A Potential Technological Solution In Reducing Achievement Gap Between White And Black Students[1]

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Abstract

This chapter presents preliminary findings from an observational study conducted at a large urban university exploring the utility of online intelligent tutoring system (ITS) in the classroom. Specifically, the study was designed to assess the efficacy of ALEKS (Assessment and LEarning in Knowledge Spaces) to reduce the gap often observed in the course grade scores for black and white students enrolled in an undergraduate behavioral statistics course. The study involved retroactively comparing the academic performance of students from online sections of a behavioral statistics course that used the ALEKS on-line tutorial system with that of students who took the same behavioral statistics course under the traditional lecture format. Preliminary findings revealed that the typical gap in performance, as measured by letter grade, observed between black and white students was essentially eliminated when the ALEKS ITS was introduced into the classroom.

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Introduction

Disparities in achievement measures that exist between black and white students, commonly referred to as the black-white achievement gap, are widely discussed in educational literature (Lubienski, 2008). In fact, even before the advent of modern standardized tests, there was extended analysis (e.g., Crowley, 1932) of performance gaps on tests between black and white students. In particular, much has been written about performance disparities among blacks, whites, and other ethnic minority groups on the mathematical section of standardized tests, such as the Scholastic Aptitude Test (SAT). A common finding is that the scores of black students lag behind those of whites in the United States. For example, the mean combined score on the mathematics and verbal sections of the SAT was 17% higher for white students than for black students (www.jbhe.com/features/49_college_admissions-test.html). Additionally, some research indicates that black students score at least one standard deviation below white students on standardized tests (Fryer & Levitt, 2004). These disparities remain, despite the fact that, both black and white students have made major gains in absolute terms on exams such as the National Assessment of Educational Progress (NAEP), an assessment of the educational achievement of elementary and middle school students (http://nces.edu.gov/nationsreportcard, 2008). The most recent reports can be found from National Education Association (NEA, http://www.nea.org/home/AchievementGaps.html) and Institute of Education Sciences (IES, http://nces.ed.gov/nationsreportcard/studies/gaps/).

Similar to the disparity in performance observed among blacks and whites on standardized exams, the black-white achievement gap is also evident in mathematics course grades (Lubienski, 2002). Differences exist between grades in mathematics courses at all levels (Lubienski, 2002). Often, these disparities start as early as kindergarten and persist across grade levels, and in some cases, widen over time (www.jbhe.com/features/49_college_admissions-test.html).

There is no clear explanation for the why the black-white achievement disparity emerges or why it sometimes increases over time (Hodges & Nowell, 1999). A widely ranging set of factors have been asserted to explain these racial differences in student achievement test scores, with a significant amount of attention focused on student's socioeconomic status, family, peer, and school factors, as well as student learning characteristics, academic ability, and other environmental and structural factors (e.g., Brooks-Gunn, Klebanov, & Duncan, 1996; Jeynes, 2003; Phillips et al., 1998; Hanashek & Rivkin, 2006; Orr, 2003; www.swcomputer.org/pdf/African_American_Overview.pdf).

In the majority of the educational literature that discusses the black-white achievement gap, socioeconomic status has been identified as one of the key contributors to the disparity in achievement observed among various racial groups (Hedges & Nowell, 1999). Students living in persistentpoverty aremore likely than other students to suffer from many conditions that impede their learning including poor health, frequent changes in residents that require transfer to new schools repeatedly, lack of books and eductional resources in their hoes, parents or guardians with lower levels of education, and unstable family structures. However, Lubienski (2002) also examined socioeconomic status and its relation to the black-white achievement gap. The findings from this study indicated that students' socioeconomic status may not be the sole contributor to the achievement gap. In fact, white students from low- and high-income families achieved at higher levels than their black counterparts (Lubienski, 2002). In a like manner, Fryer and Levitt (2004) discussed the socioeconomic status of the schools that students attend as an important factor in students' achievement levels.

Cultural attitudes and racism have also been shown to play a critical role in the achievement gap. In this regard, some researchers contend that many bAfrican American students simply stop trying to excel academically because they do not want to be thought of as "acting white" by their peers. Relatedly, some researchers suggest that black students are not motivated to excel because they perceive that others do not view them as capable or expect them to fail.

