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The Math Placement Tests:
Relationships to Mathematics Course
Performance, Mathematics Course Selection,
and Other Predictors of
Academic Achievement

Report 1991-06

Tracy Thorndike-Christ
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Executive Summary

The Math Placement Tests have been used by all four-year institutions in the state of Washington to aid in the placement of students into their first college-level mathematics course since 1984. This report was prepared in response to concerns of Western Washington University's Mathematics Department regarding the usefulness of the placement tests in correctly placing students in mathematics courses.

The relationships of the math placement tests to final mathematics course grade and other indicators of academic achievement, including high school GPA, WPCT-Q score, and SAT-M score were evaluated. The math placement tests were found to be moderately positively related to final grade and each of the three indicator variables. The math placement tests were not, in most cases, superior to high school GPA and/or WPCT-Q score in prediction of final mathematics course grade.

The percentage of students who passed (earned a grade of C- or better) their mathematics course varied depending on the course in which they enrolled, which placement test they took, and the score they received on the placement test. The probability of receiving a C- or better among those who took the Intermediate Algebra Test ranged from a low of 48.2 percent in Math 103 to a high of 72.4 percent in Math 155. The chance of passing a mathematics course for those who took the Pre-Calculus Test ranged from a low of 63.5 percent in Math 103 to a high of 90.9 in Math 104. In general, the probability of receiving a passing grade increased with higher Math Placement Test scores.

For a number of courses, the current cut-off score on the Intermediate Algebra Test may be too low. Students who enrolled with scores below, at, or slightly above these cut-offs had, in many cases, only a slim chance of passing the course. Conversely, cut-off scores on the Pre-Calculus Test for admission to many courses were too high. Students who had a reasonable chance of passing these courses would be denied admission based on the current cut-off points. It is suggested that the current cut-off scores be re-evaluated and when new cut-offs are decided upon, that they be more strictly adhered to.

Introduction

The Math Placement Tests are currently used by all four-year public universities in the state of Washington to aid in the placement of students in their first college-level mathematics course. The Math Placement Tests replaced the Washington Pre-College Test (WPCT) as an indicator of a student's level of mathematical ability for placement purposes in the fall of 1984. The switch was instigated by the University of Washington, although there was, and still is, some uncertainty regarding the superiority of the Math Placement Tests over the WPCT as predictors of academic achievement as measured by final mathematics course grade. To date, only two of the four-year state institutions utilizing the math placement tests have conducted, and made public, studies of the math placement tests' validity. This study was conducted at the request of Western Washington University's Mathematics Department to help evaluate the usefulness of the Math Placement Tests in correctly placing Western's students into their first mathematics class.

The following report provides a summary of the results of analyses conducted to explore the relationship of the three levels of the Math Placement Test (Basic Algebra, Intermediate Algebra, and Pre-Calculus) with mathematics course selection and final mathematics course grade. Based on the Math Placement Test score, the probability of receiving a passing grade (C- or better) was computed for the majority of mathematics courses that a student may enroll in immediately after taking the Placement Test. The records for a sample of 2332 students who took the Math Placement Test between 1987 and 1990 were obtained from the Student Information Data Base in the University's Registrar office for analysis.

The results are organized according to Math Placement Test level. The range of scores obtained on each test, as well as the mean score earned, are provided followed by the percentages of students who enrolled in different mathematics courses. The relationship of each level of the Math Placement Test to other predictors of academic achievement (including high school GPA, Washington Pre College Test Quantitative [WPCT-Q] score, and SAT-Mathematics [SAT-M] score) are also described.

Due to the overlapping cut-off points of the three levels of the Math Placement Test and the variety of mathematics courses a student may choose to enroll in, two mathematics courses were chosen for the evaluation of the relationship of Math Placement Test score to final mathematics course grade. Math 102 and Math

The Office of Institutional Assessment and Testing would like to acknowledge the participation of Mathematics Department Chairman Thomas Read in the preparation of this report.

124 were selected because a large percentage of students elect to enroll in these courses. Relationships of students' Math Placement Test scores to their grades in these courses and the ability of these scores, and those on other predictor variables, to predict course grade are discussed.

Scores on the Intermediate Algebra Test and the Pre-Calculus Test were grouped into intervals of three for analysis. The percentage of students who enrolled in a course and completed it with a passing grade (C- or better) was computed for each course in which at least 25 members of our sample had enrolled.

Relationship of Placement Test Score to Course Grade and Other Predictors of Academic Achievement

Basic Algebra Test

Only six students in this sample elected to take the Basic Algebra Test. Test scores ranged from 16 to 40, with an average test score of 29.33. Five students enrolled in Math 102 and one enrolled in Math 103.

Intermediate Algebra Test

Of the 2332 students in the overall sample, 1192 took the Intermediate Algebra Test. Students' test scores ranged from 4 to 42, with an average score of 21.73. The majority of these students enrolled in Math 102 (54.9 percent). The percentages of students who enrolled in other mathematics courses were as follows: 7.1 percent in Math 103; 5.4 percent in Math 104; 10.0 percent in Math 105; 0.1 percent in Math 124; 14.6 percent in Math 155; 0.5 percent in Math 156; 7.0 percent in Math 197; 0.2 percent in Math 240; and 0.2 percent in Math 281.

Students who took the Intermediate Algebra Test had WPCT-Q scores ranging from 31 to 77, with an average score of 51.96. Only 563 of these students had SAT-Mathematics scores in their records. The SAT-M scores of those students ranged from 280 to 760, with an average score of 477.80.

Both the WPCT-Q and the SAT-M were moderately positively correlated with the Intermediate Algebra Test. The relationship between a student's Intermediate Algebra Test score and his or her WPCT-Q score was $r = .51$. The relationship between a student's Intermediate Algebra Test score and his or her SAT-M was $r = .60$.

High school grade point averages of students who took the Intermediate Algebra Test ranged from 2.19 to 4.00, with an average high school GPA of 3.27. Scores on the Intermediate Algebra Test had a relatively weak, though statistically

significant, positive relationship with high school GPA ($\bar{r} = .28$).

Students Who Took the Intermediate Algebra Test and Enrolled in Math 102. Of the 1192 students who took the Intermediate Algebra Test, 655 enrolled in Math 102. Course grades, available for 560 of these students, ranged from F (0.00) to A (4.00). Over 75 percent of students who received grades in Math 102 earned a C- or better.

There was a moderate, positive relationship between students' Intermediate Algebra Test scores and their final course grade in Math 102 ($\bar{r} = .36$). This relationship was effectively equivalent to that between high school GPA and final Math 102 grade ($\bar{r} = .37$) and between SAT-M score and final grade ($\bar{r} = .34$). A somewhat weaker relationship was found between the WPCT-Q scores and final Math 102 grades of these students ($\bar{r} = .29$).

Three of the four above-listed variables significantly contributed to the prediction of final Math 102 grade. The strongest predictor was high school GPA which accounted for 20 percent of the variability in final grade. With the addition of WPCT-Q score to the equation, 26 percent of the variability in final Math 102 grade accounted for. Math Placement Test score improved the accuracy of the prediction only slightly. The composite of the three significant predictor variables accounted for 27 percent of the variability in final Math 102.

Students Who Took the Intermediate Algebra Test and Enrolled in Math 124. Of the 1192 students who took the Intermediate Algebra Test, only one enrolled in Math 124. This student received a B out of the course. Correlations between final course grade in Math 124 and math placement test score, WPCT-Q score, and SAT-M score could not be computed because only one student was in this category.

Pre-Calculus Test

Of the students in this sample, 1134 took the Pre-Calculus test. Students test scores ranged from 3 to 40, with an average test score of 21.13. The majority of these students enrolled in either Math 102 (21.3 percent) or in Math 124 (20.8 percent). The percentages of students who enrolled in other mathematics courses were as follows: 6.5 percent in Math 103; 8.7 percent in Math 104; 19.1 percent in Math 105; 0.9 percent in Math 125; 1.4 percent in Math 128; 11.6 percent in Math 155; 5.6 percent in Math 156; 3.7 percent in Math 197; and 0.4 percent in Math 281.

Students who took the Pre-Calculus Test had WPCT-Q scores ranging from 35 to 77, with an average WPCT-Q score of 57.72. Only 521 of the 1134 students who took the Pre-Calculus Test had

SAT-M scores in their records. The scores of these students ranged from 250 to 750, with an average score of 546.45.

The relationship between a student's Pre-Calculus Test score and his or her WPCT-Q score was $r = .55$. The relationship of students' Pre-Calculus Test scores to their SAT-M scores was $r = .61$. Both the SAT-M and WPCT-Q were moderately positively correlated with the Pre-Calculus Math Placement Test.

The high school grade point averages of students who took the Pre-Calculus Test ranged from 2.20 to 4.00, with an average high school GPA of 3.41. Scores on the Pre-Calculus Test had a moderately strong positive relationship to high school GPA ($r = .43$).

Students Who Took the Pre-Calculus Test and Enrolled in Math 102. Of the 1134 students who took the Pre-Calculus Test, 241 enrolled in Math 102. Course grades, available for 233 of these students, ranged from F (0.00) to A (4.00). Over 85 percent of the students who took the Pre-Calculus Test and received grades for Math 102 earned a grade of C- or better.

The relationships of the predictor variables to final Math 102 grade were basically equivalent. High school GPA had a moderately strong relationship with final grade in Math 102 ($r = .48$). The relationship between a student's score on the Pre-Calculus Test and his or her final grade in Math 102 was $r = .46$. The relationship between SAT-M score and final grade was $r = .45$. The WPCT-Q scores and final Math 102 grades of these students were also moderately positively related ($r = .41$).

