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APPENDIXES
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Using High School and College Data to Predict Teacher Candidates' Performance on the Praxis at Unibetsedåt Guåhan (University of Guam)

See https://go.usa.gov/x6s2w for the full report.

Appendix A. Unibetsedåt Guåhan (University of Guam) admissions requirements and research on the Praxis Core test

This appendix first describes the requirements for prospective K–12 teacher candidates to gain admission to the Unibetsedåt Guåhan (University of Guam, UOG) School of Education prior to fall 2018. It then briefly summarizes research on the Praxis Core test, a key admissions requirement. The last section explains the findings from Santos (2020), a qualitative study that conducted focus groups with UOG students to learn how they prepared for the test.

Unibetsedåt Guåhan School of Education admissions requirements

Between fall 2012 and fall 2017 the School of Education had four admissions requirements for its teacher preparation program: completing at least 54 credit hours in specified courses, passing the Praxis Core test, earning a cumulative grade point average of 2.7 or higher, and submitting a signed waiver for review of all academic records. According to the School of Education admissions website (Unibetsedåt Guåhan, 2019), the 54 credit hours that students needed to complete before applying to the School of Education included:[1]

- Pedagogy: ED 110 (Introduction to Teaching) or equivalent, ED 192 (Practicum: Observation and Participation), and ED 201 (Human Growth and Development).
- English: EN 110 (first-year English), EN 111 (Writing for Research), and CO 210 (Fundamentals of Communication).
- Math: MA 110 (Basic Mathematical Applications), MA 115 (Introductory College Algebra), MA 150 (Mathematics for Elementary School Teachers), MA 161A (College Algebra), or MA 165 (Precalculus).

The School of Education currently accepts scores on either Praxis I or the Praxis Core test for admission. Prior to 2014 candidates for the School of Education were required to take the Praxis I, or the preprofessional skills test. The Praxis I has been phased out and replaced with the Praxis Core Academic Skills for Educators (the Praxis

[1] Other required courses include General Psychology and one science course; recommended courses include Culture and Education in Guam, History of Guam, History of Micronesia, Natural History of Guam, and State and Territorial Government.

Core test), which consists of reading, writing, and math subtests. The required subtest scores are 156 for reading, 162 for writing, and 150 for math. The Praxis Core test is currently required for admission to the School of Education.

Research on the Praxis Core test

Existing research on the Praxis Core test corroborates what much of the research on higher education assessments finds: outcomes on the standardized assessment (in this case, the Praxis Core test) are positively correlated with ACT scores (Hall & West, 2011), SAT scores (Blue et al., 2002; Pool et al., 2004), and undergraduate grade point average (Tyler, 2011). Another study focusing on supporting teacher candidates found that students who take the Praxis Core test earlier in their college career have a higher pass rate (Tyler, 2011). While these findings might apply to students on Guåhan, they do not provide the support needed to answer the questions this study addresses (which student demographic and academic preparation characteristics predict passing the Praxis Core test).

The Praxis Core test consists of three subtests in reading, writing, and math. Topics on the reading subtest include key ideas and details; craft, structure, and language skills; and integration of knowledge and ideas. The writing subtest focuses on argumentative writing and informative/explanatory writing. The math subtest covers numbers and quantities, algebra, geometry, statistics, probability, and data and interpretation.

The current research on whether some student groups perform better (or worse) on the Praxis Core test is limited. In particular, Harris (2015) found that 55 percent of White test takers, 35 percent of Hispanic test takers, and 22 percent of Black test takers passed the math subtest on the first attempt, indicating differential pass rates by race/ethnicity. The current study focuses on different racial/ethnic groups because the UOG student body is 48 percent Pacific Islander and 44 percent Asian (Unibetsedåt Guåhan, 2018). Furthermore, the Praxis Core test's technical manual does not provide a category for Pacific Islanders (ETS, 2020), so it is unclear whether this group performs better or worse than others.

This also is the first study to look at student academic background as a factor in passing the Praxis Core test. By better understanding which courses might lead to higher performance on the test, secondary and postsecondary schools might have more opportunities to prepare students interested in education careers. High school and college educators might also be able to identify students who are interested in becoming teachers but have poorer academic preparation and provide them targeted academic support or intervention.

Praxis Core test preparation: A qualitative study

A qualitative study conducted by UOG faculty listened to student perspectives on how they prepared for the Praxis Core test and how the university could support them (Santos, 2020). To understand the factors students considered helpful, the study interviewed 11 students who passed the test.[2] Overall, interviewees agreed that the test allowed them to demonstrate basic knowledge in reading, writing, and math considered essential to entering the teaching profession. Some interviewees who had taken Advanced Placement or honors courses in high school said the reading and writing required in those courses prepared them for the Praxis Core test.

Interviewees discussed what they had done to prepare for the test. Preparation time varied, with some preparing for a whole semester and others spending only about two weeks actively studying. Other interviewees said they purchased study resources, sought tutoring, and talked with friends who were familiar with the test. Some interviewees took at least one Praxis subtest more than once, and they often studied for a subtest more purposefully after they failed their first attempt.

[2] UOG faculty are aware that some students do not pass the Praxis Core test. However, for the purposes of the qualitative study, they wanted to focus on students who had passed.

The interviewees had attempted the Praxis subtests anywhere from a combined three times (that is, passing all three subtests on the first attempt) to a total of 18 attempts. When UOG faculty asked why students took the subtests multiple times, several interviewees indicated an unwillingness to give up on their dream of becoming a teacher. Interviewees commented that it was important to them to make a difference in students' lives, reinforcing these individuals' interest in and willingness to persist in pursuing their passion of teaching.

Interviewees also had an opportunity to provide recommendations and suggestions on how the School of Education faculty and staff could better support students in preparing for the Praxis Core. A summary of their suggestions is in box A1.

This qualitative study complements the current study, which focuses on demographic and academic characteristics that predict success on the Praxis Core test and its individual subtests.

Box A1. Interviewees' suggestions for Unibetsedåt Guåhan to help them prepare for the Praxis Core test

- Create study groups and have study guides on hand.
- Offer a test or course so students can figure out their strengths and weaknesses as a test taker and use this knowledge to study for the tests.
- Create an organized group of students who have already taken the Praxis Core test to mentor students preparing to take it.
- Provide financial support.
- Have professors communicate about it in classes.
- Provide Praxis Core Made Easy books. Buy practice books.
- Offer a course specific to the Praxis Core test.[1]

Note

1. The UOG math department and the School of Education created a math course called Mathematics for Elementary School Teachers. The course covered much of the content that elementary educators need and included a component on geometry, which was missing from the math content at the university but was needed for the Praxis math subtest.

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Appendix B. Methods

This appendix provides further details on the study's data sources, variables, sample, missing data, and analytic methods.

Data sources

The Guåhan Department of Education (GDOE) and Unibetsedåt Guåhan (University of Guam, UOG) provided data for the study. GDOE provided students' primary language spoken at home, high school course grades, high school course attendance, and high school graduation date. UOG provided demographic data (semester/term start date, gender, race/ethnicity, and Pell Grant status), high school from which students graduated, cumulative high school grade point average, college course grades, and Praxis Core test results (whether students passed or failed, date of test, and the name of the subtest).

