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Fairness of Automated Essay Scoring of GMAT® AWA

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Abstract

This study investigates the fairness of the automated essay scoring from the Analytical Writing Assessment to six subpopulation groups of Graduate Management Admission Test® (GMAT®) test takers: American English vs. non-American English writers, English native speakers vs. English-as-a-second-language speakers, males vs. females, and examinees of three different ethnic groups. Propensity score matching was used to create control groups by matching each member of the studied groups on multiple variables. The study shows that none of the subpopulation groups has an unfair advantage and none has been unfairly punished by the automated essay scoring.

Introduction

The Graduate Management Admission Test (GMAT) exam is used in the process of admitting candidates into business administration and other graduate educational programs around the world. The GMAT has an essay component—the Analytical Writing Assessment (AWA). Most essays in the GMAT AWA are rated by one human rater and by an automated essay scoring system (AES), the IntelliMetric® system of Vantage Learning Inc. A previous study (Rudner, Garcia, & Welch, 2006) has shown that the AES scores are comparable with the human scores of the GMAT AWA, but the fairness of the AES to subgroups was not studied.

This study was prompted by a British GMAT test taker who wrote and expressed concern about the possibility of the AES punishing essays written in non-US English. This was and still is a legitimate concern, not just for non-US-English speakers, but also for any other subpopulation groups of GMAT test takers. This study addresses the concerns of, and investigates the fairness of, the AES to six subpopulation groups of test takers: test takers who write in non-US English; test takers who speak English as a second language; male vs. female test takers; and test takers who are US citizens of Asian, African, or Latin American origins.

Methodology

An experimental design was not feasible in this study because it was impossible to assign test takers randomly to subpopulation groups. Some of the group memberships of test takers were demographic; others were predetermined by other attributes when test takers were ready to take the GMAT exam. The best design for this study was to form a studied group from a subpopulation first and then create a control group from a reference subpopulation by matching the characteristics of the individuals in the studied group on variables that might influence their performance on the AWA. Finally, the AES scores of the two groups were compared and tested for statistical significance. Ten variables were selected and controlled through the matching process in this study.

Studied and Controlled Variables

The GMAT exam has three components: a quantitative section measures quantitative reasoning ability, a verbal section measures verbal reasoning ability, and an essay section measures analytical ability through two essays. Four scores are reported for the GMAT exam. A quantitative score and a verbal score are reported on the scale of 0 to 60 with an increment of 1, and a total score that results from the combined

performance of both the quantitative and verbal sections is reported on a scale of 200 to 800 with an increment of 10. In the AWA section, each test taker writes two essays in response to two prompts. Each essay is rated twice on a scale of 0 to 6 with an increment of 1. The AWA score is the mean of the four ratings (two for each essay) on the same scale rounded to 0.5.

Typically, each AWA essay is rated by a human rater and an automated essay scoring system, the IntelliMetric (Dikli, 2006) system of Vantage Learning Inc. IntelliMetric is an intelligent computer scoring system that emulates the process carried out by human raters. The automated scoring system is theoretically grounded in a cognitive model often referred to as a "brain-based" or "mind-based" model of information processing and understanding. IntelliMetric draws upon the traditions of cognitive processing, artificial intelligence, natural language understanding, and computational linguistics in the process of evaluating written text. An evaluation of the IntelliMetric for use with GMAT essays can be found in Rudner, Garcia, and Welch (2006).

In this study, two subscores were calculated for each test taker. An AES score was computed as the mean of the two AES ratings and a human score was computed as the mean of the two human ratings. The AES score served as the dependent variable to identify possible differential impact of the IntelliMetric system on subpopulation groups.

The AES scores of a studied group were compared with those of a control group, a matched group consisting of test takers from a reference subpopulation. The basic idea of matching is to form groups that are as similar as possible on relevant characteristics (variables). Writing ability was the key characteristic in this study. It was important that the studied and control groups had comparable writing ability because any differences in the AES scores between the two groups could be confounded by the differences in writing ability. The computed AWA human score was used in the matching process to control for any possible group differences due to writing ability. All human essay raters had gone through extensive training in rating the GMAT essays. Human raters were aware of the differences among dialects of the English language, choices of words, and culturally related preferences of expressions. Accordingly, we assumed that the human scores were not biased against essays written by subpopulation groups. Differences between the two groups on AES scores would then indicate bias in the AES.

