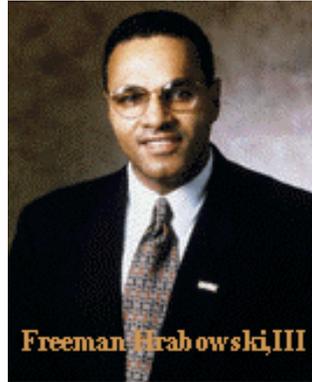# Freeman A. Hrabowski, III

In the 1960's, Birmingham, Alabama was bubbling over with racial prejudice and violence. The city was nicknamed "Bombingham" because of the numerous bombings of black homes and churches that occurred during this time. Martin Luther King, Jr. made speeches from Birmingham, and in May of 1963 he called upon the African-American children there to participate in a protest called the "Children's March." The march was comprised of hundreds and hundreds of children from throughout the city. Over 900 were arrested and placed in city jails, and some were even injured because of the brutality of the police. One young man who spent five days in jail for protesting was thirteen year-old Freeman A. Hrabowski, III [5,16].

Hrabowski had participated in the march with the consent of his parents, despite the fact that his mother's teaching job would be threatened if her children were involved. Hrabowski's parents encouraged him to be proud of his racial heritage and stand up for his rights. They took him to civil rights meetings in Alabama and participated in the boycott of stores owned by whites, by wearing jeans to church on Easter Sunday instead of buying new clothes [5]. In essence,

Hrabowski's parents had prepared him to deal with the prejudices he would encounter in his childhood.

Hrabowski experienced more pain as a result of racial violence in the months following the march. On Easter Sunday, Hrabowski's classmate and friend Cynthia Wesley was murdered in the infamous 16th Street Baptist Church bombing that killed four African-American girls. The bombing took place only a month after King's "I have a dream" speech and brought nationwide attention to the racial disaster in Birmingham. Hrabowski was one of the few children who attended Cynthia Wesley's funeral mass [5, 16].

Not only did Hrabowski experience the effects racial hatred in general society, but he also saw them in his own education. When he was in the second grade, Hrabowski peeled the cover off his textbook to discover that it had been discarded by a white school in Birmingham. He was being taught with material that was not good enough for the white students, but fine for the blacks. Hrabowski's teacher told him to "get the knowledge, and you'll be fine" [5,16].

Freeman A. Hrabowski, III did just that and more. At the age of 19, he graduated from Hampton Institute with highest honors in Mathematics. Hrabowski went on to receive a Masters in Mathematics and a Doctorate in Education Administration/Statistics at the University of Illinois at Urbana-Champaign [3,4,5,16]. The title of Hrabowski's dissertation, finished in 1975, was "A Comparison of Graduate Academic Performance of Black Students Who Graduated from Predominately Black Colleges and Predominantly White Colleges" [1]. There is no information on why Hrabowski chose to pursue a

career in Mathematics or Education, but it can be assumed that since his mother was an educator, she encouraged him in his scholastic endeavors.

Freeman A. Hrabowski cannot be described as either a pure or applied mathematician. Throughout his career he has published several papers dealing with minority educational issues and supported with statistical research. More than exploring mathematics, Hrabowski has become interested in making the field of mathematics, as well as the sciences, more accessible to minority students.

In 1987, Hrabowski joined the University of Maryland, Baltimore County (UMBC) as vice Provost and has now been the President of the University for over 10 years [3,4,5]. When he came to UMBC, it was a commuter school, built in the late 1960's to serve the inner city population in the area. No African American had ever earned an A in a science class [9].

Hrabowski has been credited with transforming UMBC into what U.S. News & World Report an educational "powerhouse." In fact, in the winter of 2000, UMBC awarded more degrees in biochemistry to African-American students than any other college in the nation. UMBC is known for its academic environment; it has no football team but the chess club has been international champions for three of the last four years and returns home to letter jackets and pep rallies. Last year, the average Freshman SAT was 1400 [6].