Variables

Student demographic characteristics. The analyses for research question 2 on which demographic and high school academic preparation characteristics of students who graduated from a Guåhan public high school predict prospective teacher candidates passing the Praxis Core test and each of its subtests included the following student demographic variables:

- *High school graduation cohort.* The year a student graduated from high school. The study included six cohorts that consisted of students who graduated in spring of each of the following years: 2012, 2013, 2014, 2015, 2016, and 2017.
- *High school attended.* The name of the Guåhan public high school from which the student graduated. High schools included were George Washington High School, John F. Kennedy High School, Okkodo High School, Simon Sanchez High School, Southern High School, and Tiyan High School.
- *Gender.* Whether a student is identified as male or female.
- *Race/ethnicity.* The race/ethnicity that a student is identified as: CHamoru, Filipino, or other (White Non-Hispanic, Black, Hispanic, Chinese, Korean, Japanese, other Asian, or other Pacific Islander).
- *Primary language spoken at home.* A student's primary language spoken at home. Languages were coded based on their language family and included Austronesian languages (CHamoru, Refaluwasch [Carolinian], Chuukese, Pohnpeian, Tagalog, Ilocano, Visayan, and other Philippine languages) and non-Austronesian (English, Mandarin, Korean, and other).
- *Pell Grant status.* Whether a student received a Pell Grant while enrolled at UOG. This was used as a proxy for socioeconomic status and is included as a high school covariate because students complete the Free Application for Federal Student Aid, which determines eligibility for Pell Grants in college, while in high school. Other measures of student's socioeconomic status were unavailable.

The analyses for research question 3 on which demographic and college academic preparation characteristics of all prospective teacher candidates, regardless of the high school from which they graduated, during their first three years at UOG predict their passing the Praxis Core test and each of its subtests included the following student demographic variables:

- *Gender.* Whether a student is identified as male or female.
- *Race/ethnicity.* The race/ethnicity that a student is identified as: CHamoru, Filipino, Pacific other (Pohnpeian, Chuukese, or other Pacific Islander), or other (White Non-Hispanic, Black Hispanic, or Asian). Race/ethnicity

was coded differently from how it was coded for research question 1 because the larger sample for research question 2 allowed for more subgroups.

- *Pell Grant status.* Whether a student received a Pell Grant while enrolled at UOG. This was used as a proxy for socioeconomic status.

Due to substantial missing data (approximately 70 percent missing), primary language spoken at home was not used for research question 3.

Guåhan graduates' high school academic preparation characteristics. The analyses for research question 2 included the following student high school academic preparation variables:

- *Cumulative high school grade point average.* Cumulative high school grade point average for each student. In Guåhan public high schools the range of possible grade point averages is 0.00 to 5.00 for Advanced Placement and honors courses and 0.00 to 4.00 for other courses. Thus, students who enroll in Advanced Placement or honors courses can have a grade point average above 4.00, while students who do not enroll in those courses cannot. Grade point average was included as a continuous variable in the models to maximize the statistical power of the analyses, use information about all values of grade point average along the continuous scale, and avoid any loss of information that could occur by treating it as a categorical variable.
- *Attendance rate across high school math courses.* The extent to which a student attended high school math courses. First, a student's absence rate for each high school math course by academic term was calculated by determining the percentage of days the student was present in that math class. Attendance rate percentages were then averaged across all the student's math courses in grade 9–12 to create the final math attendance rate.
- *Attendance rate across high school English courses.* The extent to which a student attended high school English courses. First, a student's attendance rate for each high school English course by academic term was calculated by determining the percentage of days the student was present in that English class. Attendance rate percentages were then averaged across all the student's English courses in grade 9–12 to create the final English attendance rates.
- *Total high school math credits.* The total number of math credits a student earned during grades 9–12.
- *Total high school English credits.* The total number of English credits a student earned during grades 9–12.
- *Total high school Advanced Placement and honors math credits.* The total number of Advanced Placement and honors math credits a student earned during grades 9–12.
- *Total high school Advanced Placement and honors English credits.* The total number of Advanced Placement and honors English credits a student earned during grades 9–12.
- *Grade 9–12 math course grades by semester.* The grade, on a scale of 0–100 (0–110 for Advanced Placement and honors courses), for semester 1 or semester 2 for grade 9–12 math courses. The courses include Pre-Algebra (MA 104), Algebra I (MA 201), Algebra II (MA 203), Geometry (MA 204), and Trigonometry/Analytical Geometry (MA 301). Only courses attempted by at least 30 students in the sample were included.
- *Grade 9–12 English course grades by semester.* The grade, on a scale of 0–100 (0–110 for Advanced Placement and honors courses), for semester 1 or semester 2 for grade 9–12 English courses. The courses include English 9 (LA 101), English 10 (LA 201), English 11 (LA 301), and English 12 (LA 401). Only courses attempted by at least 30 students in the sample were included.

Unibetsedåt Guåhan student college academic preparation characteristics. The analyses for research question 3 included the following student college academic preparation variable:

- *Grades for courses required for admission to the UOG School of Education.* Grades for the courses required for admission to the UOG School of Education were used when at least 30 students attempted the course.[1] For the following courses the grades were coded as ordinal variables with possible values of not attempted, withdrew, F, D, C, B, and A:
    - Basic Mathematical Applications (MA 110).
    - Introductory College Algebra (MA 115).
    - Introductory Statistics (MA 151).
    - Freshman Composition (EN 110).
    - Writing for Research (EN 111).
    - Introduction to Teaching (ED 110).
    - Human Growth and Development (ED 201).
    - Fundamentals of Communication (CO 210).

    The course grades for Practicum: Observation and Participation (ED 192) were coded as ordinal variables with possible values of not attempted, failed, and passed.

    For students who did not complete one of the above courses by the time they took a Praxis subtest, that course was coded as not attempted.[2]

Praxis Core test outcomes. The analyses for research questions 2 and 3 included the following Praxis Core test outcome variables:

- *Passing Praxis Core test.* Whether a student passed all three Praxis subtests within three years of enrolling at UOG if the student attempted at least one of the three subtests.
- *Passing Praxis reading subtest.* Whether a student passed the Praxis reading subtest within three years of enrolling at UOG if the student attempted it.
- *Passing Praxis writing subtest.* Whether a student passed the Praxis writing subtest within three years of enrolling at UOG if the student attempted it.
- *Passing Praxis math subtest.* Whether a student passed the Praxis math subtest within three years of enrolling at UOG if the student attempted it.

Data processing and determination of analytic samples

This section explains how the samples were determined for research questions 1, 2, and 3. Figure B1 shows the number of students at each step of the creation of the analytic samples.

Sample for research questions 1 and 2.[3] The study team took several steps to process the data and determine the analytic sample for research questions 1 and 2 (referred to as group 1 in the main report), which included students who graduated from a GDOE public high school between spring 2012 and spring 2017, enrolled as first-time students at UOG between fall 2012 and fall 2017, and attempted at least one Praxis subtest within three years of

[1] Although MA 150 (Mathematics for Elementary School Teachers), MA 161A (College Algebra), and MA 165 (Precalculus) are required courses, they were not included in the models because fewer than 30 students attempted them.