In addition to the AWA human score, three clusters of variables that might affect writing scores were included in the matching process. The first cluster consisted of the GMAT quantitative and verbal scores, undergraduate grade point average (GPA), and highest educational level. The purpose of including these was to control for the differences on general academic achievement between the two groups. The second cluster included undergraduate major of study, intended MBA degree pursued, and number of years of work experience. The purpose of matching on these variables was to control for the differential training and work experience that might result in different writing ability and writing styles between the two groups. These differences might also be reflected in their choice of future studies. Therefore, the intended MBA degree was also included in this cluster. Some believe that older students and female students are better writers than their younger and male counterparts. To control for those demographic differences, the third cluster included was gender and age. It is important to note that all three clusters of variables were included in the matching process because they might interact with the AES scoring process, therefore confounding the results from the comparisons of the group differences in the AES scores. By matching these, the impact of these confounding variables was brought under control.

Propensity Score Matching

Matching 10 variables simultaneously is not an easy job to perform by hand. This study used propensity score matching (Rosenbaum & Rubin, 1983; Rosenbaum & Rubin, 1985; Rubin & Thomas, 1996; Rudner & Peyton, 2006) to create the matched control groups. The basic idea behind this method is to run a logistical regression on all the controlled variables to predict test takers' membership of the group of interest. Test takers with similar characteristics on the controlled variables will have similar probability (propensity score) of being a member of the studied

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group. Then, a control group can be formed by selecting a member of the reference group that has the closest propensity score to a member in the studied group. This "nearest neighbor" propensity score matching method matches with the composite formed by the included variables.

Sample Size and Statistical Power

Sample size in this study was a crucial aspect of the design. In general, when the difference between the studied and control groups is statistically significant, it is easy to conclude that the AES scores for the two groups are not the same. When the difference is not statistically significant, however, there are two plausible interpretations. One is that the two groups do not differ in their AES scores; the other is that the statistical test did not have enough power to detect the difference due to inadequate sample size. In order to avoid inadequate statistical power in this study, sample sizes were calculated for each of the comparisons.

First, a meaningful difference of 0.2 on the 0 to 6 AWA scale was selected. The population standard deviation of the GMAT AWA scores is 1.2 and a difference of 0.2 is one sixth of a standard deviation. This is considered a small effect size in the statistical sense (Cohen, 1988). In practice, this difference is even smaller than the rounding errors since the reported AWA score is rounded to 0.5. To ensure adequate statistical power in the comparisons, the sample size for a matched-pair *t*-test was calculated with an estimated standard deviation of the difference of 1.0 using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007). The projected sample size was 265 for each group for a power of 0.9 in a matched-pair *t*-test. The actual sample size was 300 for each group in this study for all the comparisons. The chosen sample size should allow adequate statistical power to detect a group difference of 0.2 points or larger. In case a group difference of such a magnitude was observed and it was statistically nonsignificant, the only conclusion would be that the two groups were not different on the AES scores and the observed difference was random error.

Data

Test taker data from the GMAT exam were collected in the March to December 2006 period. Test takers' records containing essays rated by two human raters were excluded from the analyses. Also excluded were records with adjudicated essay scores. When the two ratings on an essay are more than one point apart, the third score is given by a human rater, usually a more experienced essay-scoring leader. The score on the essay could be either the average of the three scores or the third score overwriting the other two. As a result, all adjudicated essay scores become less—or even not at all—affected by the AES. Therefore, they were removed from the data set before the analyses. The final data set for this study included 104,332 test takers.

Results and Discussions

For each of the studied subpopulations, a random sample of 300 was to form the studied group. A control group was then formed by finding and selecting the "closest neighbors" of the 300 from a reference subpopulation based on the 10 variables described above. Finally, the AES scores between the two groups were compared. In this section, the matching results are first presented. Means and standard deviations of the two groups are given in tables for undergraduate GPA, years of employment, age, GMAT verbal and quantitative scores, and AWA human score. The number of test takers in each category for the two groups is also displayed in tables for gender, undergraduate major, highest education level, and MBA degree pursued. Finally, the comparisons of the AES scores between the two groups are presented.