One of the greatest accomplishments of Hrabowski's work is the Meyerhoff Scholarship Program that began in 1989. With the help of philanthropists Robert and Jane Meyerhoff, Hrabowski created a "highly

structured education and mentoring program," which originally targeted African American males, and later African American females, and now accepts students of any race. Hrabowski wanted to begin to fill the gap in science engineering, and medical research. He did this by recruiting some of the top minority students interested in science and mathematics in the country, placing them together with other students who possessed great potential, and fostering an atmosphere of academics and success [3,5,9,16].

For his work with this program, Hrabowski was awarded the first US Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. Other awards given to Hrabowski include the Distinguished Citizen Award from the Boy Scouts of America, The Hatikvah Award (The Jewish National Fund), The Educator Achievement Award (NSF), The Golden Torch Academic Award (National Action Council for Minorities in Engineering) and the Educator Achievement Award from the National Science Foundation. Hrabowski presently serves as a consultant to the National Science Foundation, the National Institutes of Health, the National Academy of Sciences, and the US Department of Education, and he is a member of the American Council on Education [3,4,5,9].

Hrabowski's doctoral dissertation could not be acquired because the University of Illinois at Urbana-Champaign would not release it. Instead, two articles were found that contained enough statistics that allowed for an analysis of statistical technique. When one performs a statistical analysis the technique or test used must answer the question being asked, but should be the correct

kind of test for the data given [11]. We will analyze and critique the statistical techniques in the two articles.

One article, entitled "Graduate School Success of Black Students from White Colleges and Black Colleges," published in 1977, did not employ the most appropriate statistical technique. The question Hrabowski was trying to answer was whether or not African-American students from historically Black colleges and African-American students from predominantly white colleges go on to graduate from Doctoral programs. In this article, he used an F-test to analyze the proportion of graduates from predominantly Black colleges and predominantly white colleges who went on to graduate from Doctoral programs. The F-test is a technique that is usually used for testing numerical data, not proportional data [13]. Proportional data represents percentages or proportions of a sample from a particular category. For example, in this case the categories the students were placed in were either graduated from a Doctoral program or not graduated from a Doctoral program. A better test for analyzing the categorical data Hrabowski had would have been a X^2-test (chi-squared test). A X^2-test has three general uses, which are explained below:

1. Goodness of fit
1. Testing for independence
1. Test of homogeneity

The X^2-test for goodness of fit is used when determining if the proportions of the samples agree with a specified distribution. The X^2-test of independence is used when subjects in a single population are classified according to two different variables. It is used to determine if there is any dependency between the two

categorical variables. The X^2-test of homogeneity is computed in a similar manner to the X^2-test of independence, except that the X^2-test of homogeneity is used when there are several populations and one variable [13]. For the data available, the X^2-test of homogeneity would have been more appropriate. The X^2-test for homogeneity is used to determine whether the two populations, students from Black colleges and students from white colleges, have similar or homogeneous distributions with respect to some categorical variable, in this case graduating from a Doctoral program.

In the article, the data is arranged in a table. The rows of the table generally contain the groups being compared and the columns typically contain the different categories. The test statistic is $X^2 = \Sigma \ [(o_i - e_i)^2 / e_i]$, where o_i is the observed value and e_i is the expected value. The expected value is found by computing $e_i = RC/n$, where R is the row total, C is the column total, and n is the total number of observations (in this case students).

The table below contains the actual numbers from Hrabowski's article, and the values in the table are the observed values.

Graduation Rates in Doctoral Programs among Black Graduate Students by Type of College

Group	Graduated	Not Graduated	Total
A (Students from black colleges)	24	39	63
B (Students from white colleges)	10	30	40
Total	34	69	103

In the following table are the expected values for the table of observed values above, calculated using the formula presented above.