[2] Since students can take each Praxis subtest separately, a student's college academic preparation characteristics can differ for each subtest. This is because the student might have completed additional courses between attempting each subtest. For the model that examined passing the Praxis Core test (all three subtests), the academic preparation characteristics for the most recent subtest attempt were used. Additionally, only courses attempted within the first three years of college enrollment were included.

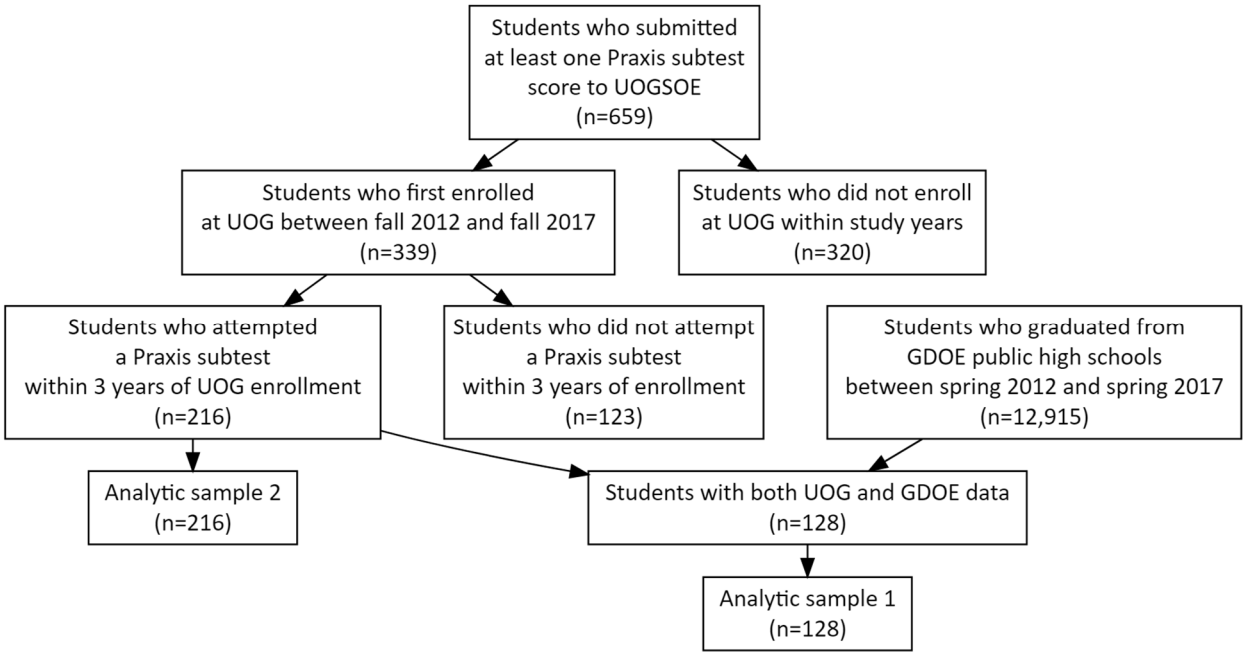
[3] Research question 1 addresses the overall pass rates for the Praxis Core test and the pass rates for the individual subtests for each analytic sample. Research question 2 uses analytic sample 1 (students who graduated from a Guåhan public high school), and research question 3 uses analytic sample 2 (all students, regardless of the high school from which they graduated).

enrolling. First, the study team cleaned the data from UOG. Next, the study team merged the new database containing the UOG data with the GDOE data using students' first and last names. Given that student names across the two datasets were not identical (due to misspellings or slight name changes from year to year), inexact matches that met a threshold of similarity were created using fuzzyjoin (Robinson, 2019). Fuzzyjoin, an R package (R Core Team, 2020), was used to match students on first and last name (the only common variables across the two databases) using a probability of likely matches. The study team examined the name and gender of all students joined using this process to confirm that matches were correct. Incorrect matches were then deleted.

After combining the GDOE and UOG data, the study team identified 128 students who met the selection criteria to be included in the final analytic sample for research questions 1 and 2. However, this sample was used only in models that predicted passing the Praxis Core test. Students could have attempted different combinations of the three Praxis subtests, since each subtest can be taken independently. For models predicting passing each subtest, only students who attempted the subtest were included. The sample size was 124 students for the reading subtest, 123 students for the writing subtest, and 123 students for the math subtest.

Sample for research questions 1 and 3. The final analytic sample for research questions 1 and 3 (referred to as group 2 in the main report) included all students, regardless of the high school from which they graduated, who enrolled as first-time students at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted at least one Praxis subtest within three years of enrolling. After these criteria were applied, there were 216 students in the final analytic sample for research questions 1 and 3. However, this sample was used only in models that predicted passing the Praxis Core test. Students could have attempted different combinations of the three subtests, since each subtest can be taken independently. For models predicting passing each subtest, only students who attempted the subtest were included. The sample size was 207 students for the reading subtest, 202 students for the writing subtest, and 207 students for the math subtest.

Figure B1. Number of students at each step of the creation of the analytic samples



GDOE is Guåhan Department of Education. UOG is Unibetsedåt Guåhan (University of Guam). UOGSOE is Unibetsedåt Guåhan (University of Guam) School of Education.
Source: Authors' calculations based on data from GDOE and UOG.

Missing data

Missing data for research questions 1 and 2 (analytic sample 1). Of the 128 students in the sample for research questions 1 and 2, 86 had missing data for at least one variable (table B1). Only students with Praxis subtest scores were used in the conditional inference classification tree models.

The conditional inference classification trees used in this study robustly handle missing data. When an observation has a missing value for a predictor variable, the conditional inference classification tree algorithm uses surrogate splits to account for the missing data. To perform a surrogate split, another predictor variable that the model determines performs similarly to the original variable is used in lieu of the original predictor variable with the missing value to determine how to make a split in the final decision tree. Because the algorithm uses surrogate splits, all observations in the sample were used in models.