The best predictor of final Math 102 grade was Math Placement Test score which accounted for 33 percent of the variability in final Math 102 grades. High school GPA improved the accuracy of the prediction substantially. These two variables accounted for 46 percent of the variability in final 102 grade. With the addition of SAT-M score, the composite of these three variables accounted for 55 percent of the variability in final course grade.

Students Who Took the Pre-Calculus Test and Enrolled in Math 124. Of the 1134 students who took the Pre-Calculus Test, 236 enrolled in Math 124. Final course grades were available for 202 of these students. These grades ranged from F (0.00) to A (4.00). Over 93 percent of students who took the Pre-Calculus Test and enrolled in Math 124 received a final course grade of C- or better.

Students' final grades in Math 124 were moderately positively correlated with their scores on the Pre-Calculus Math Placement Test ($r = .37$). The magnitude of this relationship was of a size equivalent to those observed between final course

grade and high school GPA ($r = .32$) and between final course grade and WPCT-Q score ($r = .33$). There was no relationship between a student's SAT-M score and his or her final grade in Math 124.

The only variable that significantly contributed to the prediction of Math 124 final grade was WPCT-Q score. However, WPCT-Q score accounted for only 13 percent of the variability in Math 124 grades.

Probability of Receiving a Passing Grade

Intermediate Algebra Test

Students Who Took the Intermediate Algebra Test and Enrolled in Math 102. Of the 655 students in our sample that took the Intermediate Algebra Test and enrolled in Math 102, 67.5 percent received a passing grade of C- or better. The other 32.5 percent either received a failing grade or withdrew from the course.

Although the cut-off score on the Intermediate Algebra Test for admission into Math 102 is 10, 21 students in our sample enrolled in Math 102 with a lower placement test score. The percentage of these students who passed Math 102 was less than 30 percent. Students who scored between 10 and 12 on this test had only a 36.6 percent chance of passing Math 102. Those who earned scores of 13 to 15 had a 61.4 percent probability of passing Math 102. At this point, the relationship between probability of passing and test score becomes linear. As test scores go up, the probability of passing Math 102 goes up (see Figure 1). The results of this analysis suggest that the current cut-off score of 10 may be too low, resulting in too many students failing to successfully complete the course. A cut-off score in the 13 to 15 point range would result in a more reasonable number of students passing.

Students Who Took the Intermediate Algebra Test and Enrolled in Math 103. Of the 85 students in our sample who took the Intermediate Algebra Test and enrolled in Math 103, only 48.2 percent earned a passing grade of C- or better. More than half (51.8 percent) either received a failing grade or withdrew from the course.

The current cut-off score on the Intermediate Algebra Test for admission into Math 103 is 20. All students who enrolled in Math 103 with a test score lower than 19 failed the course. Only 23.5 percent of students who had a test score between 19 and 21 earned a grade of C- or better. The percentage of those with test scores between 22 and 24 who passed was 53.8 percent. However, students who scored between 25 and 27 had only a 35.7 percent chance of successfully completing the course. At the 28 to 30 score interval, 58.3 percent earned passing grades and at

this point the relationship between probability of passing and test score became linear (see Figure 2). All higher score intervals corresponded with higher probabilities of passing Math 103. The results, although based on a modest sample size, suggest that the cut-off score for Math 103 may also be too low.

Students Who Took the Intermediate Algebra Test and Enrolled in Math 104. Of the 64 students in our sample who took the Intermediate Algebra Test and enrolled in Math 104, 60.9 percent of them earned a passing grade. The other 39.1 percent either failed the course or withdrew.

Approximately two-thirds of the students who earned scores between 22 and 24 or between 25 and 27 on the Intermediate algebra Test (66.7 percent and 67.9 percent respectively) and enrolled in Math 104 passed the course. For those who earned scores of the 28 and higher, the percentage who passed Math 104 was about 50 percent (see Figure 3).

Students Who Took the Intermediate Algebra Test and Enrolled in Math 105. Of the 119 students who took the Intermediate Algebra Test and enrolled in Math 105, 67.5 percent received passing grades. The other 32.8 percent either failed the course or withdrew.

The current cut-off score on the Intermediate Algebra Test for admission into Math 105 is 27. Students who scored between 25 and 27 had a 68.8 percent chance of successfully completing this course. Of those who scored between 28 and 30, 55.9 percent received passing grades. Over two-thirds of those who scored between 31 and 33 (68.8 percent) earned grades of C- or better. From this point, as test scores increased, so did the probability of passing Math 105 (see Figure 4).

Students Who Took the Intermediate Algebra Test and Enrolled in Math 155. Of the 174 students who took the Intermediate Algebra Test and enrolled in Math 155, 72.4 percent earned passing grades of C- or better. The other 27.6 percent either failed the course or withdrew.

Students who scored at the current cut-off score on the Intermediate algebra Test (20) had only a 40 percent chance of passing Math 155. Of those who scored in the 22 to 24 interval, 61.9 percent passed the course. For all scores higher than this, the percentage of students who received passing grades went up as placement test score went up (see Figure 5). The low passing rate among students who scored less than 22 on the placement test suggests that the cut-off score currently may be too low.

Students Who Took the Intermediate Algebra Test and Enrolled in Math 197. Of the 84 students in our sample who took the Intermediate Algebra Test and enrolled in Math 197, 56.0 percent

received passing grades. The other 44.0 percent either received failing grades or withdrew from the course.

Students with test scores between 19 and 21 had a 45.5 percent chance of passing Math 197. Those scoring between 22 and 24 were somewhat more successful (59.5 percent passing). Only 40 percent of those with scores between 25 and 27 passed the course. The probability of students who scored 28 or higher on the Intermediate Algebra Test passing Math 197 was very good (83.3 percent and up). These results suggest that students with an Intermediate Algebra test score of less than 28 should be advised to register for a lower level course (see Figure 6).

Pre-Calculus Test

Students Who Took the Pre-Calculus Test and Enrolled in Math 102. Of the 241 students in this sample who took the Pre-Calculus test and enrolled in Math 102, 84.6 percent earned passing grades for the course. The remaining 15.4 percent either failed the course or withdrew.

Students who earned placement test scores between 4 and 6 had a 70.4 percent chance of passing Math 102. The probability of successfully completing Math 102 increased as students' scores increased. All students who scored 16 points or more passed Math 102 (see Figure 7). The cut-off score on the Pre-Calculus test for admission into Math 102 is 6. This score seems higher than necessary since students with a Pre-Calculus test score of 4 and higher have a high probability of success in this course.

Students Who Took the Pre-Calculus Test and Enrolled in Math 103. Of the 74 students who took the Pre-Calculus Test and enrolled in Math 103, 63.5 percent passed the course with a grade of C- or better. The other 36.5 percent either withdrew from or failed the course.

Students who scored between 7 and 9 on the Pre-Calculus test had a 33.3 percent chance of successfully completing Math 103. Of those who scored between 10 and 12, 62.5 percent earned grades of C- or better. The vast majority of students who took the Pre-Calculus test and enrolled in Math 103 scored between 10 and 21 on the test. Approximately two-thirds of students in each score interval passed the course. This percentage did not go up as scores increased (see Figure 8). Currently the cut-off for admission into Math 103 is a score of 12. This cut-off appears to be at an optimal point.

Students Who Took the Pre-Calculus Test and Enrolled in Math 104. Of the 99 students in this sample who took the Pre-Calculus test and enrolled in Math 104, 90.9 percent of them earned grades of C- or better. Only 9.1 percent withdrew from or failed the course.

Students who scored above 7 on the Pre-Calculus test had at least a 66.7 percent chance of passing Math 104. All students who scored 22 points or above passed the course (see Figure 9). The cut-off score on the Pre-Calculus test for admission into Math 104 is 17. This cut-off may be too high, since students scoring as low as 7 points have a reasonable chance of successfully completing this course.

Students Who Took the Pre-Calculus Test and Enrolled in Math 105. Of the 217 students in this sample who took the Pre-Calculus test and enrolled in Math 105, 70.3 percent passed the course. The other 20.7 percent either failed the course or withdrew.

Students who scored 10 or better on the Pre-Calculus test had at least a 60 percent chance of passing Math 105. Those who received higher scores had an increased probability of earning a C- or better (see Figure 10).

The cut-off score on the Pre-Calculus test for admission into Math 105 is currently set at 21. Three students in this sample were admitted into Math 105 with placement test scores between 4 and 6. Only one of these students passed the course. Another 75 students in this sample who were admitted to the course with a placement test score higher than 6 and lower than 21. Over two-thirds of these students passed the course. Given this, the current cut-off score of 21 is probably too high.

Students Who Took the Pre-Calculus Test and Enrolled in Math 124. Of the 236 students who took the Pre-Calculus test and enrolled in Math 124, 80.1 percent passed the course with a C- or better. The remaining 19.9 percent either withdrew from the course or received a final grade of less than C-.

Over 50 percent of the students who scored less than 25 on the Pre-Calculus test failed Math 124. Those who scored between 25 and 27 had a 64.9 percent chance of passing this course. Students who earned scores higher than 27 had an increasingly better chance of passing Math 124 (see Figure 11).

The current cut-off score on the Pre-Calculus test for admission into Math 124 is 25. Based on this sample, this is an appropriate score to use as a criterion for admission to this course.

Students Who Took the Pre-Calculus Test and Enrolled in Math 155. Of the 131 students who took the Pre-Calculus test and enrolled in Math 155, 84.7 percent earned grades of C- or better. The remaining 15.3 percent either received a grade of less than C- or withdrew from the course.

The majority of students who earned a Pre-Calculus test score above 10 passed Math 155. Those who scored between 13 and 15 had a 68.2 percent chance of passing the course. For those who scored higher than 15, the probability of passing increased with higher scores. No fewer than two-thirds of the students in any given score interval passed the course (see Figure 12).

Students Who Took the Pre-Calculus Test and Enrolled in Math 156. Of the 63 students in this sample who took the Pre-Calculus test and enrolled in Math 156, 76.2 percent passed the course. The other 23.8 percent either withdrew or received a grade less than C-.