Compounding these socio-cultural factors are several structural and institutional factors that are believed to contribute to the black-white achievement gap. Students from disadvantaged backgrounds often encounter school conditions that only exacerbate the problem. Limited availability of resources in the schools that serve mainly black students, larger class sizes, fewer qualified teachers, and limited access to technology in the classroom are all factors that impede the academic development that is necessary for black students to perform at similar levels as white students (Fryer & Levitt, 2004; Lubienski, 2002; Judge, Puckett, & Bell, 2006, www.swcompcenter.org/pdf/African_American_Overview.pdf).

Narrowing the Achievement Gap through Technology in the Classroom

What is needed to reduce the black-white achievement gap is not only complex but controversial. Many researchers and practitioners are using after-school tutoring sessions and remedial programs to help narrow the gap. De-tracting students so that equally qualified teachers, expectations, curriculum and resources are avilable within schools as well as tracking students by ability groups are also being used. As schools consider students' ability levels, some researchers and practitioners are considering strategies to identify specific skill and knowledge deficits students might have and are, then, responding in targeted ways. With the introductioin of learning technologies into the classroom, many are exploring the utility of online intelligent tutoring systems as strategies for reducing the black-white achievement gap.

In actuality, computer technology for educational purposes ranges from the use of computers for in-class assignments and web-based tutorials to distance learning and virtual classrooms (Mitra, Joshi, Kemper, Woods, & Gobble, 2006). It is obvious that more and more classrooms are equipped with computers, that computer software packages are being adopted to enhance the learning experience, and that learning applications are more accessible through the Internet (Packard, 2007). Included in the ranks of these applications are online intelligent tutoring systems (ITS), like ALEKS, that can be used to enhance students' knowledge base and ultimately improve academic achievement (Packard, 2007).

As is shown frequently in the literature on the relationship between use of technology and academic achievement, students who use computers or engage in online learning experiences tend to perform better in school than students who do not have technology incorporated into their learning activities (Clements, 1999; Judge, 2005; Judge et al., 2006). This finding holds for children regardless of their ethnicity or racial and socioeconomic background. For example, Judge (2005) examined the impact of computer technology on academic achievement of African-American children and found that general use of computers was positively correlated with students' achievement scores. Likewise, the use of learning software (e.g., math, reading, and science) was positively correlated with achievement (Judge, 2005). Taken together, this research suggests that technology may be a viable option for increasing achievement levels of students in minority and majority groups. However, empirical evidence of the use of technology to reduce the the achievement gap between minority and majority groups is sparse. On-line tutoring systems, such as ALEKS, provide opportunities to individually address student deficits and, thereby, close the gap in student achievement.

Objective

This chapter presents some preliminary findings from an observational study conducted at a large urban university with the purpose of exploring the effectiveness of using an online ITS, ALEKS (Assessment and Learning in Knowledge Spaces), to close the racial score gaps in an undergraduate behavioral statistics course rather than simply increase absolute scores for all groups.

Theoretical Framework

Students majoring in psychology or social sciences find behavioral statistics one of the most challenging required undergraduate courses. The primary reason for difficulty with the course is the prerequisite mathematics skill necessary to understand some of the basic concepts. This is especially true for students who have been out of school for a long time or who had a weaker mathematics background. Due to the variability of mathematics skills, lecture-based, traditional classroom instruction is very inefficient. Indeed, some students find it impossible to follow lectures, fall behind, and eventually fail.

While traditional lecture style instruction cannot help students who have fallen significantly behind, studies (e.g., Fletcher, 1990) have shown that learners do better with the help of technology. More specifically, Hagerty and Smith (2005) found that the Web-based ITS, ALEKS, helped college students learn college algebra. This research and other studies of the ALEKS system led us to explore the use of the ALEKS Behavioral Statistics package (http://www.behsci.aleks.com) as a possible solution to help those students who had fallen significantly behind in this specific course.