Non-US English and US-English-Speaking Test Takers

English speakers who do not speak US English make up the first studied subpopulation and the control group is US-English speakers. Table 1 presents the means and standard deviations for the two groups on undergraduate GPA, years of employment, age,

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GMAT verbal score, GMAT quantitative score, and AWA human score. They are all similar between the groups except for the standard deviations for undergraduate GPA. The US-English group shows less variability. The group means and standard deviations of the human scores appear to be very close with a difference of 0.03 in the means and 0.04 in the standard deviations. These are crucial evidence for successfully controlling the writing ability of the two groups. It is safe to conclude that the two groups wrote equally well on the AWA essays based on human ratings. The two groups also show similar compositions on gender (Table A-1), MBA degrees to be pursued (Table A-2), highest educational levels (Table A-3), and undergraduate majors (Table A-4). These tables are presented in the Appendix.

Table 1. Summary of Non-US English and US English Speaker Groups

	Non-US English		US English	
	Mean	Std. Dev.	Mean	Std. Dev.
Undergraduate GPA	3.29	0.75	3.28	0.38
Years employed	6.78	4.73	6.38	5.32
Age	29.78	5.68	29.38	6.17
GMAT verbal score	34.47	7.37	34.76	7.38
GMAT quantitative score	36.29	9.34	37.12	8.95
AWA human score	5.14	0.68	5.11	0.72

The means and standard deviations of the two groups on the AWA AES scores are almost identical (See Table 2). The difference in the group means is 0.04 and is not statistically significant in the *t*-test ($p = 0.428$). The null hypothesis of a population difference of 0.2 or larger is rejected. The two groups do not differ on their AWA AES scores, and the AES is therefore fair to native English test takers who do not speak US English when compared with their US-English-speaking counterparts.

Table 2. AES Scores of Non-US English and US English Speaker Groups

	Non-US English		US English	
	Mean	Std. Dev.	Mean	Std. Dev.
AWA AES score	5.23	0.69	5.19	0.70

English-as-a-Second-Language (ESL) Speakers and Native English Speakers

Test takers who speak English as a second language (ESL) make up the second subpopulation in the investigation. The control group includes native English speakers who speak British, US, Australian, or other English variations. Table 3 presents the means and standard deviations for the two groups on the undergraduate GPA, years of employment, age, GMAT verbal score, GMAT quantitative score, and AWA human score. They all appear similar between the groups except those for age. The ELS group seems to be younger and more homogeneous. The group means and standard deviations of the AWA human scores appear to be very close, with a difference of 0.09 in the means and 0.03 in the standard deviations.

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These are evidence for successfully controlling the writing ability of the two groups. It is safe to conclude that the two groups wrote equally well on the AWA essays based on human ratings. The two groups also show similar compositions on gender (Table A-5), MBA degrees to be pursued (Table A-6), highest educational levels (Table A-7), and undergraduate majors (Table A-8). These tables are presented in the Appendix.

Table 3. Summary of ESL and Native English Speaker Groups

	ESL		Native English	
	Mean	Std. Dev.	Mean	Std. Dev.
Undergraduate GPA	3.30	0.52	3.28	0.45
Years employed	4.03	3.37	4.35	4.23
Age	27.54	4.16	28.26	6.05
GMAT verbal score	26.76	8.69	26.37	8.40
GMAT quant. score	40.69	9.59	39.29	7.92
AWA human score	4.34	0.82	4.25	0.79

The means and standard deviations of the two groups on the AWA AES scores are almost identical (See Table 2). The difference in the group means is 0.02 and is not statistically significant in the *t*-test ($p = 0.73$). The null hypothesis of a population difference of 0.2 or larger is rejected. The two groups do not differ on their AWA AES scores and the AES is fair to English-as-a-second-language test takers, when compared with their native English-speaking counterparts.

Table 4. AES Scores of ESL and Native English Speaker Groups

	ESL		Native English	
	Mean	Std. Dev.	Mean	Std. Dev.
AWA AES score	4.39	0.83	4.37	0.85

Female and Male Test Takers

Female test takers make up the third subpopulation in the investigation and the control group is the male subpopulation. Table 5 presents the means and standard deviations for the two groups on undergraduate GPA, years of employment, age, GMAT verbal score, GMAT quantitative score, and AWA human score. They all appear similar between the groups. The group means and standard deviations of the AWA human scores appear to be very close with a difference of 0.03 in the means and 0.04 in the standard deviations. These show that the two groups wrote equally well on the AWA essays based on human ratings. The two groups also showed very similar compositions on MBA degrees to be pursued (Table A-9), highest educational levels (Table A-10) and undergraduate majors (Table A-11). These tables are presented in the Appendix.