Students who scored between 22 and 24 on the Pre-Calculus test had a 60 percent chance of receiving a C- or better out of Math 156. The relationship between placement test score and probability of passing Math 156 was not linear, but students who earned scores higher than 24 had at least a 66.7 percent chance of passing the course (see Figure 13).

The current cut-off score for admission into Math 156 is 23. The probability of passing Math 156 with this score is 60 percent. This percentage is perhaps a little lower than is desirable, but is probably within the range that is considered acceptable by the Mathematics department.

Students Who Took the Pre-Calculus Test and Enrolled in Math 197. Of the 42 students who took the Pre-Calculus test and enrolled in Math 197, 76.2 percent passed the course with a grade of C- or better. The other 23.8 percent either failed the course or withdrew.

Students who scored between 13 and 15 on the Pre-Calculus test had a 63.2 percent chance of passing Math 197. All students who scored above a 22 earned grades of C- or better out of this course (see Figure 14).

Discussion

In response to a request made by Western Washington University's Mathematics Department, the ability of the math placement tests to correctly place students in their first mathematics course at Western was investigated. In addition, the usefulness of the math placement tests for predicting both final mathematics course grade and probability of passing a given mathematics course were evaluated.

Math placement test scores on both the Intermediate Algebra Test and the Pre-Calculus Test were moderately positively correlated with the other indicators of academic performance used in this study (high school GPA, SAT-M score, and WCPT-Q score)

and with final course grade in Math 102 and Math 124. The usefulness of the math placement tests as predictors of final mathematics course grades varied depending on which test the student took and which course he or she enrolled in. For students who took the Intermediate Algebra Test and enrolled in Math 102, placement test score only slightly improved the prediction of final Math 102 grade once high school GPA and WPCT-Q scores were considered. A student's Pre-Calculus Test score was the best predictor of his or her performance in Math 102 among those who took the Pre-Calculus Test prior to enrolling in Math 102. However, for students who took the Pre-Calculus Test and then enrolled in Math 124, the placement test score did not aid in prediction of the final grade. The math placement tests were not, in most cases, superior to other indicators of academic achievement in prediction of final course grade.

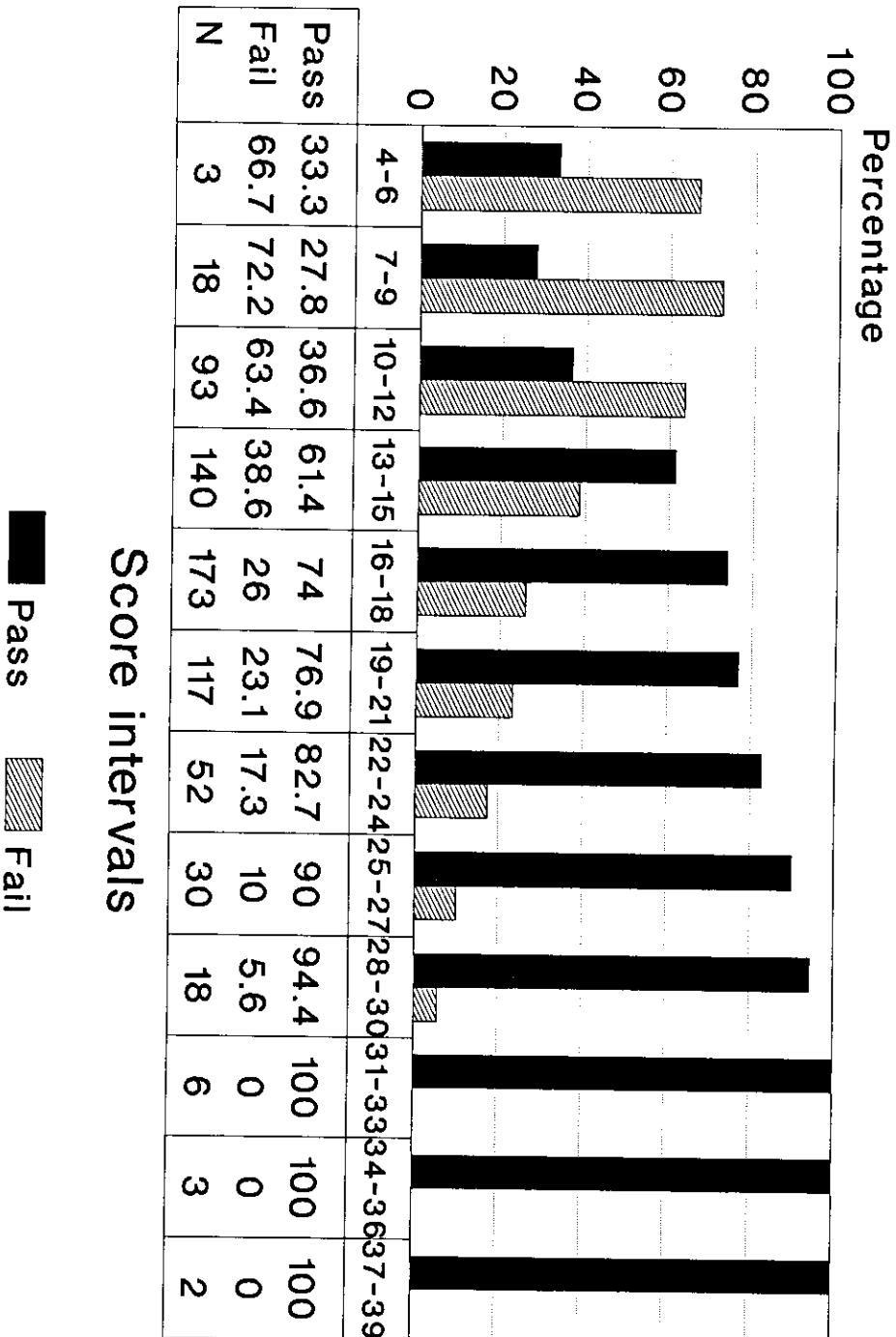
Another way of looking at the ability of the math placement tests to correctly place students in mathematics courses is the probability a student has of passing the course they enroll in. The percentage of students who earned passing grades varied depending on the course in which they enrolled, which math placement test they took, and the score they received on the placement test. Probability of receiving a C- or better among those who took the Intermediate Algebra Test ranged from a low of 48.2 percent in Math 103 to a high of 72.4 percent in Math 155. The chance of passing a mathematics course for those who took the Pre-Calculus test ranged from a low of 63.5 percent in Math 103 to a high of 90.9 percent in Math 104. In general, the probability of receiving a passing grade (C- or better) out of a given mathematics course increased with higher Math Placement Test scores.

Overall, students who took the Pre-Calculus test had a higher probability of passing a given mathematics course than those who took the Intermediate Algebra test. One reason for this may be that, for a number of courses, the current cut-off score on the Intermediate Algebra Test is too low. This allows students who have only a slight possibility of passing a given course to enroll in it. Conversely, the cut-off scores on the Pre-Calculus test for admission to many courses are too high. In a number of cases, students with scores lower than the current Pre-Calculus cut-off had a reasonable chance of earning a grade of C- or better out of their mathematics course.

The high failure rate in a number of courses can be partially explained by the possible misplacement of test score cut-off points for admission to those classes. However, in addition to incorrectly placed cut-off scores, many students are being allowed to enroll in courses with scores below the recognized cut-off point. In the case of the Intermediate Algebra test, these students are very likely to fail the course they enroll in.

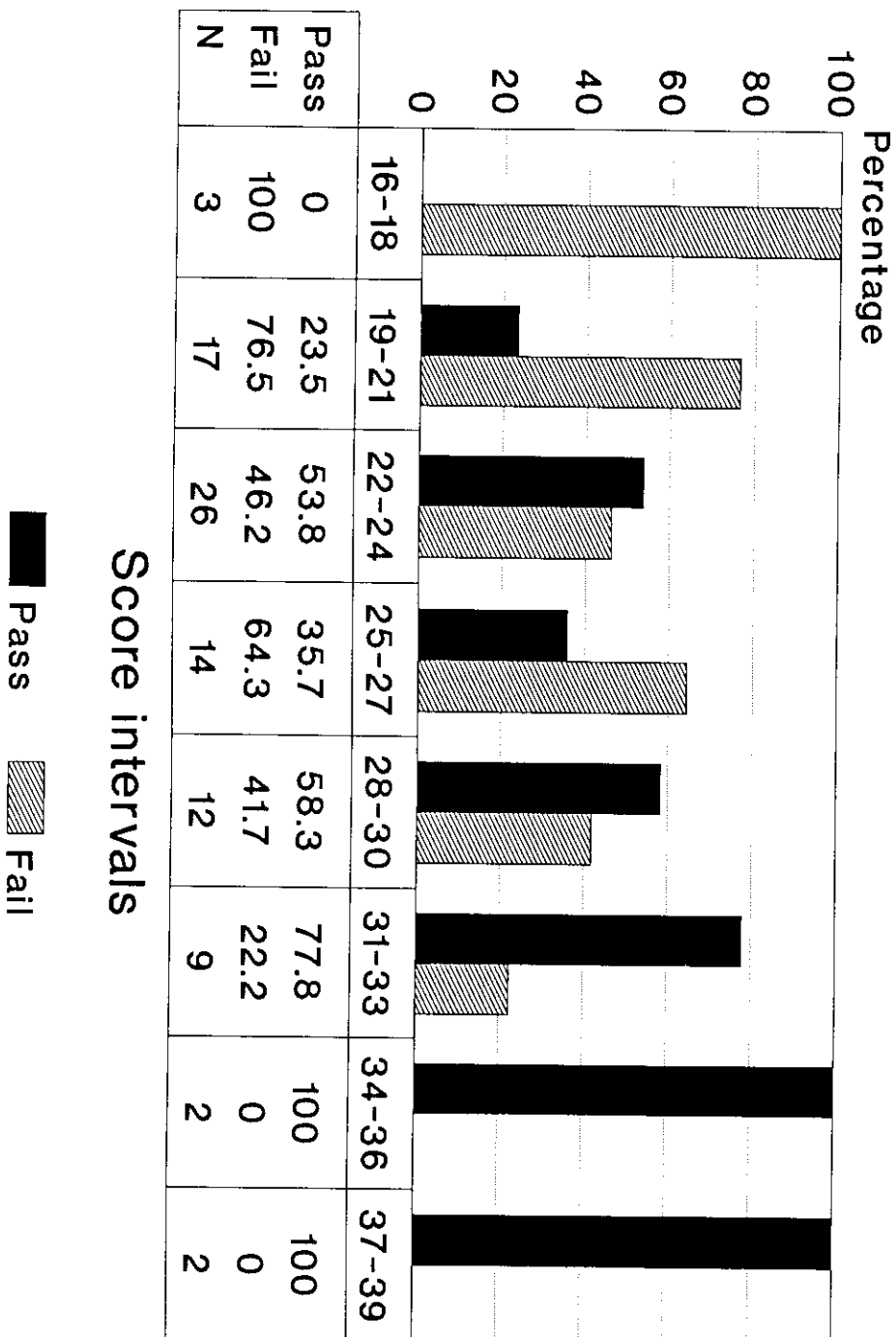
These results suggest that the math placement tests do not, in most cases, significantly improve the prediction of final mathematics course grade over other indicators of academic achievement already in a student's records. High school GPA and/or WPCT-Q score were superior to math placement test scores in the prediction of final course grade in all but one of the courses evaluated. While the placement tests could be used to help correctly place students in mathematics courses, the current cut-off scores for admission to the majority of mathematics courses were either too high (preventing students who would be successful from enrolling) or too low (allowing students with little chance for success to enroll in the course). In addition, a large number of students were allowed to enroll in courses even though they did not meet the cut-off score required for admission. If use of the placement tests is to continue, it is suggested that current cut-off scores be re-evaluated and when new cut-offs are decided upon, that they be more strictly adhered to.