Table B1. Percentage of missing records for each student characteristic for research questions 1 and 2

Characteristic	Percent missing data	Number of students with missing data (*n* = 128)
High school attended	0.0	0
High school graduation cohort	0.0	0
Unibetsedåt Guåhan semester/term start	0.0	0
Gender	0.0	0
Race/ethnicity	0.0	0
Primary language spoken at home	27.3	35
Received Pell Grant	0.0	0
Cumulative high school grade point average	38.3	49
English 9 (LA 101) semester 1 course grade	0.0	0
English 9 (LA 101) semester 2 course grade	0.0	0
English 10 (LA 201) semester 1 course grade	0.0	0
English 10 (LA 201) semester 2 course grade	0.0	0
English 11 (LA 301) semester 1 course grade	16.4	21
English 11 (LA 301) semester 2 course grade	16.4	21
English 12 (LA 401) semester 1 course grade	15.6	20
English 12 (LA 401) semester 2 course grade	17.2	22
Pre-Algebra (MA 104) semester 1 course grade	65.6	84
Pre-Algebra (MA 104) semester 2 course grade	65.6	84
Algebra I (MA 201) semester 1 course grade	9.4	12
Algebra I (MA 201) semester 2 course grade	9.4	12
Algebra II (MA 203) semester 1 course grade	8.6	11
Algebra II (MA 203) semester 2 course grade	10.9	14
Geometry (MA 204) semester 1 course grade	4.7	6
Geometry (MA 204) semester 2 course grade	9.4	12
Trigonometry/Analytical Geometry (MA 301) semester 1 course grade	62.5	80
Trigonometry/Analytical Geometry (MA 301) semester 2 course grade	67.2	86
Number of high school math credits	0.0	0
Number of high school English credits	0.0	0
Number of Advanced Placement and honors math credits	0.0	0
Number of Advanced Placement and honors English credits	0.0	0
High school math attendance	0.0	0
High school English attendance	0.0	0

Source: Authors' analysis of data from the Guåhan Department of Education and Unibetsedåt Guåhan.

Missing data for research questions 1 and 3 (analytic sample 2). Except for home language, none of the variables used for research questions 1 and 3 had any missing values. If a student did not have a grade for a course that was used in the models, the course grade was coded as "not attempted" because the student did not take the course. Student home language was not used for research question 3 because over 70 percent of students had missing values.

Analytic methods

This section describes the analytic methods used to answer research questions 1, 2, and 3.

Descriptive analyses. As part of preliminary analyses, the study team used R (R Core Team, 2020) to calculate means, standard deviations, and percentages to describe the demographic and academic preparation characteristics of students in the study samples. The characteristics included in these descriptive analyses are described in the variables section above. In addition, the percentage of students in each sample who passed each Praxis subtest within three years of enrolling at Unibetsedåt Guåhan was also calculated.

Conditional inference classification tree analyses. To address research questions 1, 2, and 3, the study team used R (R Core Team, 2020) and the R package partykit (Hothorn & Zeileis, 2015) to run conditional inference classification trees (Hothorn et al., 2006). Despite the name "conditional inference" trees, the method's results are descriptive, not inferential. The conditional inference tree model classifies individuals into mutually exclusive subgroups using a nonparametric approach that results in a classification tree. The classification trees explain how student demographic and academic preparation variables predict whether a student passed a Praxis Core test. Classification trees were used in this study instead of logistic regression because the trees are an exploratory statistical method that helps select covariates that are related to the outcome of interest in the absence of a strong hypothesis or theory. Classification trees can use more predictor variables with smaller samples than regression analysis can because classification trees choose which predictor variables best predict the outcomes, while regression models must model the effect of all specified variables, which can be problematic if the regression model's strict assumptions are violated (Kuhn & Johnson, 2013, pp. 108, 174). Due to the nonparametric nature of the method, classification trees can also identify nonlinear variable interactions in the data without the need to prespecify them (as with regression), which could more fully capture the data's complexity. Conditional inference classification trees were used instead of traditional recursive partitioning classification trees (Breiman et al., 1984) because conditional inference classification trees are less biased toward continuous variables and categorical variables with many levels (Hothorn et al., 2006). In a traditional recursive partitioning classification tree analysis, those variables may be spuriously selected given the model's bias.

Each conditional inference classification tree model included several predictors. However, the conditional inference classification tree algorithm selects only a subset of the included predictor variables that it determines best describe the final classification of students into those who passed the Praxis Core test and those who did not. The algorithm determines those decisions (splits in the tree) by performing permutation tests. If a possible split has a permutation test value that is larger than a specified threshold, the split is made; otherwise it is not. The threshold for the permutation tests, known as the minimum criterion, was allowed to vary for each model. The minimum criterion values could range from 0 to 1. For additional information on the permutation tests and the tree algorithm, see Hothorn et al. (2006). The *p*-values given by the conditional inference tree models for the permutation tests at each split should not be used to determine whether the split is statistically significant because the permutation test is not directly testing that and because the threshold for allowing the splits varied for each model (Hothorn et al., 2006). In addition, the trees were limited to a minimum node size of 10 observations.

Since the sample sizes in this study were small, there was a risk that classification trees might overfit the data. To reduce that risk, the final models were selected by using leave-one-out cross-validation with the R package caret (Kuhn, 2020). Leave-one-out cross-validation was used instead of k-fold cross-validation because the sample size

for each model was small and the k-fold cross-validation could result in highly biased models (James et al., 2013). Although leave-one-out cross-validation might result in a larger variance for the estimates of the model's error than k-fold cross-validation (James et al., 2013), it produces unbiased estimates of the model's error variance, which was considered more critical.

During the leave-one-out cross-validation process, 100 values were randomly selected using a uniform distribution with a range of 0 to 1 for the minimum criterion values by the caret package; the package then performed the leave-one-out cross-validation for each of the 100 models with the randomly selected minimum criterion values. Next, the package calculated unweighted Cohen's kappas and model predictive accuracy statistics for each resampling during the leave-one-out cross-validation. The kappa values and accuracies were then averaged across the leave-one-out cross-validation resamples for each of the minimum criterion values. The minimum criterion value that was selected for each model was the one with the highest Cohen's kappa value during the leave-one-out cross-validation. If multiple minimum criterion values had the same Cohen's kappa value, the smallest of those minimum criterion values was selected.

The Cohen's kappa values measured the proportion of correctly predicted outcomes (whether the student passed) by the models after correct predictions due to chance were accounted for (Kuhn & Johnson, 2013). The kappa values were calculated as the observed model accuracy minus the expected accuracy divided by one minus the expected accuracy. The expected accuracy was based on the marginal totals of the model's error matrix (a matrix of the predicted outcome values versus observed outcome values). Unweighted kappa values treat partial agreements between expected accuracy and observed accuracies as perfect disagreements. Using Cohen's kappa values to select models is helpful particularly when the predicted outcomes are unbalanced (when one is more probable than the other). In such cases, using the model accuracy can be misleading because high accuracy can be achieved by guessing that either all cases meet the outcome or all cases do not meet the outcomes, depending on which is more probable. In contrast, Cohen's kappa takes into account and corrects for chance agreement (Kuhn & Johnson, 2013).

To answer research question 2, four final conditional inference classification tree models were used. The first model predicted whether a student passed the Praxis Core test. This model included all the student demographic and high school academic preparation variables listed above. The second and third models predicted whether a student passed the reading and writing subtests, respectively. These two models also included all the student demographic and high school academic preparation variables listed above, except for math-specific variables (math course grades, math course attendance, total math credits, and total math Advanced Placement and honors credits). The fourth model predicted whether a student passed the math subtest. This model included all the student demographic and high school academic preparation variables listed above except for English-specific variables (English course grades, English course attendance, total English credits, and total English Advanced Placement and honors credits). A similar approach was used to address research question 3, with one exception. All the models for research question 3 included all the demographic and college academic preparation variables listed above. Findings presented in appendix C were not included in the main report when the split resulted in a group of 20 or fewer students. However, all the tree nodes in appendix C have at least 10 students in them.

