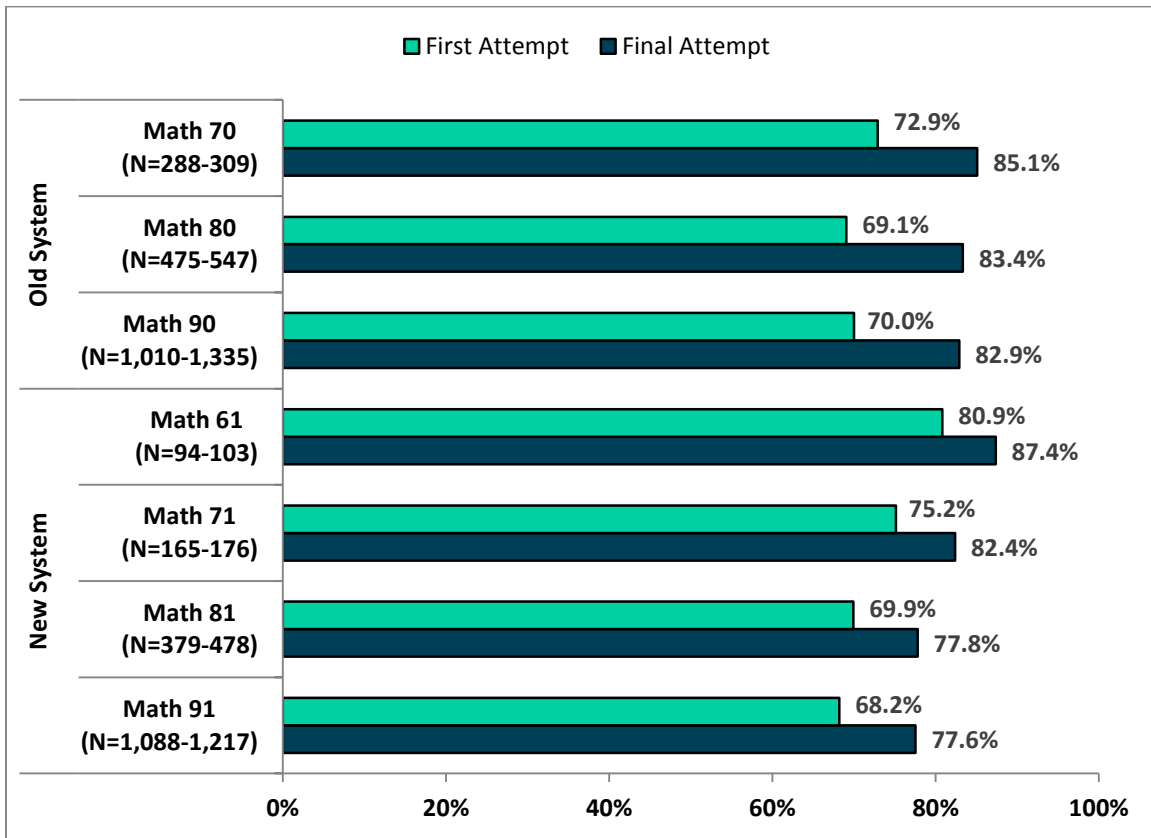

ULTIMATE MATH 119 SUCCESS RATE

Figure 2.2 shows students' success rate in each developmental math course and the ultimate success rate in Math 119 of students who pass that course. Note that, as described in the methodology, the Math 119 success rate measures completion within a fixed period of time, rather than open-ended completion, to ensure that comparisons between old and new courses are not biased by the fact that students taking the old courses had more time to reach and complete Math 119. The figure shows the following:

▪ **The ultimate Math 119 success rate for students who passed the lowest-level developmental math courses (Math 61 and Math 70) is low.** Figure 2.1 shows that if students ultimately do take Math 119, the success rate is not different for students who begin the developmental sequence at a lower level as compared to those who begin at a higher level. However, the percentage of students beginning at a lower level and making it to and succeeding in Math 119 is very low. Out of all the students who passed Math 61, only 8.9 percent ultimately passed Math 119 within two and a half years. For Math 70, the figure was only 5.2 percent. This is lower than the ultimate success rate for students starting from other course levels, indicating that students who start the developmental course at the lowest level may need more support to keep on track while advancing through the course sequence.

- **The success rates for Math 61 and Math 81 are low.** The success rate for Math 61 is 75.8 percent and for Math 81 is 73.6 percent. These are two of the lowest passing rates in the new system. IVC may consider investigating further the reasons for the low pass rates in these two courses.

- **The pass rate for each developmental math course in the new system is higher than the corresponding course in the old system**. The course pass rates are higher in the new system by 5 to 15 percentage points compared with the corresponding rate in the old system.

- **The ultimate Math 119 success rates for students passing each developmental course are also higher in the new system.** Only 5.2 percent of students who passed Math 70 ultimately passed Math 119 within two and a half years, but the corresponding rates for Math 61 and Math 71 were 8.9 percent and 11.8 percent, respectively. The gap in success rates for Math 81 and Math 80 is 7.4 percentage points in favor of the newer course, and it is 4.2 percentage points for Math 91 and Math 90.