Expected Graduation Rates in Doctoral Programs among black Graduate Students by Type of College

Group	Graduated	Not Graduated	Total
A (Students from black colleges)	20.80	42.20	63
B (Students from white colleges)	13.20	26.80	40
Total	34	69	103

For the observed values and the expected values in the two tables:

$$X^2 = (24 - 20.80)^2 / 20.80 + (39 - 42.20)^2 / 42.20 + (10 - 13.20)^2 / 13.20 +$$

$$(30 - 26.80)^2 / 26.80 . \text{ Therefore } X^2 = 1.89 \text{ [1]}.$$

The degrees of freedom, denoted df, is equal to $(r - 1)(c - 1)$, which in words is the number of rows minus one, times the number of columns minus one. Assuming the row and column totals are fixed, the df represents the number of cells that could vary in the table before dependency occurs. For the two by two table, the df $= (2 - 1)(2 - 1) = 1$, which means only one cell could be manipulated because the other cells are dependent on the value in that one cell. From the X^2 table found in most statistic textbooks, (on page 897 of Exploring Statistics: A Modern Introduction to Data Analysis and Inference, 2nd Edition by Larry J. Kitchens) it is determined that $.200 < p < .100$. The variable p stands for the level of significance. A smaller p indicates more significance, and the accepted small p is $p<.05$. This means that there is not a significant difference between

the proportion of students from black colleges graduating from Doctoral programs to the proportion of black students from white colleges graduating from Doctoral programs [11]. Hrabowski came to the same conclusion with the F-test, but using the F-test could have led him to a different conclusion.

The second article containing statistics that was analyzed and critiqued was published in 1995 and titled "Enhancing the Success of African-American Student in the Sciences: Freshmen Year Outcomes," he performed tests that were judged to be more appropriate for the question he was asking as well as the data available. In the article Hrabowski explained that a comparison was made between the students in the Meyerhoff Program at UMBC and a sample of students who were going into mathematical and science fields who had graduated prior to the establishment of the Meyerhoff Program.

To perform an accurate analysis of the effects of the treatment, in this instance the Meyerhoff Program, comparisons were done on characteristics shared by both groups that could affect the end results. Hrabowski performed comparisons on SAT math and verbal scores, high school grade point averages, gender, and the number of science course credits earned during the freshman year. The science courses included chemistry, physics, biology, math, engineering, and computer science courses. The test Hrabowski used was a two-sample t-test. To check the values he calculated, the two-sample t-test has been reconstructed.

The statistics necessary for conducting a two-sample t-test include: x = the mean of the sample, n = the number in the sample, and s = the sample

standard deviation (sd). The test statistic for the t-test is: t = $(x_1 - x_2) / \sqrt{(s_1^2 / n_1) + (s_2^2 / n_2)}$. From the table in his article that compared the SAT Math scores for the Meyerhoff students, denoted by the subscript 1, and the sample of students who did not go through the Meyerhoff Program, denoted by the subscript 2, x_1 =635.7, s_1 = 59, n_1 = 69, x_2 = 607.7, s_2 = 46.3, and n_2 = 43.

Therefore t = $(635.7 - 607.7) / \sqrt{(59^2 / 69) + (46.3^2 / 43)}$, which equals 2.80 with p<.01. This number was not the number Hrabowski reported in his article. It was hypothesized that the reason there was a difference in the two numbers was because Hrabowski used a pooled t-test, which is a special case of the two-sample t-test. A pooled t-test is very similar to a regular t-test, but it is calculated based on the assumption that the population standard deviations, $\_1$ and $\_2$, are equal. This means that the sample standard deviations, s_1 and s_2, can be combined into one estimation of the joint population standard deviation, $\_$. The equation for a pooled t-test is t = $(x_1 - x_2) / s_p \sqrt{(1 / n_1) + (1 / n_2)}$, where s_p = the pooled standard deviation. To find the pooled standard deviation, $s_p = \sqrt{[(n_1 - 1) s_1^2 + (n_2 - 1) s_2^2] / (n_1 + n_2 - 2)}$. For the numbers in Hrabowski's article $s_p = \sqrt{[59^2 (69 - 1) + 46.3^2 (43 - 1)] / (69 - 43 + 2)}$, which means s_p = 54.50. When the pooled t-test was calculated, t = $(635.7 - 607.7) / 54.50 \sqrt{(1 / 59) + (1 / 43)}$, t was found to be equal to 2.64 with p<.01, which was the same value Hrabowski found. In fact, Hrabowski did use the pooled t-test [14].