ALEKS Behavioral Statistics decomposes concepts in basic statistics, from frequency distributions to Analysis of Variance [ANOVA], into small units, called "items," There is a total of 19 mathematics readiness items and 109 statistics items. Each item is presented as a unique type of problem that students are required to solve. Items are then are grouped together into larger content areas that must be learned to demonstrate mastery in behavioral statistics. This collection of the 128 problem types forms a comprehensive course in behavioral statistics.

The power of ALEKS is rooted in its sound theoretical foundation, Knowledge Space Theory (Doignon and Falmagne, 1999; Falmagne, Cosyn, Doignon, and Thiéry, 2006), which enables the fine tuning of instruction for individual students. Every interaction between ALEKS and a student results in a reappraisal of the student's knowledge state, signaling a student's critical weaknesses or lacunae, formulated in terms of the curriculum, and allowing a precise gearing of teaching.

In addition to these features, there are other advantages to using a Web-based ITS such as ALEKS. For example, ALEKS is available anytime, anywhere with an internet connection. This flexibility is especially helpful for students who have difficulty following traditional lectures due to a lack of basic mathematics knowledge and need additional time to catch up. Furthermore, ALEKS is designed such that students need to master prerequisite knowledge in order to learn subsequent, more advanced topics. It is through this design that ALEKS guides the learning progress of each student and prevents a student from becoming lost in concepts for which he or she is not ready.

Thus, the primary reason to implement ALEKS in the undergraduate statistics course is that it provides a technological solution that allows students with lower levels of mathematics achievement to work more efficiently toward mastery of statistical concepts.

Methods

Research Design

A nonequivalent control group design was used to compare the academic performance of students from online sections of a behavioral statistics course using ALEKS to a retrospective comparison group comprised of students enrolled in the same course taught in a traditional lecture format. The original data set included 2329 students who enrolled in Behavior Statistics at this urban institition between the Fall of 1994 until through the Spring of 2008. Course grades were obtained from the university's Office of Institutional Research. data from a smaller subset of students (N=1309) were included in the current study. Students were excluded from the analysis due to one or more of the following reasons: 1) without ACT nor SAT mathematics score, 2) received grade "I" (incomplete) or early withdraw, 3) not Black nor White, and 4) was in a class less than 10 students. Hence, the study sample included 370 Black students and 939 White students in 69 classes taught by 32 different professors. Among these 1309 students, there were 112 students took the course online using ALEKS and 1197 students were enrolled in traditionally taught lecture sections (see table 1).

Table 1 is about here

Measures

The analyses are based on a measure of grade performance. Several steps were taken in developing the grade performance measure. First, students' letter grades were retrieved from the university's database and those who withdrew early or had an incomplete were removed from the data. Only students enrolled in class size over 10 and with ACT or SAT scores are included in the analysis. Valid grades were then transformed into numeric counterparts: A, B, C, D, and F into 4, 3, 2, 1, and 0, respectively. For students who took the course more than once, their highest grade was used. Because some instructors may consistently be more lenient or stricter in grading than others, valid students' grades from the same instructor were converted into standardized z scores in order to alleviate potential grading biases by individual instructors and to make the course grade from different instructors comparable.

Procedures

Each of the classes using the traditional lecture format was led by an instructor and met two days a week, with one hour devoted to a computer lab section (using SPSS). The online sections of the course used ALEKS, an online math tutorial system. For this study, ALEKS provided a self-paced distance-learning course. Students were required to spend approximately 8 hours per week on this 4 credit-hour class. Each lecture and online classes were was led by a professor with a graduate student/teaching assistant. The online classes were offered to students, beginning during the Fall semester of 2004. Both course formats, online and lecture sections, were available to students between 2004 and 2008. Students self-selected to either of the classes.

Analysis

Three different analytical procedures were completed. The results are presented and compared below. First, a two-way ANOVA was performed with the z-score grade as the dependent variable and race (black vs. white) and course formats (online vs. traditional) as the independent variables. Second, an analysis of covariance (ANCOVA) was conducted by adding the ACT mathematics scores as the covariate. ACT mathematics scores are made available for all 1309 students. For those students who only have SAT scores, their SAT score is converted into equivalent ACT scores based on a conversion table from Collegeboard.com (http://professionals.collegeboard.com/profdownload/pdf/rr9901_3913.pdf). Third, an analysis of covariance (ANCOVA) was conducted by adding the cumulative GPA prior to enrolling in the course as the covariate variable. This is made into a separate model because, among the 1309 students, the University cumulative GPA is only available for 992 of the students.