Figure 2.2: Ultimate Math 119 Success Rate for Students Passing Each Developmental Course Using the Final Attempts
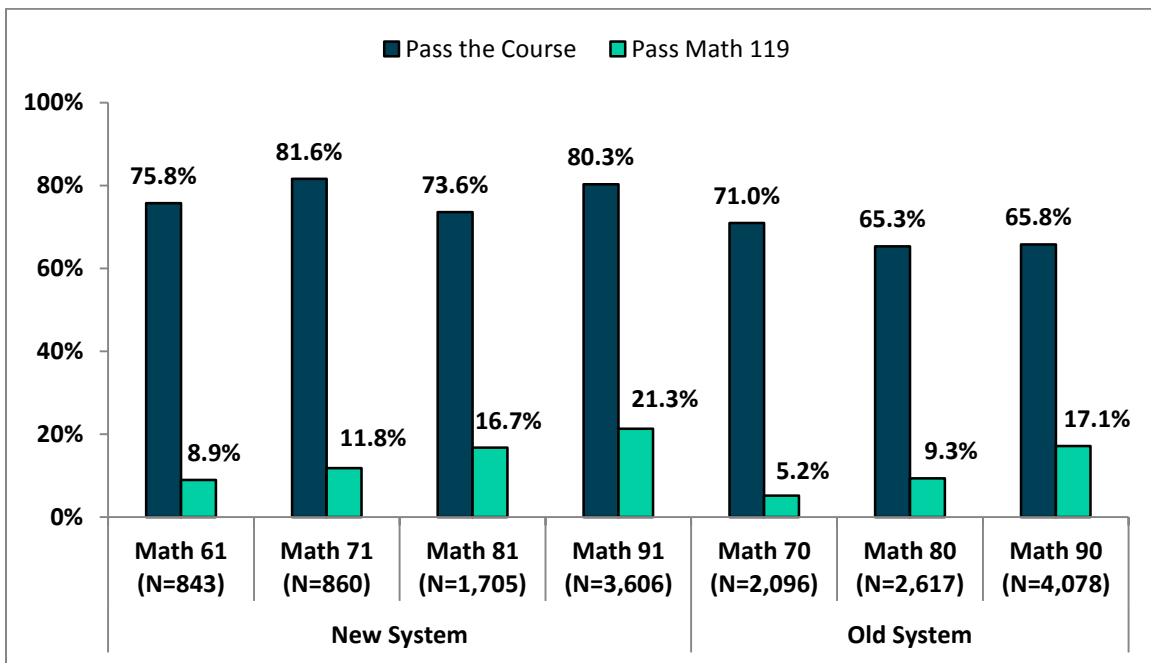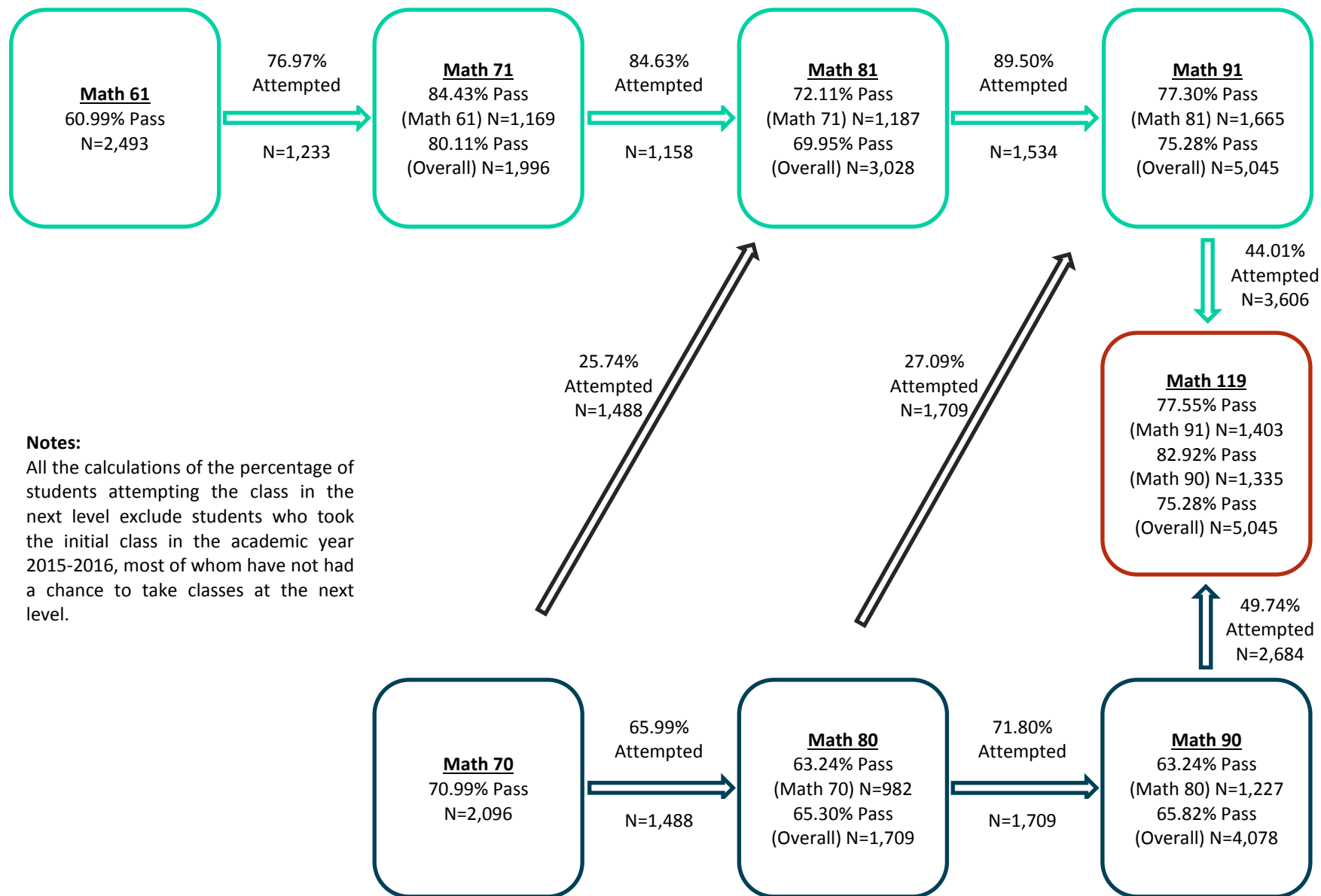
COURSE FLOWCHART FOR DEVELOPMENTAL MATH COURSES