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Table 5. Summary of Male and Female Groups				
	Female		Male	
	Mean	Std. Dev.	Mean	Std. Dev.
Undergraduate GPA	3.19	0.68	3.21	0.48
Years employed	4.26	4.57	4.28	4.32
Age	27.14	5.76	27.13	4.87
GMAT verbal score	28.15	8.72	27.93	7.63
GMAT quant. score	32.91	11.16	32.33	10.70
AWA human score	4.58	0.81	4.61	0.85

The means and standard deviations of the two groups on the AWA AES scores are almost identical (See Table 6). The difference in the group means is 0.05 and is not statistically significant in the *t*-test ($p = 0.5$). The null hypothesis of a population difference of 0.2 or larger is rejected. The two groups do not differ on their AWA AES scores and the AES is fair to female test takers, when compared with their male peers.

Table 6. AES Scores of Male and Female Groups				
	Female		Male	
	Mean	Std. Dev.	Mean	Std. Dev.
AWA AES score	4.67	0.86	4.62	0.87

Asian American and Caucasian American Test Takers

Asian American test takers make up the fourth subpopulation in the investigation and the control group consists of their Caucasian counterparts. Table 7 presents the means and standard deviations for the two groups on the undergraduate GPA, years of employment, age, GMAT verbal score, GMAT quantitative score, and AWA human score. They are all similar between the groups. The group means and standard deviations of the AWA human scores are very close, with a difference of 0.01 in the means and 0.04 in the standard deviations. These are evidence for successfully controlling the writing ability of the two groups. It is safe to conclude that the two groups wrote equally well on the AWA essays based on human ratings. The two groups also show very similar compositions on gender (Table A-12), MBA degrees to be pursued (Table A-13), highest educational levels (Table A-14) and undergraduate majors (Table A-15). These tables are presented in the Appendix.

Table 7. Summary of Asian American and Caucasian American Groups				
	Asian		Caucasian	
	Mean	Std. Dev.	Mean	Std. Dev.
Undergraduate GPA	3.24	0.38	3.21	0.49
Years employed	3.82	2.99	4.29	4.13
Age	26.45	3.39	26.95	4.71
GMAT verbal score	31.74	7.99	31.33	7.40
GMAT quant. score	37.14	9.06	37.11	8.29
AWA human score	4.90	0.71	4.89	0.75

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The means and standard deviations of the two groups on the AWA AES scores are almost identical (See Table 8). The difference in the group means is 0.01 and is not statistically significant in the *t*-test (p = 0.1). The null hypothesis of a population difference of 0.2 or larger is rejected. The two groups do not differ on their AWA AES scores and the AES is fair to Asian American test takers, when compared with their Caucasian counterparts.

Table 8. AES Scores of Asian American and Caucasian American Groups

	Asian		Caucasian	
	Mean	Std. Dev.	Mean	Std. Dev.
AWA AES score	5.1	0.76	5.0	0.75

African American and Caucasian American Test Takers

African American test takers make up the fifth subpopulation in the investigation and the control group is their Caucasian counterparts. Table 9 presents the means and standard deviations for the two groups on the undergraduate GPA, years of employment, age, GMAT verbal score, GMAT quantitative score, and AWA human score. They all appear similar between the groups. The group means and standard deviations of the AWA human scores appear to be very close with a difference of 0.02 in the means and 0.06 in the standard deviations. These are evidence for successfully controlling the writing ability of the two groups. It is safe to conclude that the two groups wrote equally well on the AWA essays based on human ratings. The two groups also show very similar compositions on gender (Table A-16), MBA degrees to be pursued (Table A-17), highest educational levels (Table A-18), and undergraduate majors (Table A-19). These tables are included in the Appendix.

Table 9. Summary of African American and Caucasian American Groups

	African		Caucasian	
	Mean	Std. Dev.	Mean	Std. Dev.
Undergraduate GPA	2.97	0.47	2.95	0.69
Years employed	5.95	5.49	6.11	5.83
Age	28.52	6.57	28.63	6.84
GMAT verbal score	23.72	7.71	24.17	7.27
GMAT quant. score	23.49	10.64	23.27	9.21
AWA human score	4.25	0.89	4.23	0.83

The means and standard deviations of the two groups on the AWA AES scores are almost identical (See Table 10). The difference in the group means is 0.05 and is not statistically significant in the paired *t*-test (p = 0.41). The null hypothesis of a population difference of 0.2 or larger is rejected. The two groups do not differ on their AWA AES scores and the AES is fair to African American test takers, when compared with their Caucasian counterparts.