FIGURE 1 : INTERMEDIATE ALGEBRA TEST
Test score intervals and course # 102



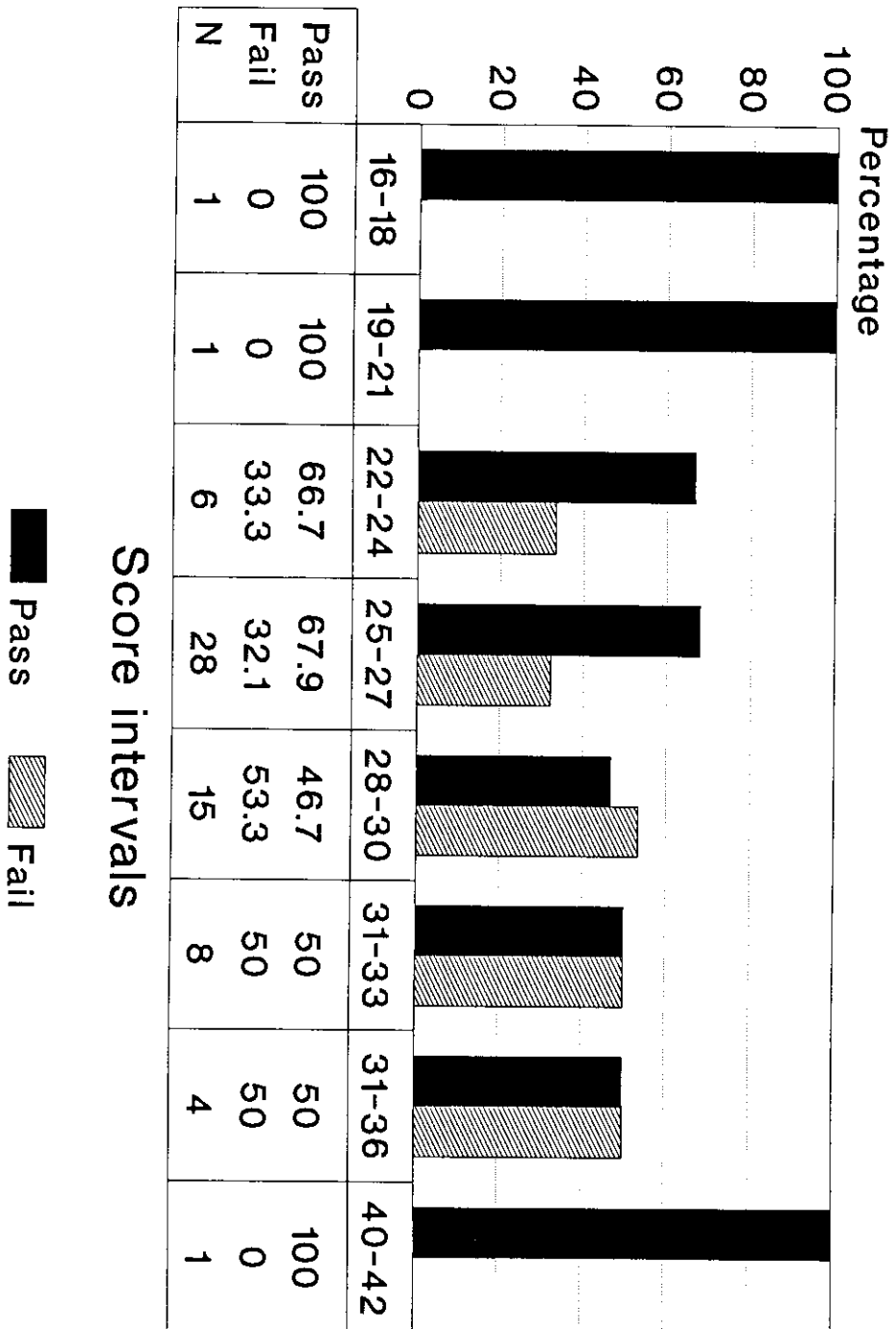
*current cut-off score is 10

**FIGURE 2 : INTERMEDIATE ALGEBRA TEST
Test score intervals and course # 103**



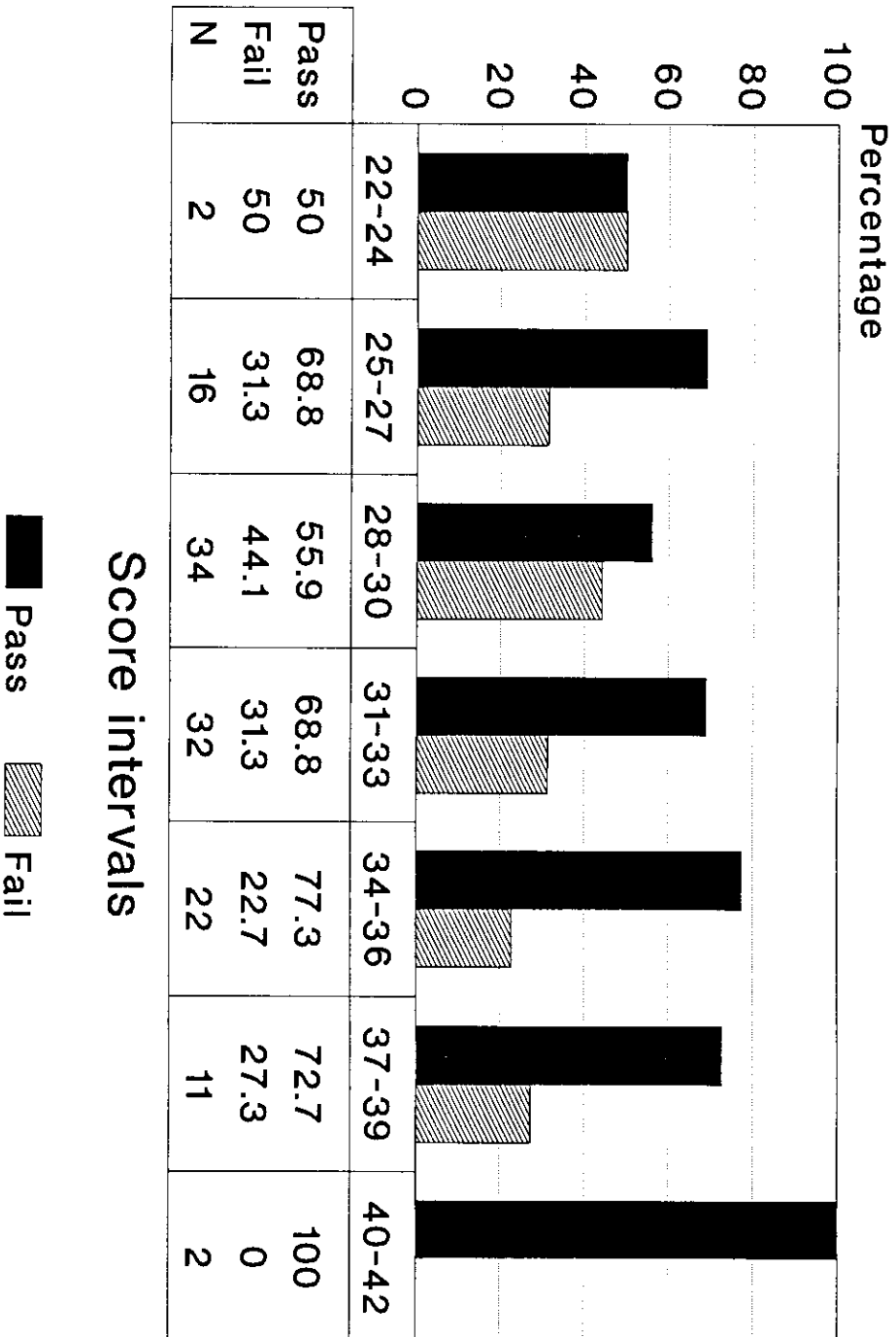
*current cut-off score is 20

FIGURE 3 : INTERMEDIATE ALGEBRA TEST
Test score intervals and course # 104



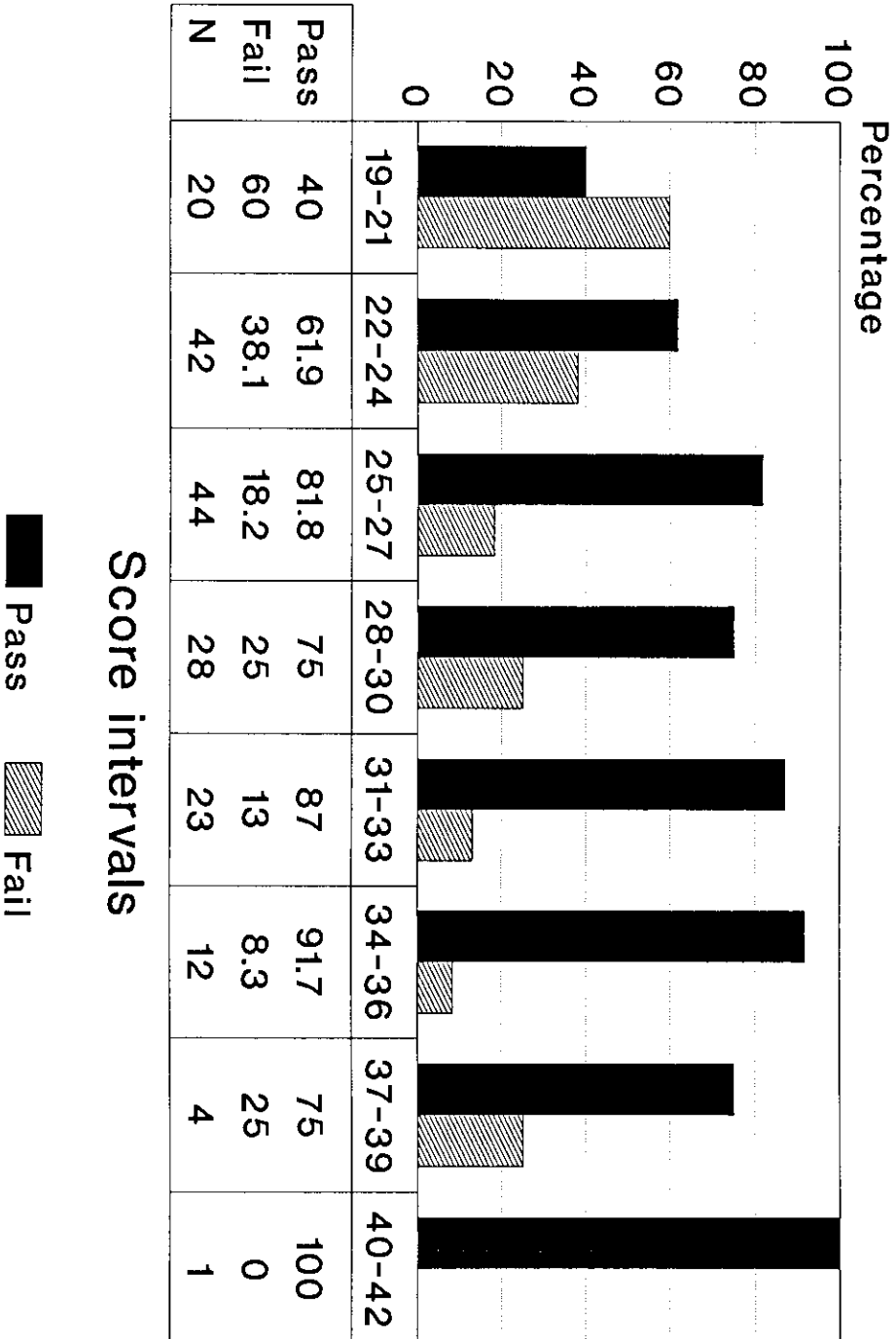