Results

The two-way ANOVA model, as presented in Table 2, shows that there is a significant interaction between Race and Class Format ($F(1,1305)=6.04$, $p=0.014$). Further tests show White students perform significantly better than Black students in the lecture format (0.162 vs -0.299, $F(1,1195)=59.559$, $p=0.000$) but exhibit comparable performance in the online (ALEKS) format (0.085 vs. 0.100, $F(1,110)=0.007$, $p=0.934$, n.s).

Table 2 is about here

To examine whether the observed difference continue to exist when racial differences in academic performance prior to entering college is controlled, an ANCOVA model with ACT Mathematics score is used as the covariate. The findings revealed that the ACT Mathematics score of black students are significantly lower than that of the white students (18.16 vs. 21.43, t(1307)=-13.554, p=0). The ACT Mathematics scores for students were not significantly different (20.53 vs. 20.20, t(1307)=-0.805, p=0.421) in either the lecture and or online format. The results of the ANCOVA model are presented in Table 3.

Table 3 is about here

With ACT mathematics score as the covariate, the analysis show a significant interaction between Race and Format (F(1,1304)=5.876, p=0.006). Furthermore, the ANCOVA reveals that performance of Black students is slightly better than White students in the Online condition (0.283 vs -0.008, F(1,109)=2.533, p=0.114, n.s). White students perform significantly better than Black students in the lecture condition (0.094 vs -0.122, F(1,1194)=12.723, p=0.000).

Another ANCOVA is then conducted in which the cumulative GPA prior to enrollment in the statistics course is used as the covriate. With a total of 1168 students (there are students missing accumulate GPA prior to the enrollment of the statistics class), we observed similar outcomes. Black students had significantly lower GPAs than did white students (2.75 vs 3.1, t(990)=-9.9, p=0.00). The average GPA for lecture students (3.00) and online students(2.90) were not significantly different (p=0.102, n.s). The results of the second ANCOVA model is summarized in Table 4.

Table 3 is about here

Summary

Major findings

The first noteworthy change from the ANOVA model to the ANCOVA model is that the explained variance of the course grade increases from 4.4% to 14.4% (ACT Math) and 38.5% (GPA), an indication that student performance prior to the course is a important factor to consider when studying racial gaps. Most interesting findings from the observation are the reversed order between White students and Black students when considering the prior performances. These observations suggest that using ITS systems such as ALEKS help students who were behind relatively more efficiently.

These analyses demonstrate the potential value of an online ITS as a tool for eliminating racial disparities in college students' academic performance. Differences in the final grades for passing black and white students enrolled in a behavioral statistics course were eliminated in this study. Results indicate that disparities in the performance of black and white students were present in lecture-based behavioral statistics sections but were not present in online ITS-based sections that used ALEKS. This finding held even when the results were adjusted for prior GPA and ACT mathematics scores.

Limitation of the Current Study

While the findings from the study are encouraging, there are some limitations that preclude generalization of the findings. The study used a sample of 1300 students (out of 2300) taking behavior statistics in the last 15 years from an urban University. Generalizability is limited by the non-random sample, though the findings are still convincing that a technological solution is possible to solve the well documented black-white achievement gap in higher education. Another limitation is that the analyses and conclusions are based on observational data, information on family background, student learning characteristics, and other factor that may play a role in racial academic gaps are unavailable for consideration. Nonetheless, the three analytical models yield consistent findings and they demonstrate the potential value of an online intelligent tutoring systems (ITS) as a tool for eliminating racial disparities in college students' academic performance.