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Table 10. AES Scores of African and Caucasian American Groups				
	African		Caucasian	
	Mean	Std. Dev.	Mean	Std. Dev.
AWA AES Score	4.27	0.92	4.32	0.86

Latino American and Caucasian American Test Takers

Latin American test takers make up the last subpopulation in the investigation and the control group is their Caucasian counterparts. Table 11 presents the means and standard deviations for the two groups on the undergraduate GPA, years of employment, age, GMAT verbal score, GMAT quantitative score, and AWA human score. They all appear similar between the groups. The group means and standard deviations of the AWA human scores appear to be very close with a difference of 0.02 in the means and 0.04 in the standard deviations. These show that the two groups wrote equally well on the AWA essays based on human ratings. The two groups also show similar compositions on gender (Table A-20), MBA degrees to be pursued (Table A-21), highest educational levels (Table A-22), and undergraduate majors (Table A-23). These tables are included in the Appendix.

Table 11. Summary of Latino and Caucasian American Groups				
	Latino		Caucasian	
	Mean	Std. Dev.	Mean	Std. Dev.
Undergraduate GPA	3.14	0.44	3.16	0.46
Years employed	5.94	5.09	5.71	5.85
Age	28.60	6.12	28.17	6.71
GMAT verbal score	27.75	7.85	27.34	7.44
GMAT quant. score	28.34	9.54	28.42	9.47
AWA human score	4.60	0.84	4.58	0.80

The means and standard deviations of the two groups on the AWA AES scores are almost identical (See Table 12). The difference in the group means is 0.02 and is not statistically significant in the *t*-test ($p = 0.71$). The null hypothesis of a population difference of 0.2 or larger is rejected. The two groups do not differ on their AWA AES scores and the AES is fair to Latino American test takers, when compared with their Caucasian counterparts.

Table 12. AES Scores of Latino and Caucasian American Groups				
	Latino		Caucasian	
	Mean	Std. Dev.	Mean	Std. Dev.
AWA AES Score	4.66	0.89	4.64	0.86

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Summary of Results

The studied groups were formed by random sampling from the available test takers of subpopulations of interest, and matched control groups were formed from reference subpopulations using propensity score matching. The differences of the AES scores between groups were analyzed.

All the studied groups were comparable with the 10 matching variables with similar means and standard deviations or similar compositions to their control groups. The propensity matching between the pairs of groups was a success.

All the studied subpopulation groups had very similar human scores to their control counterparts. The observed mean differences ranged from 0.01 to 0.09 with similar standard deviations so that the writing ability was comparable between the pairs of studied and control groups.

The studied subpopulation groups had mean AES scores very similar to their control groups. The differences in AES scores ranged from 0.01 to 0.05 with comparable standard deviations. None of the *t*-tests showed statistical significance. We might conclude that none of the pair-wise differences in the AES scores between the studied and control groups were larger than or equal to 0.2 in the population. In fact, the very small differences indicated that the AES scores were almost the same between the studied and control groups.

Conclusions

The current study investigates the fairness of the GMAT AWA AES to six subpopulation groups of test takers. The groups include test takers who write in non-US-English, test takers who speak English as a second language, male and female test takers, and US citizens of Asian, African, or Latin American origins. This study used propensity score method to create control groups by matching the individuals in the studied subpopulation groups. The matching is successful and the studied and control groups are equal on 10 matched variables. The observed mean AES scores are almost identical between the compared groups. Therefore, conclusions can be drawn that none of subpopulation groups is unfairly punished by the IntelliMetric system and the AES is fair to the six subpopulation groups of GMAT AWA test takers.

Contact Information

For questions or comments regarding study findings, methodology or data, please contact the GMAC Research and Development department at research@gmac.com.