The classification tree results presented in the main report for both research questions 2 and 3 were tested for statistical significance with post-hoc chi-square tests. This test was done for each split in the tree that was used in the report. However, the *p*-values were not corrected for multiple comparisons and should be interpreted with caution. All the splits in the main report were statistically significant at $p < .05$.

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Appendix C. Supporting analysis

This appendix presents detailed results of the findings from the three research questions addressed in the study.

Detailed results of descriptive statistics

This section provides descriptive statistics (percentages, means, and standard deviations) across all prospective K–12 prospective teacher candidates in the final analytic samples. Table C1 shows the percentage of students in group 1 (Guåhan public high school graduates; research questions 1 and 2) and group 2 (all students in the Unibetsedåt Guåhan [UOG] analytic sample, regardless of the high school from which they graduated; research questions 1 and 3) who passed the Praxis Core test and the individual subtests. Table C2 shows the number of attempts students made on the Praxis subtests for both groups 1 and 2. Tables C3 and C4 include demographic and high school academic preparation characteristics for group 1. Tables C5 and C6 include demographics and college academic preparation characteristics for group 2. Table C7 provides tests for differences between the predictor variables for students who graduated from a Guåhan public high school and those who did not.

Table C1. Percentages of students in groups 1 and 2 who passed the Praxis Core test and its subtests (reading, writing, and math) within three years of enrolling at Unibetsedåt Guåhan (research question 1)

Test or subtest	Group 1	Group 2
Praxis Core test (passed all three subtests)		
Passed	52.3	50.5
Not passed	47.7	49.6
Praxis reading subtest		
Passed	79.0	78.7
Not passed	21.0	21.3
Praxis writing subtest		
Passed	72.4	69.3
Not passed	27.6	30.7
Praxis math subtest		
Passed	61.0	60.4
Not passed	39.0	39.6

Note: Percentages might not sum to 100 because of rounding. For group 1 (students who graduated from a Guåhan public high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted at least one Praxis subtest within three years of enrolling), the sample size is 128 students for the Praxis Core test, 124 students for the reading subtest, 123 students for the writing subtest, and 123 students for the math subtest. For group 2 (all students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted at least one Praxis subtest within three years of enrolling), the sample size is 216 students for the Praxis Core test, 207 students for the reading subtest, 202 students for the writing subtest, and 207 students for the math subtext.
Source: Authors' analysis of data from the Guåhan Department of Education and Unibetsedåt Guåhan.

Table C2. Percentages of students in groups 1 and 2 who took each Praxis subtest zero times, one time, and two or more times within three years of enrolling at Unibetsedåt Guåhan (research questions 1, 2, and 3)

Number of attempts	Group 1	Group 2
Praxis reading subtest		
0	4.7	4.6
1	82.8	82.0
2 or more	12.5	13.5
Praxis writing subtest		
0	5.5	6.9
1	71.9	71.0
2 or more	22.7	22.2
Praxis math subtest		
0	5.5	4.6
1	58.6	65.9
2	17.2	14.7
3	7.8	5.5
4 or more	10.9	9.3

Note: Percentages might not sum to 100 because of rounding. For group 1 (students who graduated from a Guåhan public high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted at least one Praxis subtest within three years of enrolling), the sample size is 128 students for the Praxis Core test, 124 students for the reading subtest, 123 students for the writing subtest, and 123 students for the math subtest. For group 2 (all students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted at least one Praxis subtest within three years of enrolling), the sample size is 216 students for the Praxis Core test, 207 students for the reading subtest, 202 students for the writing subtest, and 207 students for the math subtext.
Source*:* Authors' analysis of data from the Guåhan Department of Education and Unibetsedåt Guåhan.

Table C3. Descriptive statistics for demographic characteristics of students in group 1 (research questions 1 and 2)

Characteristic	Percent of students (*n* = 128)
Gender	
Male	19.2
Female	80.8
Race/ethnicity	
Chamorro	25.4
Filipino	62.3
Other	12.3
Primary language	
Austronesian languages	31.5
Other languages	41.5
Missing	26.9
Received Pell Grant	
Yes	62.3
No	37.7
High school graduation year	
2012	3.7
2013	40.8
2014	17.7
2015	18.5
2016	10.8
2017	8.5
High school	
George Washington High School	16.9
John F. Kennedy High School	30.0
Okkodo High School	20.0
Simon Sanchez High School	20.8
Southern High School	8.5
Tiyan High School	3.8

Note: Percentages might not sum to 100 because of rounding. Group 1 refers to students who graduated from a Guåhan public high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted at least one Praxis subtest within three years of enrolling.
Source: Authors' analysis of data from the Guåhan Department of Education and the Unibetsedåt Guåhan.

Table C4. Descriptive statistics for high school academic experience characteristics of students in group 1 (research questions 1 and 2)

Characteristic	Mean	Standard deviation	Minimum	Maximum	*n*-valid
Cumulative high school grade point average	3.80	0.45	2.45	4.43	79
English 9 (LA 101) semester 1 course grade	91.58	8.49	60.00	100.00	128
English 9 (LA 101) semester 2 course grade	91.79	8.94	60.00	106.00	128
English 10 (LA 201) semester 1 course grade	96.39	10.19	55.00	110.00	128
English 10 (LA 201) semester 2 course grade	96.73	9.64	66.00	110.00	128
English 11 (LA 301) semester 1 course grade	95.33	8.68	73.00	110.00	107
English 11 (LA 301) semester 2 course grade	95.47	9.90	68.00	110.00	107
English 12 (LA 401) semester 1 course grade	94.49	10.26	61.00	110.00	108
English 12 (LA 401) semester 2 course grade	94.38	10.55	63.00	110.00	106
Pre-Algebra (MA 104) semester 1 course grade	88.41	10.25	62.00	100.00	44
Pre-Algebra (MA 104) semester 2 course grade	88.65	10.86	60.00	100.00	44
Algebra I (MA 201) semester 1 course grade	87.80	10.94	60.00	100.00	116
Algebra I (MA 201) semester 2 course grade	87.13	10.75	60.00	100.00	116
Algebra II (MA 203) semester 1 course grade	86.47	12.11	49.00	108.00	117
Algebra II (MA 203) semester 2 course grade	88.05	11.30	60.00	110.00	114
Geometry (MA 204) semester 1 course grade	85.69	12.64	40.00	101.00	122
Geometry (MA 204) semester 2 course grade	85.93	10.83	55.00	100.00	116
Trigonometry/Analytical Geometry (MA 301) semester 1 course grade	95.14	12.54	49.00	110.00	47
Trigonometry/Analytical Geometry (MA 301) semester 2 course grade	95.58	10.71	62.00	110.00	42
Number of high school math credits[a]	3.93	0.75	2.75	8.00	128
Number of high school English credits[a]	4.10	0.34	3.75	6.00	128
Number of Advanced Placement and honors math credits[a]	0.47	0.72	0.00	4.00	128
Number of Advanced Placement and honors English credits[a]	1.38	1.28	0.00	3.00	128
High school math attendance	0.98	0.02	0.89	1.00	128
High school English attendance	0.98	0.02	0.86	1.00	128

Note: Group 1 refers to the 128 students who graduated from a Guåhan high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted at least one Praxis subtest within three years of enrolling. The *n*-valid column lists the number of observations with observed (nonmissing) data for each characteristic.

a. Students earn 0.5 credit for each semester they pass a course. Both Advanced Placement and honors courses also count for 0.5 credit per semester.