Future Directions

The findings of this study suggest that racial gap in the final grades for black and white students enrolled in a behavioral statistics course may be reduced and even eliminated when a different learning environment, an online ITS, is present. The improvement in the performance of black students in online classes should not be interpreted as white students suffering disadvantages in non-traditional learning environment. Rather, it should lead to further examination of the roles that different learning styles and cultural backgrounds play in teaching and learning when continuous effort is made to close the academic performance gap between racial groups.

Even though the current study does not have data to support causal arguments, future research can explore the following hypotheses. First, it is likely that black students, in general, may retreat from the competitive group learning as experienced in lecture format and feel more relaxed and efficient when working alone in with an online ITS. Second, it is also possible that the flexibility of an online class is a key advantage to black students in case they need longer time to complete learning tasks and wherein they experience less anxiety associated with class quizes and exams. Finally, numerous online learning systems/software are available and not all of them are effective. It is important to study and design flexible and effective learning enviroments to meet learners with different styles and preferences.

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Table 1: Frequency of students whose data are analyzed in the study.

	Lecture	**Online**	**Total**
Black	332	38	370
White	865	74	939
Total	1197	112	1309

Table 2. Two-way ANOVA of the standardized course grade.

Tests of Between-Subjects Effects

Dependent Variable: Z-score for Grade

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	51.341[a]	3	17.114	20.053	.000
Intercept	.053	1	.053	.062	.803
RACE	4.521	1	4.521	5.297	.022
Format	2.374	1	2.374	2.782	.096
RACE * Format	5.154	1	5.154	6.040	.014
Error	1113.692	1305	.853		
Total	1167.001	1309			
Corrected Total	1165.033	1308			

a. R Squared = .044 (Adjusted R Squared = .042)

Race * Lecture or Online

Dependent Variable: Z-score for Grade

Race	Lecture or Online	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Black	No	-.299	.051	-.399	-.200
	Yes	.100	.150	-.194	.394
White	No	.162	.031	.100	.223
	Yes	.085	.107	-.125	.296

Estimated Marginal Means of Z-score for Grade

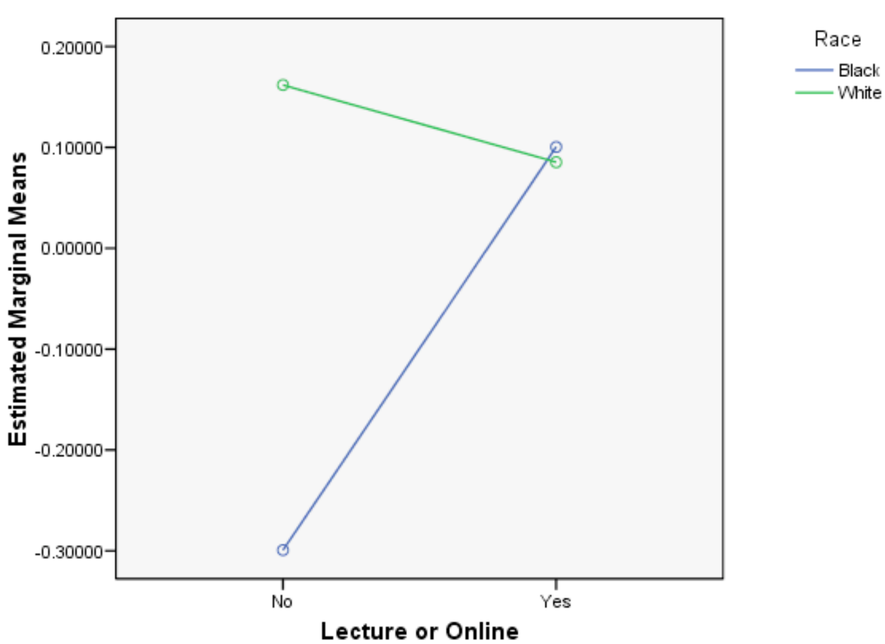

Table 3. ANCOVA of the standardized course grade with ACT Mathematics Scores as Co-variant.