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Appendix

Table A-1. Gender Composition of Non-US English and US English Speaker Groups

Gender	Non-US English	US English
Female	69	80
Male	231	220
Total	300	300

Table A-2. Composition of MBA Degree Pursued of Non-US English and US English Speaker Groups

MBA Degree to Be Pursued	Non-US English	US English
Doctorate in Business (PhD or DBA)	2	0
Executive MBA (EMBA)	50	36
Joint Degree – MBA/Engineering	0	1
Joint Degree – MBA/Law	2	3
Other Joint Degree	2	0
Master of Accountancy (MA)	2	2
Master of Public Administration (MPA)	1	2
MBA (Master of Business Administration and Master of Science)	219	236
Other Degree	13	12
Undecided	9	8
Total	300	300

Table A-3. Composition of Highest Education Level of Non-US English and US English Speaker Groups

Highest Education Level	Non-US English	US English
Have not yet completed undergraduate or first university	15	11
Completed undergraduate or university degree	185	202
Have taken graduate courses beyond first degree	38	43
Have attained a master's degree	58	39
Have attained a doctoral degree	4	5
Total	300	300

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Table A-4. Composition of Undergraduate Major of Non-US English and US English Speaker Groups		
Undergraduate Major	**Non-US English**	**US English**
Accounting	18	20
Actuarial Science	3	2
Agriculture	1	0
Art History	1	1
Biological Sciences	8	12
Business Education	6	9
Chemistry	2	9
Computer Science	15	13
Economics	22	30
Engineering	47	43
English	3	3
Finance	24	20
History	11	8
Information Systems/Technology	4	6
International Business	5	6
Journalism	1	1
Languages	10	9
Law	11	15
Management	18	14
Marketing	5	6
Mathematics	10	11
Medicine/Nursing	6	10
Operations Management/Production	3	0
Philosophy	5	1
Physics	4	4
Political Science	7	6
Psychology	5	6
Sociology	1	0
Other Business/Management/Economics	12	6
Other Engineering/Computer Science	6	1
Other Fine Arts	1	0
Other Humanities	8	6
Other Science/Mathematics	6	11
Other Social Sciences/Law	1	3
Major or field of study is not shown	10	8
Total	300	300

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Table A-5. Gender Composition of ESL and Native English Speaker Groups		
Gender	**ESL**	**Native English**
Female	109	113
Male	191	187
Total	300	300

Table A-6. Composition of MBA Degree Pursued of ESL and Native English Speaker Groups		
MBA Degree to Be Pursued	**ESL**	**Native English**
Doctorate in Business (PhD or DBA)	10	8
Executive MBA (EMBA)	10	22
Joint Degree – MBA/Engineering	5	8
Joint Degree – MBA/Law	2	3
Other Joint Degree	1	4
Master of Health Care Administration (MHA)	0	1
Master of Accountancy (MA)	15	11
MBA (Master of Business Administration and Master of Science)	232	218
Other Degree	17	17
Undecided	8	8
Total	300	300

Table A-7. Composition of Highest Education Level of ESL and Native English Speaker Groups		
Highest Education Level	**ESL**	**Native English**
Have not yet completed undergraduate or first university	20	18
Completed undergraduate or university degree	197	172
Have taken graduate courses beyond first degree	21	23
Have attained a master's degree	61	81
Have attained a doctoral degree	1	6
Total	300	300

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Table A-8. Composition of Undergraduate Major of ESL and Native English Speaker Groups		
Undergraduate Major	**ESL**	**Native English**
Accounting	19	20
Actuarial Science	0	1
Anthropology	1	0
Architecture	3	0
Biological Sciences	3	5
Business Education	9	5
Chemistry	2	4
Computer Science	18	28
Economics	33	25
Engineering	53	80
English	12	1
Finance	27	25
Fine Arts	1	1
Government	0	1
History	0	2
Hotel Administration	3	2
Information Systems/Technology	15	12
International Business	11	14
Journalism	2	2
Languages	3	2
Law	6	3
Management	20	12
Marketing	10	15
Mathematics	2	1
Medicine/Nursing	2	2
Operations Management/Production	7	3
Physics	4	2
Political Science	3	3
Psychology	0	2
Sociology	1	1
Statistics	1	1
Other Business/Management/Economics	13	4
Other Engineering/Computer Science	5	10
Other Humanities	0	1
Other Science/Mathematics	5	3
Other Social Sciences/Law	3	1
Major or Field of Study Is Not Shown	3	6
Total	300	300