Source: Authors' analysis of data from the Guam Department of Education.

Table C5. Descriptive statistics for college academic experience characteristics of students in group 2 (research questions 1 and 3)

Characteristic	Percent of students (*n* = 216)						
	A	B	C	D	F	Withdrew	Not attempted
Basic Mathematical Applications (MA 110)	13.8	10.1	9.7	[a]	[a]	[a]	62.7
Introductory College Algebra (MA 115)	12.0	8.3	7.4	[a]	0	[a]	70.5
Introductory Statistics (MA 151)	24.9	14.3	13.8	[a]	[a]	[a]	40.6
Freshman Composition (EN 110)	52.5	[b]	[a]	0	0	0	28.6
Writing for Research (EN 111)	38.7	20.7	[b]	0	0	[a]	28.1
Introduction to Teaching (ED 110)	33.6	24.9	8.8	0	0	0	32.7
Human Growth and Development (ED 201)	37.3	18.0	[a]	0	0	[a]	40.6
Fundamentals of Communication (CO 210)	38.7	24.0	[b]	0	[a]	0	32.3
	Pass	Fail	Not attempted				
Practicum: Observation and Participation (ED 192)	53.9	0.0	46.1				

Note: Percentages might not sum to 100 because of rounding. Group 2 refers to all students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted at least one Praxis subtest within three years of enrolling.
a. Data are suppressed due to small sample size ($n < 10$).
b. Although the sample size is over 10, the values are suppressed to maintain student privacy for these academic characteristics.
Source: Authors' analysis of data from the Unibetsedåt Guåhan.

Table C6. Descriptive statistics for demographic characteristics of students in group 2 (research questions 1 and 3)

Characteristic	Percent of students (*n* = 216)
Gender	
Male	24.0
Female	76.0
Race/ethnicity	
CHamoru	33.6
Filipino	54.8
Pacific Other	6.9
Other	4.6
Received Pell Grant (a proxy for socioeconomic status)	
Yes	55.8
No	44.2
Unibetsedåt Guåhan enrollment year	
2012	9.2
2013	17.5
2014	13.8
2015	28.6
2016	20.7
2017	10.1

Note: Percentages might not sum to 100 because of rounding. Group 2 refers to all students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted at least one Praxis subtest within three years of enrolling.
Source: Authors' analysis of data from Unibetsedåt Guåhan.

Table C7. Differences between students in group 1 and group 2

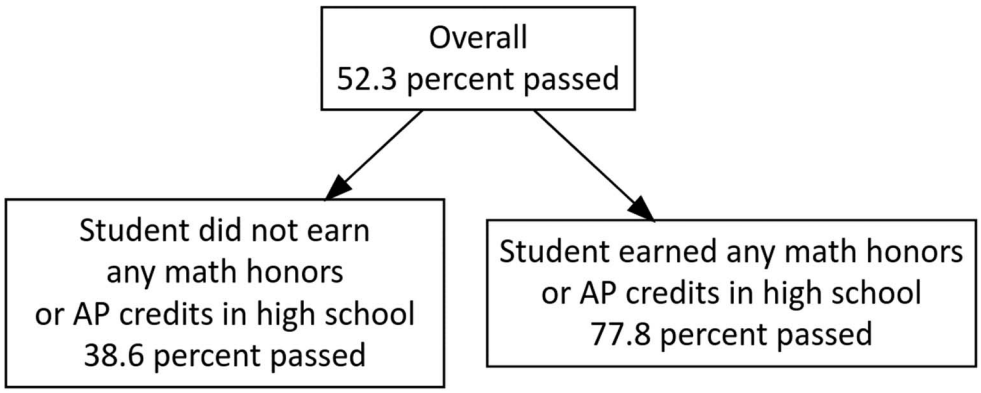
Characteristic	Statistic	Degrees of freedom	*p*-value	Test
Gender	4.31	1	.038*	Chi-squared
Race/ethnicity	11.26	2	.004**	Chi-squared
Pell Grant status (a proxy for socioeconomic status)	4.44	1	.035*	Chi-squared
Fundamentals of Communication (CO 210) grades	4,416	—	.003**	Wilcoxon rank sum test
Introduction to Teaching (ED 110) grades	4,576	—	.008**	Wilcoxon rank sum test
Practicum: Observation and Participation (ED 192) grades	4,868	—	.039*	Wilcoxon rank sum test
Human Growth and Development (ED 201) grades	4,690	—	.020*	Wilcoxon rank sum test
Freshman Composition (EN 110) grades	3,916	—	<.001***	Wilcoxon rank sum test
Writing for Research (EN 111) grades	3,785	—	<.001***	Wilcoxon rank sum test
Basic Mathematical Application (MA 110) grades	5,332	—	.383	Wilcoxon rank sum test
Introductory College Algebra (MA 115) grades	5,206	—	.240	Wilcoxon rank sum test
Introductory Statistics (MA 151) grades	4,474	—	.006**	Wilcoxon rank sum test
Passing Praxis reading subtest	0.18	1	.671	Chi-squared
Passing Praxis writing subtest	2.00	1	.158	Chi-squared
Passing Praxis math subtest	0.17	1	.683	Chi-squared

* Significant at $p < .05$; ** significant at $p < .01$; *** significant at $p < .001$.
— indicates nonparametric tests that do not have degrees of freedom.
Note: Group 1 refers to the 128 students who graduated from a Guåhan high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted at least one Praxis subtest within three years of enrolling. Group 2 refers to all 216 students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted at least one Praxis subtest within three years of enrolling.
Source: Authors' analysis of data from the Guam Department of Education and Unibetsedåt Guåhan.