In the past, it was common to use the pooled t-test because the df is easier to calculate. Modern practice, especially within the past few years, is moving away from the pooled t-test. This is due to the widespread use of

computers and the difficulty of verifying or testing the assumption that the population variances and the population standard deviations are the equal. Many people continue to use the pooled t-test because that is what was taught to them [11]. Why Hrabowski used the pooled t-test is not known, but one may guess that it was because the df was easier to calculate than that of a regular t-test. The df of a pooled t-test = $n_1 + n_2 - 2$ and the df of a regular t-test = $\{(s_1^2 / n_1) + s_2^2 / n_2)\}^2 / \{[(s_1^2 / n_1)^2 / (n_1 - 1)] + [(s_2^2 / n_2)^2 / (n_2 - 1)]\}$ [11,14]. In Hrabowski's case, the similarity of the results for the two tests indicates that the use of the pooled t-test was satisfactory. Because the results were very similar, it was not inappropriate to use a pooled t-test. However, if the calculations could have been, and were performed on a computer, it would have been just as easy to use the regular t-test values [11].

Overall, Hrabowski used better and more appropriate statistics in his more recent article. Not only did he use a t-test to compare characteristics shared by both groups, but he also used a matched t-test and an analysis of covariance, ANCOVA, on the two on the two groups. The matched t-test matches subjects in one data set with subjects in the other data set according to key characteristics to try to eliminate the biasing effects of those characteristics. The purpose of the ANCOVA is also to try to eliminate confounding factors, such as gender, high school grade point average, SAT scores, or race, so that, theoretically, the effect is only due to the treatment being analyzed. The covariates in Hrabowski's article included SAT-Math and Verbal scores, High school grade point average, gender, year of college entrance, and the total number of science credits taken

during the freshman year. An ANCOVA is an advanced statistical method that is not mentioned in the introductory statistics book that we used to understand the statistics Hrabowski used [13].

In his conclusions in the 1995 article, Hrabowski stated his results in a way more consistent with statistical practice. In the 1977 article, claims were made that extrapolated too far beyond the results of his tests. But in the second article, he stated that " . . . research cannot definitely prove that a given program is the determining cause of observed student outcomes." This indicates that he understands the results from a statistical test can show strong probabilities, but cannot prove a certain hypothesis. One can see that Hrabowski has matured statistically from the 1977 article to the 1995 article. He is using more appropriate statistical tests and his analysis of the results is more consistent.

The little boy who was subjected to extreme racism has achieved more than just "getting the knowledge". He has grown up to be the President of a nationally known university. Today, in a time where racism is still evident in the U. S., he has overcome great obstacles and encouraged hundreds of minority students. He is a true inspiration to minorities, mathematicians, and math educators.

References

1. Anderson, Ernest F. and Freeman A. Hrabowski. "Graduate School Success of Black Students from White Colleges and Black Colleges." <u>Journal of Higher Education</u>, Volume 48, Issue 3. (May-June 1977), 294-303.

   Comments: This article is one of the articles analyzed and critiqued. It was the first article found before we found out we could not obtain the Doctoral dissertation.

2. Embracing Excellence and Diversity – The School Administrator [Online]. Available from:
   http://www.aasa.org/publications/sa/1999_12/hrabowski.htm

   Comments: This article is from the AASA and is informative concerning the opinions of Hrabowski about African Americans in the sciences.

3. Freeman A. Hrabowski, III [Online]. Available from:
   http://ua1vm.ua.edu/airforum/cincinnati/hrabowskibio.shtml

   Comments: This page is a brief description of Hrabowski's life and is a good source for an overview.