*current cut-off score is 24

FIGURE 4 : INTERMEDIATE ALGEBRA TEST
Test score intervals and course # 105



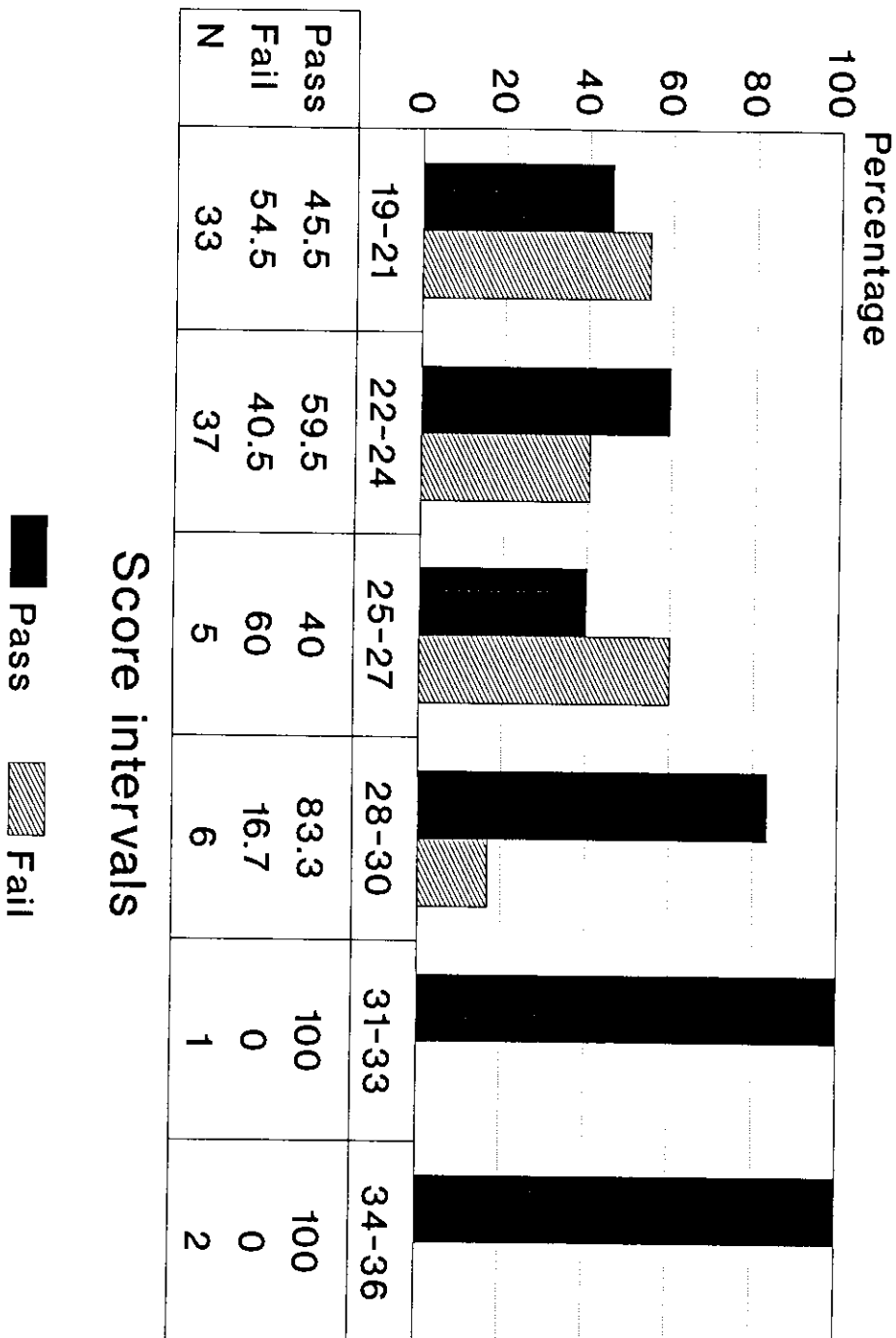
*current cut-off score is 27

FIGURE 5 : INTERMEDIATE ALGEBRA TEST
Test score intervals and course # 155



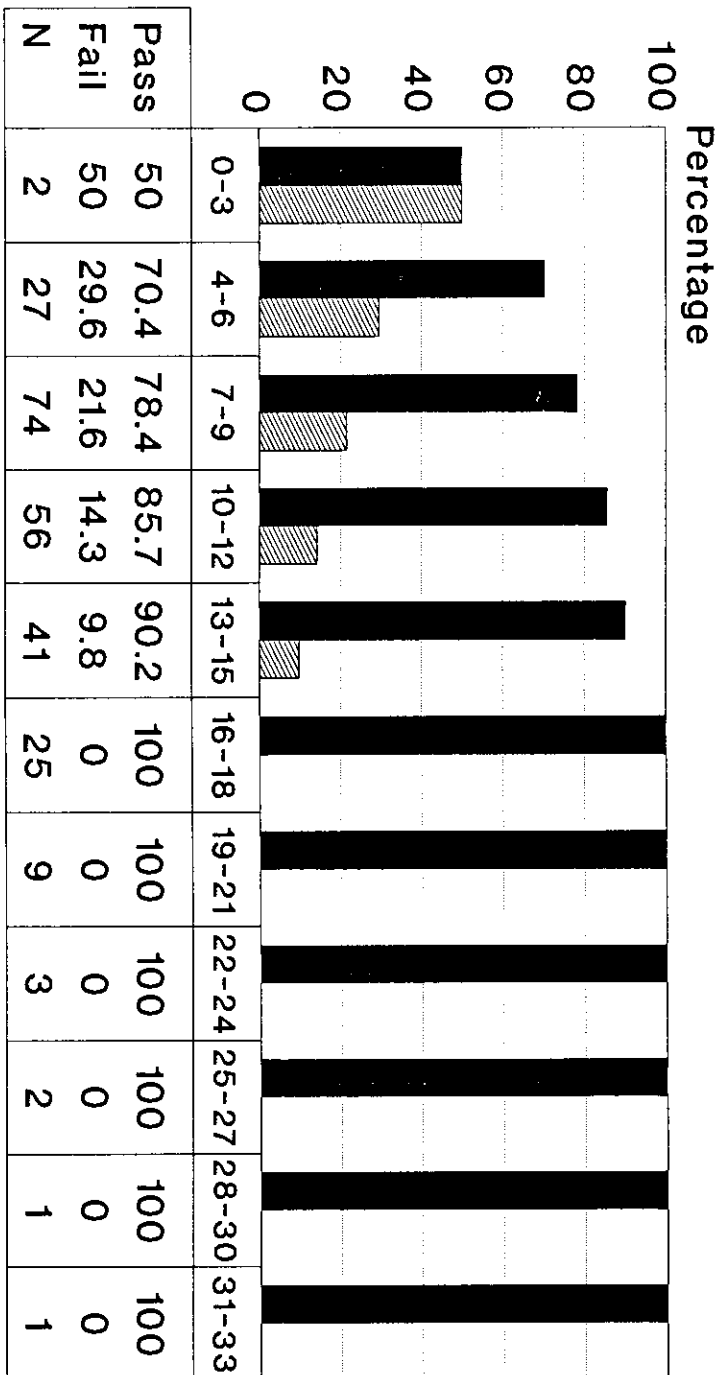
*current cut-off score is 20

FIGURE 6 : INTERMEDIATE ALGEBRA TEST
Test score intervals and course # 197a