Detailed conditional inference tree results

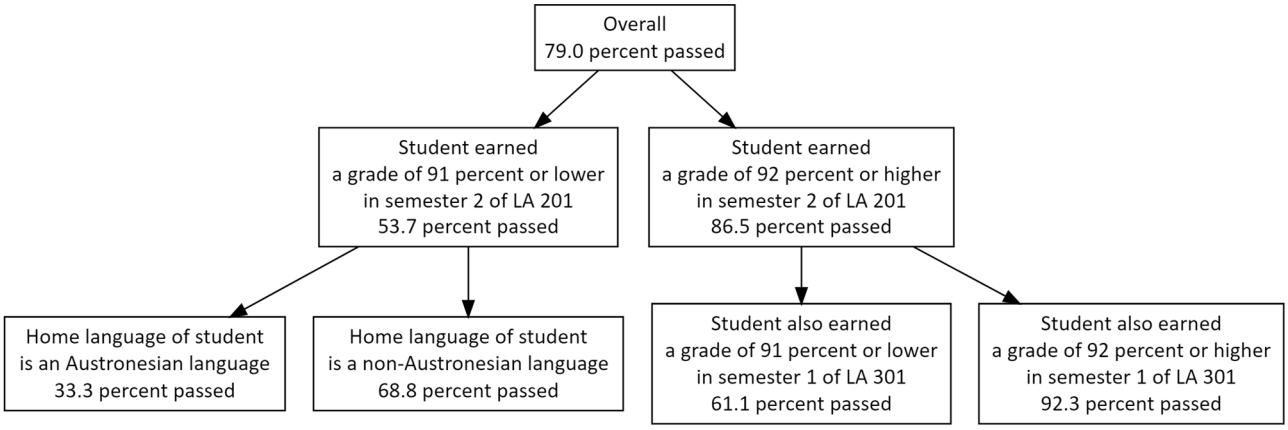
This section provides the final pruned and cross-validated conditional inference trees that were used to answer research questions 2 (figures C1–C4) and 3 (figures C5–C8). The trees branch out into nodes due to partitioning the data into smaller subgroups based on the predictor variables use to create the models. Students in a lower node also inherit the characteristics of the nodes above but represent a smaller subgroup.

Figure C1. Conditional inference tree predicting passing the Praxis Core test for group 1 (research question 2)



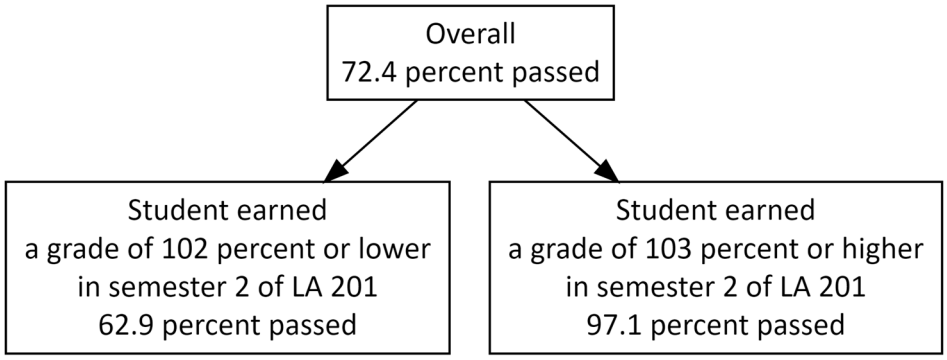
Note: Group 1 refers to the 128 students who graduated from a Guåhan high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted at least one Praxis subtest within three years of enrolling.
Source: Authors' analysis of data from the Guam Department of Education and Unibetsedåt Guåhan.

Figure C2. Conditional inference tree predicting passing the Praxis reading subtest for group 1 (research question 2)



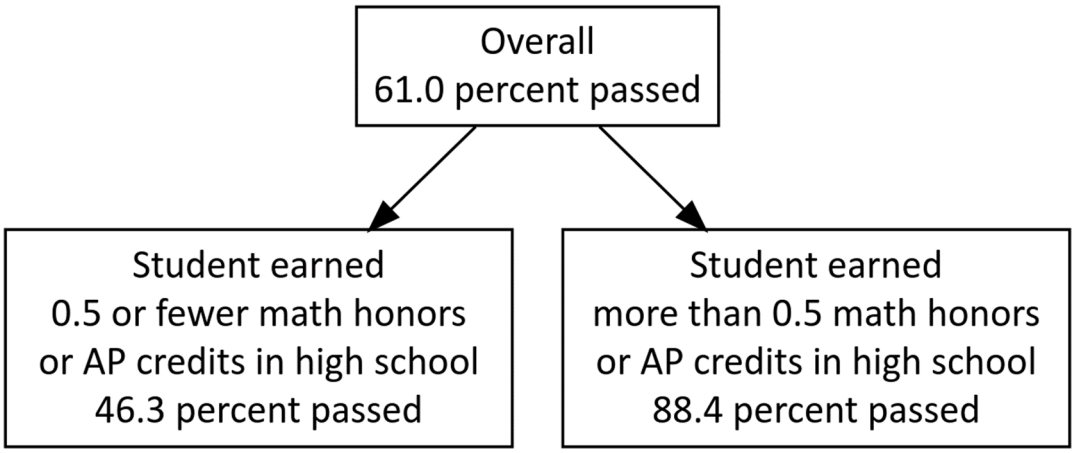
Note: LA 201 is the English course taken in grade 10, and LA 301 is the English course taken in grade 11. Group 1 refers to the 124 students who graduated from a Guåhan high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted the Praxis reading subtest within three years of enrolling.
Source: Authors' analysis of data from the Guam Department of Education and Unibetsedåt Guåhan.

Figure C3. Conditional inference tree predicting passing the Praxis writing subtest for group 1 (research question 2)



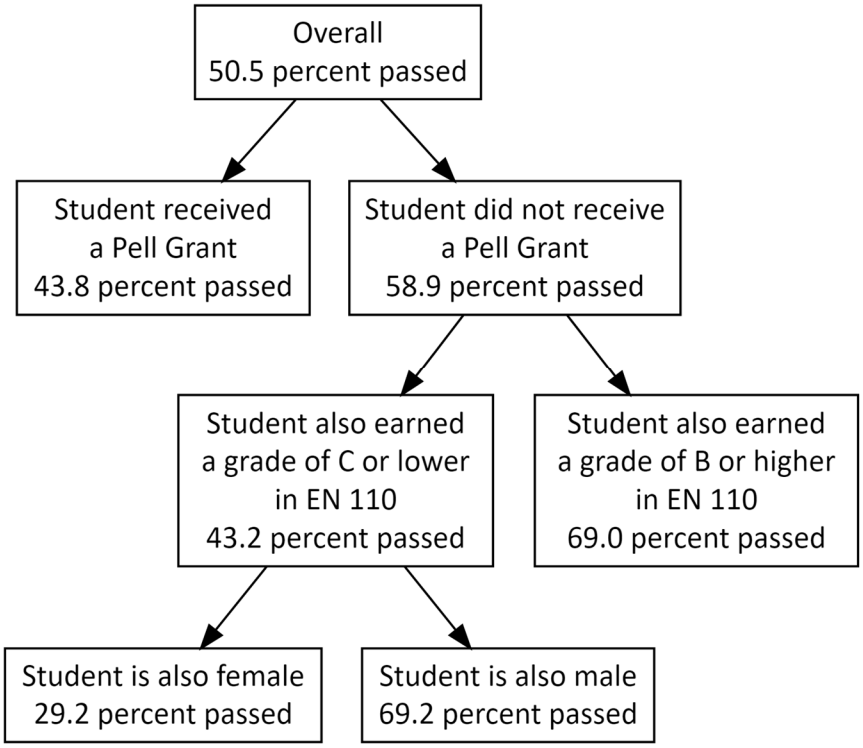
Note: LA 201 is the English course taken in grade 10. Group 1 refers to the 123 students who graduated from a Guåhan high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted the Praxis writing subtest within three years of enrolling.
Source: Authors' analysis of data from the Guam Department of Education and Unibetsedåt Guåhan.