4. Freeman A. Hrabowski, III –University of Maryland at Baltimore County [Online]. Avaliable from:
   http://www.umbc.edu/AboutUMBC/Welcome/freeman.html

   Comments: This web page is an overview of the life and accomplishments of Hrabowski. It is provided by UMBC, the University of which Hrabowski is president.

5. Freeman H. Hrabowski, III – Mathematicians of the African Diaspora [Online]. Available from:
   http://www.math.buffalo.edu/mad/PEEPS/hrabowski_freeman.html

   Comments: This web site was extremely useful in our paper. It includes an overview of Hrabowski's life as well as specific information regarding difficulties Hrabowski has encountered as a minority.

6. Freeman Hrabowski – Baltimore Business Journal [Online]. Available from:
    http://baltimore.bcentral.com/baltimore/stories/1999/08/09/focus2.html

    Comments: This article is an interview with Freeman Hrabowski. It goes over important points about his convictions concerning the education of minorities in the sciences and information about UMBC and the Meyerhoff Program.

7. The Gospel According to Freeman Hrabowski – University Business [Online].
    Available from:
    http://www.universitybusiness.com/0012/cover_umbc.html

    Comments: This page is an article from University Business and is informative concerning UMBC and specifically the Meyerhoff Program.

8. Hrabowski, III, Freeman A., Geoffrey L. Greif, and Kenneth I. Maton. Beating the Odds: Raising Academically Successful African American Males. New York: Oxford University, 1998.

    Comments: Book co-authored by Hrabowski was informative in making us aware of what important work was done by Hrabowski.

9. Hrabowski Lectures on Minority Student Success –The California Aggie [Online]. Available from:
    http://www.californiaaggie.com/archive/98/11/23/hrabowski.html

    Comments: This article is from the online version of the California Aggie newspaper. It contains information from at talk Hrabowski gave at the University. It was not extremely helpful in writing this paper.

10. Hrabowski Shares Guidelines for Successful Mentoring [Online]. Available from:
    http://www.gbc.org/news/Oct00/Hrabowski%20Seminar.html

    Comments: This page is an article that outlines Hrabowski's advice on tutoring. It was not very useful for our paper.

11. Interviews with Dr. Jill Richie, Professor at Appalachian State University.

    Comments: The interviews were very helpful in the analysis of the statistics found in the articles, as well as the understanding and comprehension of the statistical methods.

12. Kessler, James H., et al. <u>Distinguished African Americans of the Twentieth Century</u>. Phoenix, Arizona: Oryx Press, 1996.

    Comments: This book was used as a reference source. It was here that we found our first information on Hrabowski.

13. Kitchens, Larry J<u>. Exploring Statistics: A Modern Introduction to Data Analysis and Inference</u>, 2nd Ed. Pacific Grove, CA: Duxbury Press, 1998.

    Comments: This book provided good explanations for the statistical method used in Hrabowski's articles.

14. Maton, Kenneth I., Freeman A. Hrabowski,. "Enhancing the Success of African-American Students in the Sciences: Freshmen Year Outcomes." <u>School Science and Mathematics</u>, Volume 95, Issue 1. 1995. pp. 19-27.

    Comments: This article provided statistical data and information that was used in the analysis and critique. This article was a good representation of appropriate test statistics.

15. Maton, Kenneth I., Freeman A. Hrabowski. "Preparing the Way: A Qualitative Study of High Achieving African American Males and the Role of the Family." <u>American Journal of Community Psychology</u>, Volume 26, Issue 2. 1998. pp. 639-669.

    Comments: This article contained statistical information, but no tables or actual data. We decided not to use this article in the analysis and critique.

16. You Can't Keep a Good Man Down – Horizon Magazine [Online]. Available from:
    http://www.horizonmag.com/3/freeman-hrabowski.asp

    Comments: This page contains an article that is an excellent resource for information concerning Hrabowski's life as well as his work at UMBC.