Figure 2.3 shows the passing rates for the developmental math courses at different stages of the course sequence.

- **The pass rates for students in a course who passed the previous course in the sequence are higher than the overall pass rate for that course in the new system.** For students who passed the previous course in the sequence in the new system, the pass rate of the current course is 2.02 to 4.32 percentage points higher than the overall pass rate, indicating that students who successfully complete an earlier developmental course are somewhat more likely to complete the next course than a student who is starting their developmental work in that course.

- **Overall, the new system has higher pass rates than the old system.** The course pass rate is higher overall for each course in the new system. The pass rates for the courses in the old system range from 63.24 percent to 70.99 percent, while the pass rates, excluding Math 61, for the courses in the new system range from 69.95 percent to 84.43 percent.

- **The pass rate for Math 61 is low.** The course pass rate for Math 61 is 60.99 percent. The rate is the lowest among all the courses. This indicates that many students drop out of the developmental math sequence because they fail Math 61, the initial course in the sequence.

- **The rate of students attempting Math 71 after passing Math 61 is low.** After passing Math 61, about one-fourth of students choose not to continue on to Math 71. This indicates that Math 61 is an important stage where many students may make a decision on whether or not to continue the course sequence.

- **The pass rate for Math 81 is also low.** The pass rate for Math 81 is the second lowest rate among the courses in the new system. The overall pass rate is 69.95 percent, and the pass rate for students who pass Math 71 is 72.11 percent. Math 81 may be a second stage in which students are determining whether to continue through the course sequence, if they pass.

- **The attempt rates for Math 119 for students who successfully completed Math 90 and Math 91 are also low.** The attempt rate is 44.01 percent for the Math 91 to Math 119 transition and 49.74 percent for Math 90 to Math 119. This indicates that after passing Math 90 or 91, more than half of students choose not to take Math 119 at IVC.

Figure 2.3: Math Course Success Rates Using Final Attempt Grades

Math 61
60.99% Pass
N=2,493

76.97% Attempted
N=1,233

Math 71
84.43% Pass
(Math 61) N=1,169
80.11% Pass
(Overall) N=1,996

84.63% Attempted
N=1,158

Math 81
72.11% Pass
(Math 71) N=1,187
69.95% Pass
(Overall) N=3,028

89.50% Attempted
N=1,534

Math 91
77.30% Pass
(Math 81) N=1,665
75.28% Pass
(Overall) N=5,045

44.01% Attempted
N=3,606

Math 119
77.55% Pass
(Math 91) N=1,403
82.92% Pass
(Math 90) N=1,335
75.28% Pass
(Overall) N=5,045

25.74% Attempted
N=1,488

27.09% Attempted
N=1,709

49.74% Attempted
N=2,684

Notes:
All the calculations of the percentage of students attempting the class in the next level exclude students who took the initial class in the academic year 2015-2016, most of whom have not had a chance to take classes at the next level.

Math 70
70.99% Pass
N=2,096

65.99% Attempted
N=1,488

Math 80
63.24% Pass
(Math 70) N=982
65.30% Pass
(Overall) N=1,709

71.80% Attempted
N=1,709

Math 90
63.24% Pass
(Math 80) N=1,227
65.82% Pass
(Overall) N=4,078

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