Figure C4. Conditional inference tree predicting passing the Praxis math subtest for group 1 (research question 2)



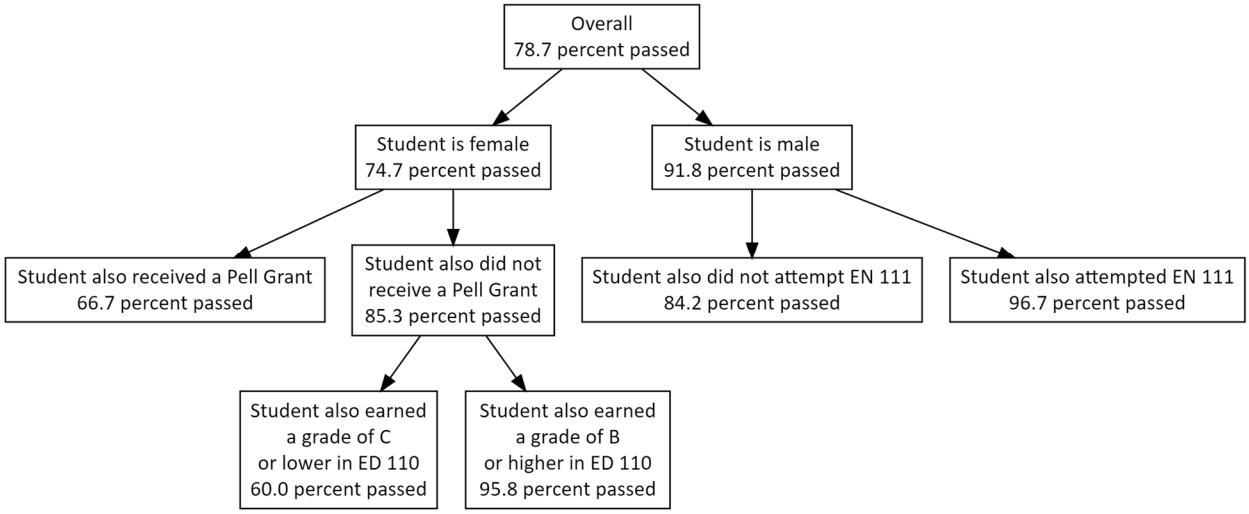
Note: Group 1 refers to the 123 students who graduated from a Guåhan high school, enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017, and attempted the Praxis math subtest within three years of enrolling.
Source: Authors' analysis of data from the Guam Department of Education and Unibetsedåt Guåhan.

Figure C5. Conditional inference tree predicting passing the Praxis Core test for group 2 (research question 3)



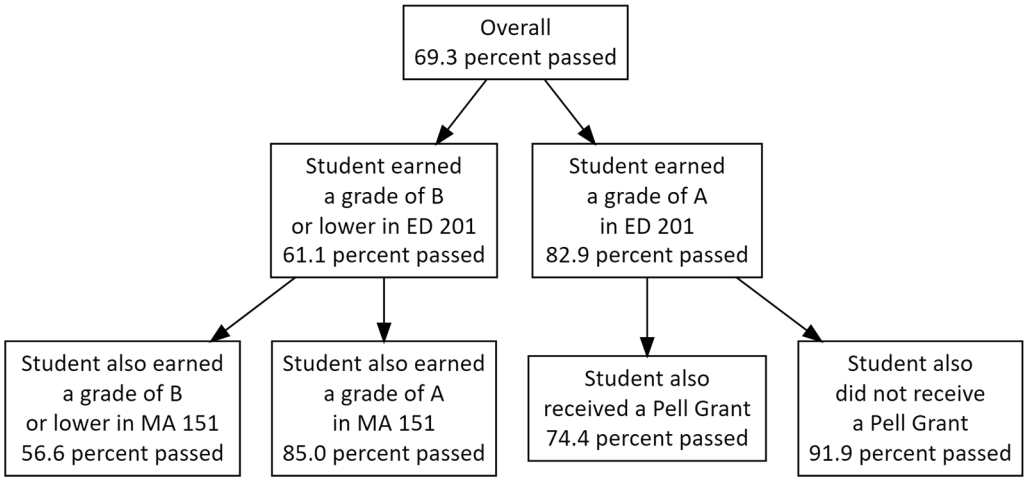
Note: EN 110 is the first-year college English course at Unibetsedåt Guåhan. Group 2 refers to all 216 students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted at least one Praxis subtest within three years of enrolling.
Source: Authors' analysis of data from Unibetsedåt Guåhan.

Figure C6. Conditional inference tree predicting passing the Praxis reading subtest for group 2 (research question 3)



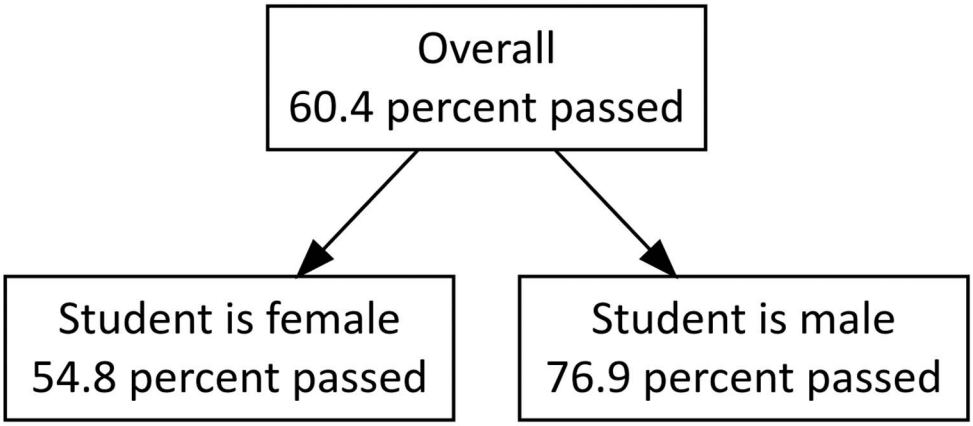
Note: ED 110 is the course Introduction to Teaching at Unibetsedåt Guåhan, and EN 111 is the course Writing for Research. Group 2 refers to all 207 students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted the Praxis reading subtest within three years of enrolling.
Source: Authors' analysis of data from Unibetsedåt Guåhan.

Figure C7. Conditional inference tree predicting passing the Praxis writing subtest for group 2 (research question 3)



Note: ED 201 is the course Human Growth and Development at Unibetsedåt Guåhan, and MA 151 is the course Introductory Statistics. Group 2 refers to all 202 students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted the Praxis writing subtest within three years of enrolling.
Source: Authors' analysis of data from Unibetsedåt Guåhan.

Figure C8. Conditional inference tree predicting passing the Praxis math subtest for group 2 (research question 3)



Note: Group 2 refers to all 207 students, regardless of the high school from which they graduated, who enrolled at Unibetsedåt Guåhan between fall 2012 and fall 2017 and attempted the Praxis math subtest within three years of enrolling.
Source: Authors' analysis of data from Unibetsedåt Guåhan.