Tests of Between-Subjects Effects

Dependent Variable: Z-score for Grade

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	168.176[a]	4	42.044	54.998	.000
Intercept	100.565	1	100.565	131.550	.000
ACT_MATH	116.834	1	116.834	152.832	.000
RACE	.129	1	.129	.169	.681
Format	2.848	1	2.848	3.725	.054
RACE * Format	5.876	1	5.876	7.687	.006
Error	996.858	1304	.764		
Total	1167.001	1309			
Corrected Total	1165.033	1308			

a. R Squared = .144 (Adjusted R Squared = .142)

Race * Lecture or Online

Dependent Variable: Z-score for Grade

Race	Lecture or Online	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Black	No	-.124[a]	.050	-.222	-.026
	Yes	.307[a]	.143	.027	.587
White	No	.092[a]	.030	.032	.151
	Yes	.014[a]	.102	-.185	.214

a. Covariates appearing in the model are evaluated at the following values: ACT_MATH = 20.5111.

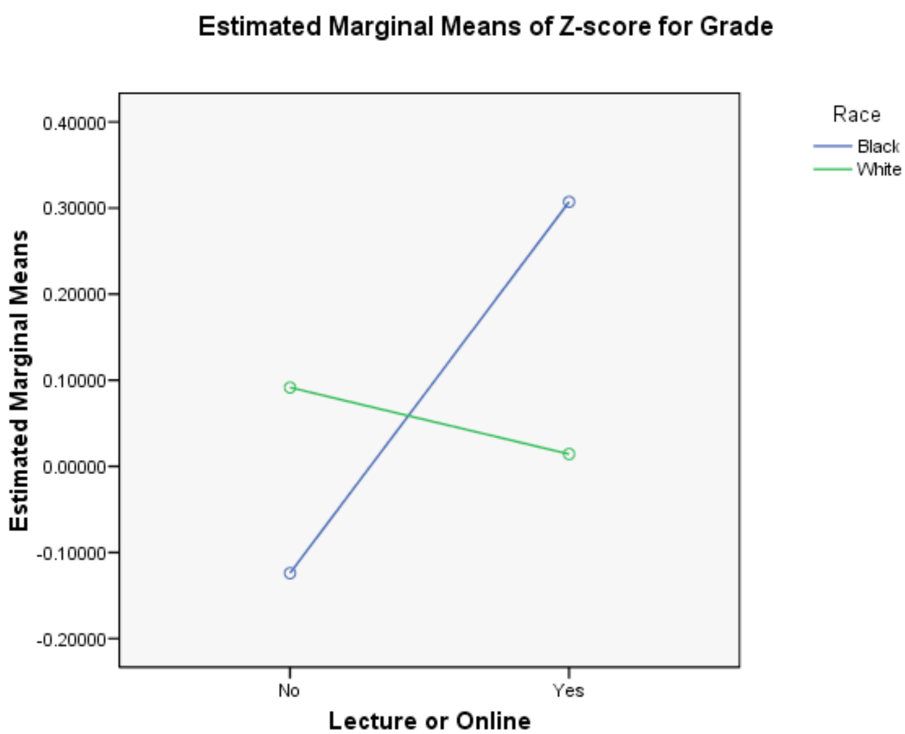

Table 4. ANCOVA of the standardized course grade with university accumulated GPA as covariate.

Tests of Between-Subjects Effects

Dependent Variable: Z-score for Grade

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	394.157[a]	4	98.539	182.102	.000
Intercept	308.952	1	308.952	570.948	.000
UCUMGPA	347.201	1	347.201	641.633	.000
RACE	1.832	1	1.832	3.386	.066
Format	8.671	1	8.671	16.024	.000
RACE * Format	4.913	1	4.913	9.079	.003
Error	628.783	1162	.541		
Total	1026.176	1167			
Corrected Total	1022.940	1166			

a. R Squared = .385 (Adjusted R Squared = .383)

Race * Lecture or Online

Dependent Variable: Z-score for Grade

Race	Lecture or Online	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Black	No	-.032[a]	.043	-.117	.052
	Yes	.513[a]	.120	.276	.749
White	No	.056[a]	.027	.002	.110
	Yes	.134[a]	.086	-.034	.302

a. Covariates appearing in the model are evaluated at the following values: UCUMGPA = 2.9903.

Estimated Marginal Means of Z-score for Grade