*current cut-off score is 20

FIGURE 7 : PRE-CALCULUS TEST Test score intervals and course # 102

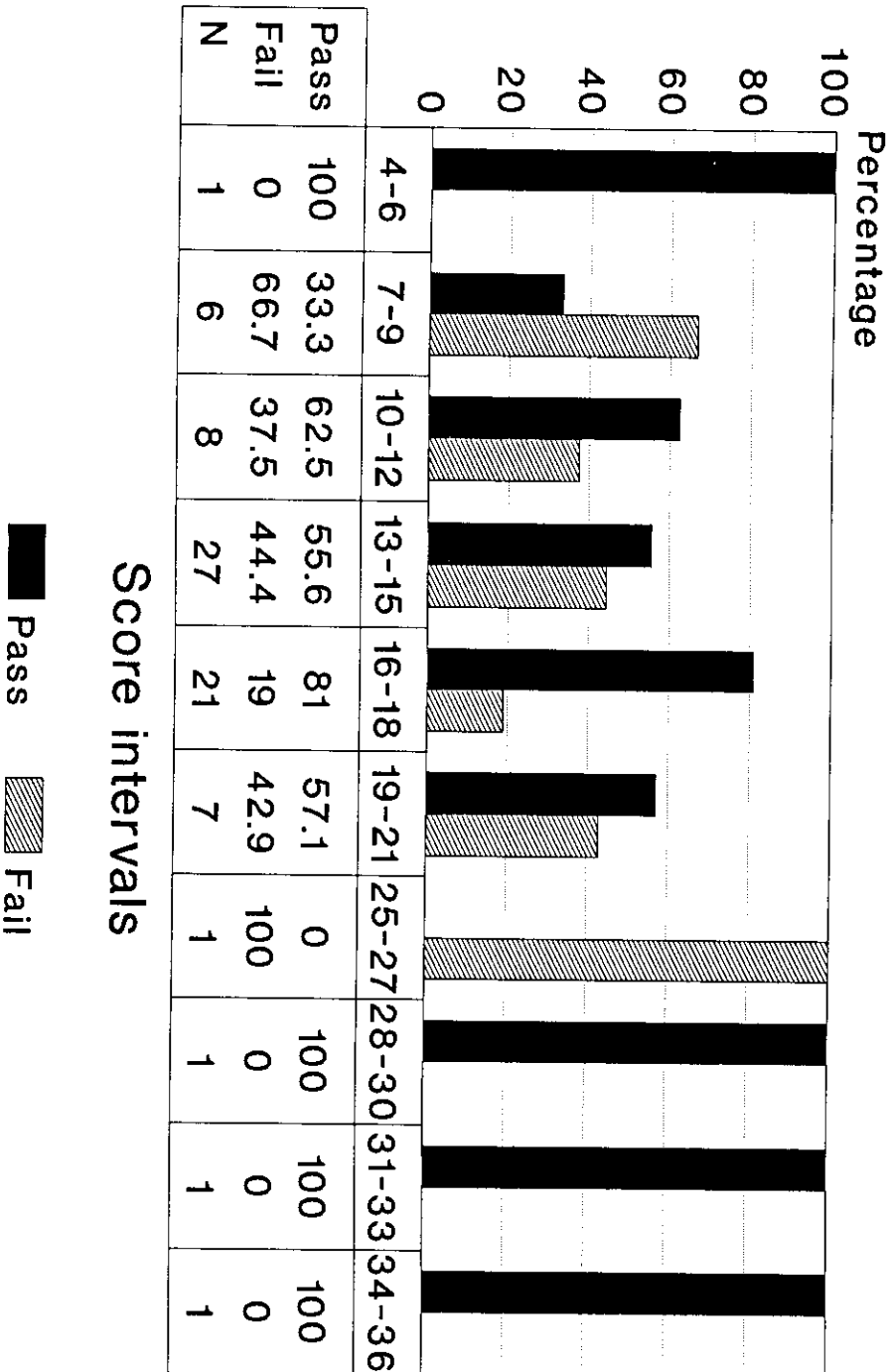


Score intervals

Pass Fail

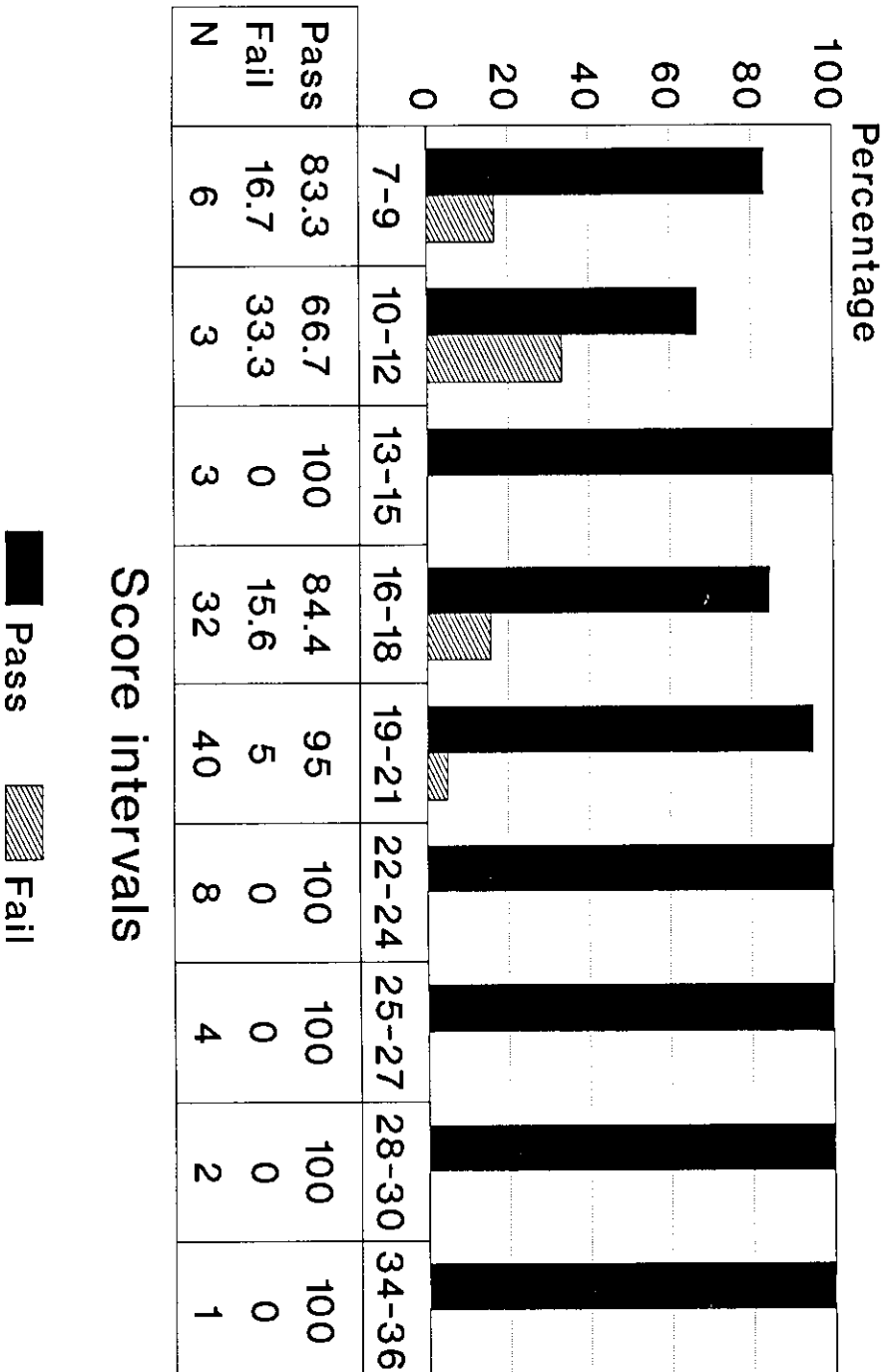
*current cut-off score is 6

FIGURE 8 : PRE-CALCULUS TEST Test score intervals and course # 103



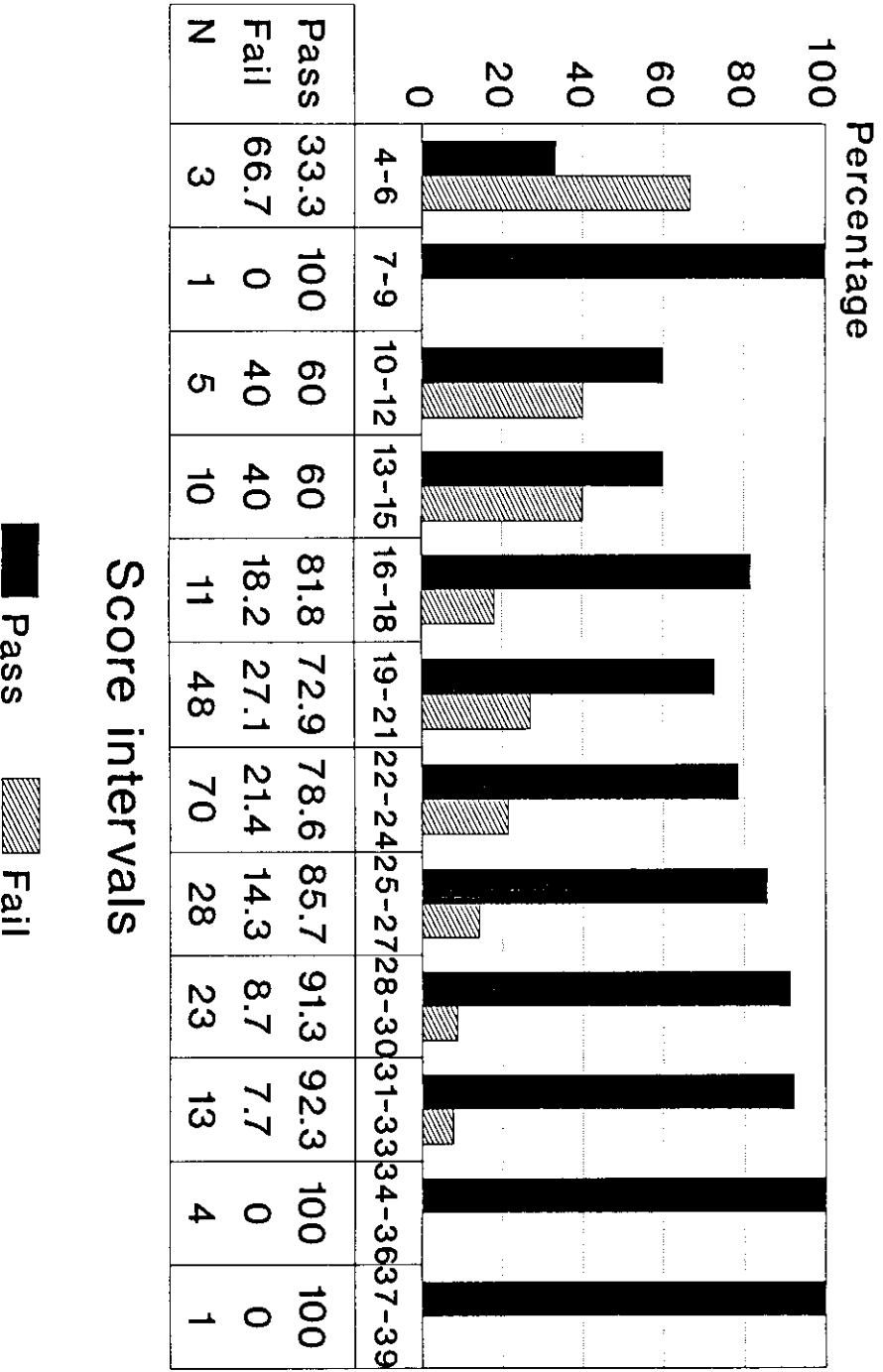
*current cut-off score is 12