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Table A-9. Composition of MBA Degree Pursued by Female and Male Group		
MBA Degree to Be Pursued	**Female**	**Male**
Doctorate in Business (PhD or DBA)	5	5
Executive MBA (EMBA)	5	13
Joint Degree – MBA/Engineering	2	2
Joint Degree – MBA/Law	6	4
Other Joint Degree	7	1
Master of Health Care Administration (MHA)	0	2
Master of Accountancy (MA)	27	36
Master of Public Administration (MPA)	0	5
MBA (Master of Business Administration and Master of Science)	227	209
Other Degree	10	11
Undecided	11	12
Total	300	300

Table A-10. Composition of Highest Education Level of Female and Male Groups		
Highest Education Level	**Female**	**Male**
Have not yet completed undergraduate or first university	42	41
Completed undergraduate or university degree	211	211
Have taken graduate courses beyond first degree	27	23
Have attained a master's degree	18	23
Have attained a doctoral degree	2	2
Total	300	300

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Table A-11. Composition of Undergraduate Major of Female and Male Groups		
Undergraduate Major	**Female**	**Male**
Accounting	40	66
Actuarial Science	1	0
Agriculture	1	0
Architecture	3	2
Art History	1	0
Biological Sciences	3	5
Business Education	6	14
Chemistry	1	2
Computer Science	2	6
Economics	23	20
Education	2	3
Engineering	17	22
English	9	6
Finance	25	21
Fine Arts	3	1
History	5	3
Hotel Administration	6	1
Information Systems/Technology	10	7
International Business	9	5
Journalism	1	0
Languages	4	4
Law	2	2
Management	27	26
Marketing	27	24
Mathematics	3	2
Medicine/Nursing	0	1
Operations Management/Production	3	2
Physics	0	1
Political Science	7	7
Psychology	12	10
Sociology	2	0
Other Business/Management/Economics	12	15
Other Engineering/Computer Science	2	2
Other Fine Arts	3	0
Other Humanities	7	4
Other Science/Mathematics	4	2
Other Social Sciences/Law	4	1
Major or field of study is not shown	13	13
Total	300	300

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Table A-12. Gender Composition of Asian American and Caucasian American Groups		
Gender	**Asian**	**Caucasian**
Female	135	131
Male	165	169
Total	300	300

Table A-13. Composition of MBA Degree Pursued by Asian American and Caucasian American Groups		
MBA Degree to Be Pursued	**Asian**	**Caucasian**
Executive MBA (EMBA)	7	11
Joint Degree – MBA/Engineering	4	3
Joint Degree – MBA/Law	7	5
Other Joint Degree	5	3
Master of Health Care Administration (MHA)	2	2
Master of Accountancy (MA)	14	10
Master of Public Administration (MPA)	1	0
MBA (Master of Business Administration and Master of Science)	248	256
Other Degree	6	4
Undecided	6	6
Total	300	300

Table A-14. Composition of Highest Education Level of Asian American and Caucasian American Groups		
Highest Education Level	**Asian**	**Caucasian**
Have not yet completed undergraduate or first university	16	16
Completed undergraduate or university degree	233	241
Have taken graduate courses beyond first degree	25	15
Have attained a master's degree	22	21
Have attained a doctoral degree	4	7
Total	300	300

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Table A-15. Composition of Undergraduate Major of Asian American and Caucasian American Groups		
Undergraduate Major	**Asian**	**Caucasian**
Accounting	13	17
Anthropology	1	1
Art History	1	0
Biological Sciences	15	9
Business Education	13	13
Chemistry	1	2
Computer Science	18	16
Economics	30	36
Education	0	1
Engineering	33	41
English	5	8
Finance	39	38
Fine Arts	1	0
History	5	0
Hotel Administration	4	1
Information Systems/Technology	16	8
International Business	4	2
Journalism	3	1
Languages	1	0
Law	0	2
Management	17	20
Marketing	19	20
Mathematics	4	5
Medicine/Nursing	3	1
Operations Management/Production	2	2
Philosophy	1	0
Physics	3	0
Political Science	4	6
Psychology	4	9
Sociology	1	3
Statistics	2	1
Other Business/Management/Economics	9	14
Other Engineering/Computer Science	5	3
Other Fine Arts	0	2
Other Humanities	5	2
Other Science/Mathematics	5	1
Other Social Sciences/Law	4	6
Major or field of study is not shown	9	9
Total	300	300

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Table A-16. Gender Composition of African American and Caucasian American Groups		
Gender	**African**	**Caucasian**
Female	166	162
Male	134	138
Total	300	300