FIGURE 9 : PRE-CALCULUS TEST Test score intervals and course # 104



*current cut-off score is 17

FIGURE 10 : PRE-CALCULUS TEST Test score intervals and course # 105

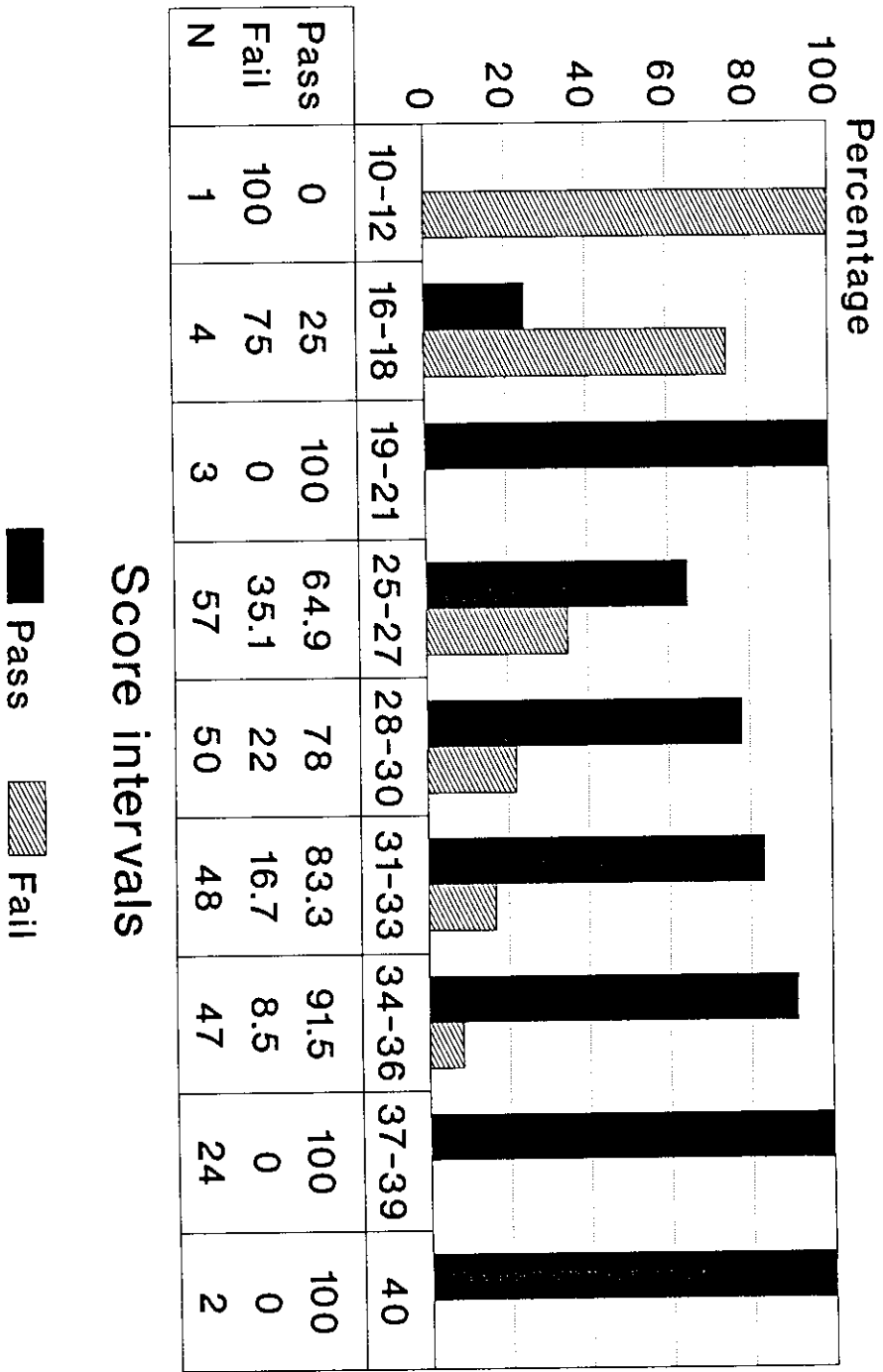


Score intervals

Pass Fail

*current cut-off score is 21

FIGURE 11 : PRE-CALCULUS TEST Test score intervals and course # 124

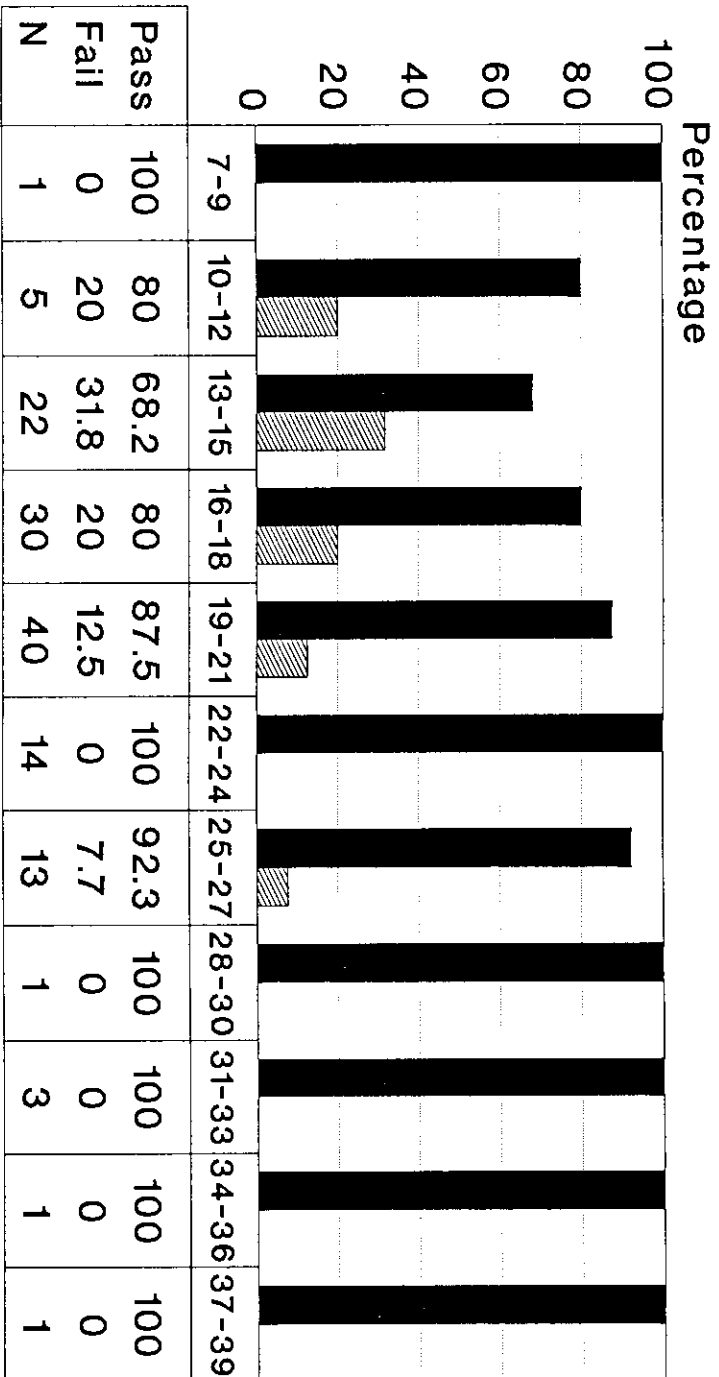


Score intervals

Pass Fail

*current cut-off score is 25