Table A-17. Composition of MBA Degree Pursued by African American and Caucasian American Groups		
MBA Degree to be Pursued	**African**	**Caucasian**
Doctorate in Business (PhD or DBA)	3	7
Executive MBA (EMBA)	8	8
Joint Degree – MBA/Engineering	1	0
Joint Degree – MBA/Law	9	9
Other Joint Degree	4	5
Master of Health Care Administration (MHA)	4	5
Master of Accountancy (MA)	22	15
Master of Public Administration (MPA)	1	1
MBA (Master of Business Administration and Master of Science)	236	237
Other Degree	6	10
Undecided	6	3
Total	300	300

Table A-18. Composition of Highest Education Level of African American and Caucasian American Groups		
Highest Education Level	**African**	**Caucasian**
Have not yet completed undergraduate or first university	23	32
Completed undergraduate or university degree	233	207
Have taken graduate courses beyond first degree	32	38
Have attained a master's degree	8	21
Have attained a doctoral degree	4	2
Total	300	300

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Table A-19. Composition of Undergraduate Major of African American and Caucasian American Groups		
Undergraduate Major	**African**	**Caucasian**
Accounting	42	50
Actuarial Science	1	0
Agriculture	0	1
Biological Sciences	8	8
Business Education	6	11
Chemistry	2	5
Computer Science	3	1
Economics	16	21
Education	2	2
Engineering	21	19
English	5	2
Finance	26	24
Fine Arts	1	2
Government	5	5
History	1	5
Hotel Administration	0	1
Information Systems/Technology	17	7
International Business	3	2
Journalism	4	4
Languages	1	1
Law	2	2
Management	31	28
Marketing	24	28
Mathematics	7	6
Medicine/Nursing	1	2
Operations Management/Production	3	1
Philosophy	1	0
Physics	0	1
Political Science	7	6
Psychology	5	9
Sociology	1	3
Other Business/Management/Economics	20	19
Other Engineering/Computer Science	1	1
Other Fine Arts	3	1
Other Humanities	5	2
Other Science/Mathematics	2	2
Other Social Sciences/Law	9	3
Major or field of study is not shown	14	15
Total	300	300

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Table A-20. Gender Composition of Latino and Caucasian American Groups		
Gender	**Latino**	**Caucasian**
Female	122	122
Male	178	178
Total	300	300

Table A-21. Composition of MBA Degree Pursued of Latino and Caucasian American Groups		
MBA Degree to Be Pursued	**Latino**	**Caucasian**
Doctorate in Business (PhD or DBA)	5	2
Executive MBA (EMBA)	15	16
Joint Degree – MBA/Engineering	2	3
Joint Degree – MBA/Law	5	8
Other Joint Degree	2	2
Master of Health Care Administration (MHA)	2	2
Master of Accountancy (MA)	30	27
Master of Public Administration (MPA)	2	0
MBA (Master of Business Administration and Master of Science)	222	223
Other Degree	8	15
Undecided	7	2
Total	300	300

Table A-22. Composition of Highest Education Level of Latino and Caucasian American Groups		
Highest Education Level	**Latino**	**Caucasian**
Have not yet completed undergraduate or first university	24	37
Completed undergraduate or university degree	223	226
Have taken graduate courses beyond first degree	33	23
Have attained a master's degree	20	13
Have attained a doctoral degree	0	1
Total	300	300

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Table A-23. Composition of Undergraduate Major of Latino and Caucasian American Groups		
Undergraduate Major	**Latino**	**Caucasian**
Accounting	45	40
Agriculture	0	1
Anthropology	2	1
Architecture	1	2
Art History	0	1
Biological Sciences	7	5
Business Education	7	4
Computer Science	6	6
Economics	15	18
Engineering	25	28
English	5	6
Finance	29	28
Fine Arts	1	2
Government	3	1
History	4	4
Hotel Administration	0	2
Information Systems/Technology	6	7
International Business	3	11
Journalism	3	1
Languages	1	0
Law	2	1
Management	27	38
Marketing	11	15
Mathematics	3	4
Medicine/Nursing	2	0
Operations Management/Production	1	3
Political Science	5	10
Psychology	20	13
Sociology	2	1
Other Business/Management/Economics	22	22
Other Engineering/Computer Science	4	3
Other Fine Arts	2	1
Other Humanities	5	3
Other Science/Mathematics	2	0
Other Social Sciences/Law	5	7
Major or field of study is not shown	24	11
Total	300	300

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