**FIGURE 12 : PRE-CALCULUS TEST
Test score intervals and course # 155**

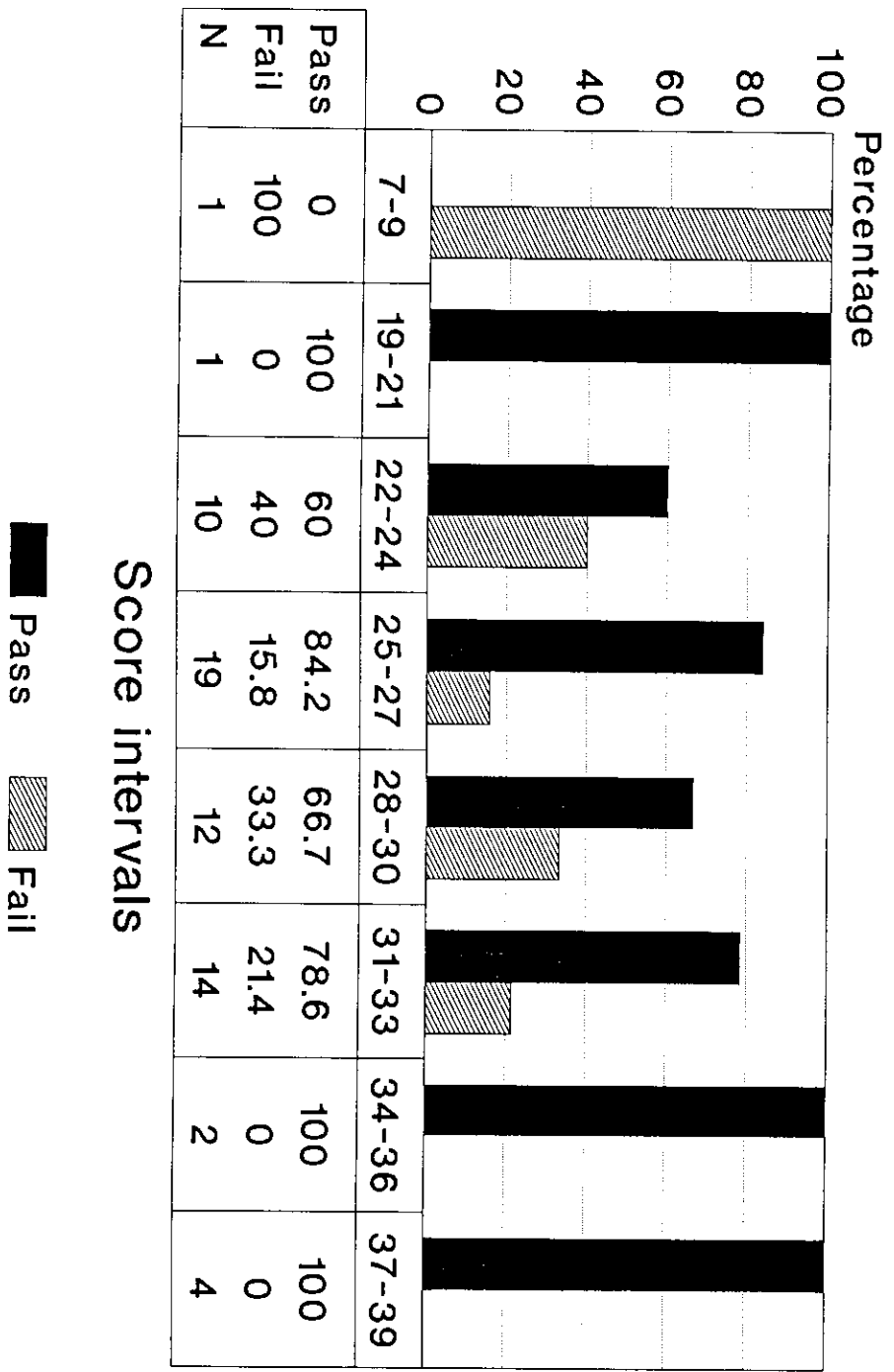


Score intervals

Pass Fail

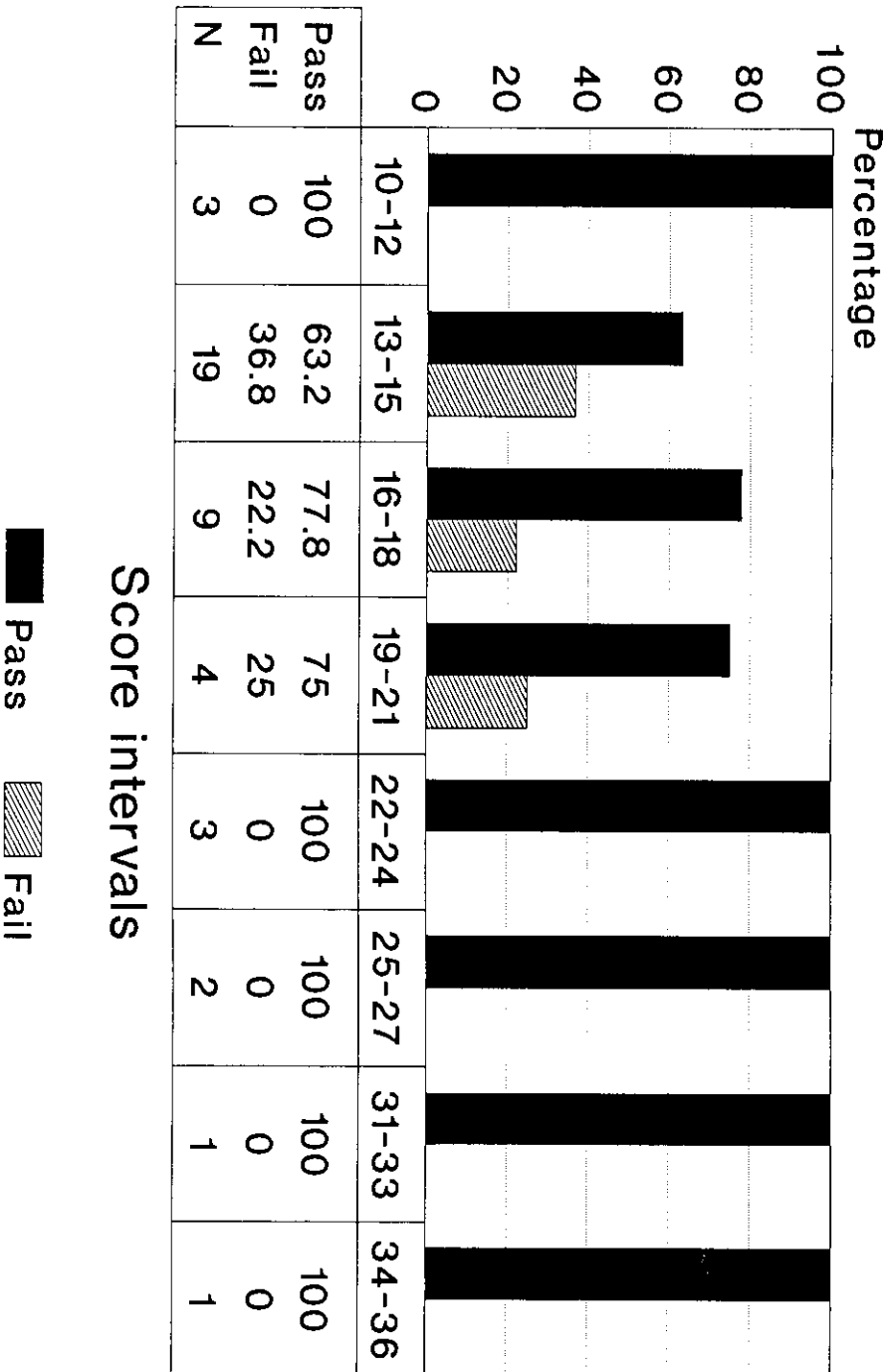
*current cut-off score is 12

FIGURE 13 : PRE-CALCULUS TEST Test score intervals and course # 156



*current cut-off score is 23

**FIGURE 14 : PRE-CALCULUS TEST
Test score intervals and course # 197a**



*current cut-off score is 12