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INVESTIGATING ISSUES IN COMPUTING EDUCATION: USABILITY FACTORS FOR THE USE OF AN OPERATING SYSTEM AMONG AFRICAN AMERICAN AND HISPANIC AMERICAN HIGH SCHOOL STUDENTS

Gabriel Estrada[1], Maurice Dawson[2], Jose Antonio Cárdenas-Haro[3]

[1]*Colorado Technical University, Colorado Springs, Colorado, USA {g.estrada8@my.cs.coloradotech.edu}*

[2]*Illinois Institute of Technology, School of Applied Technology, Center for Cyber Security and Forensics Education, Chicago, Illinois, USA {mdawson2@iit.edu}*

[3]*California State University, Bakersfield, California, USA {jcardenas23@csub.edu}*

ABSTRACT

African Americans and Hispanic Americans historically have been underrepresented in U.S. jobs in the fields of STEM in large part because of the usability of technology. In this research, the goal was to discover the usability factors relative to operating systems that may limit African Americans and Hispanic Americans from pursuit of computer science higher education. For the purpose of this study, "usability" refers to the "appropriateness of purpose." Categorized by three factors, appropriateness of purpose can be defined as (i) the effectiveness of the users' ability to complete tasks while using technology and the quality or output of those tasks, (ii) the efficiency and the level of resources used in performing tasks, and (iii) the satisfaction or users' reaction to the use of technology (Brooke, 2014). This research examined quantitative analysis based on students' routine computer task knowledge using a survey questionnaire and the SUS. The population included high school students responding to questions on common tasks and usability. A web survey was conducted to assess the measurement and understanding pattern demonstrated by the participants. The quantitative analysis of the computer usability included ANOVA, independent t-tests and orthogonal contrasts. The analysis of the SUS measured usability and learnability. The results of the data analysis showed that the combined African American and Hispanic group has a mean computer usability score that is significantly lower when compared with the other ethnicities and the SUS findings included the highest gap among this most underrepresented group in the STEM field.

KEYWORDS

High school students, Higher Education, operating system, students

1 INTRODUCTION

This analysis represents a vital gap in research relative to the study of the usability of technology and the effects on African American and Hispanic American students' limitations for pursuing computer science in higher education. According to the Association of the Study for Higher Education (ASHE), African American students aspiring to attain a Science Technology Engineering and Math (STEM) degree, to include computer science, have had the "lowest completion rate among all racial groups" (ASHE Higher Education Report, 2011). Approximately 13.2% of African American STEM degree aspirants completed their degree within five years; not far behind were Hispanic Americans at 15.9%. Additionally, empirical studies show Hispanics to be severely underrepresented among STEM graduates

2 BACKGROUND OF THE PROBLEM

Research has demonstrated that African-American, Hispanic-American and White students have considerably different educational opportunities. This is because White students fare better compared to African-Americans and Hispanic-Americans students in terms of quality of education, curriculum, school populations, all of which impact academic achievement. (Beasley & Fischer, 2012, p. 428). Despite the previous findings, no studies exist where usability was examined to determine limiting factors African American and Hispanic American students face relative to technology.

Nevertheless, where academic preparation may determine the underrepresentation of minority studies in STEM, studies also show that differences in preparation and socioeconomic background among these students continue to exist (Beasley & Fischer, 2012). In light of these, it is evident that underrepresentation of minorities in STEM is not caused by differences in aptitude but a combination of several important factors. One likely aspect of this condition is the usability of operating systems (OS).

3 STATEMENT OF THE PROBLEM

Minorities have historically been underrepresented in U.S. Jobs in the fields of STEM for a variety of reasons as noted in existing literature that attribute to this problem; however, this study examines technology usability. For the purpose of this study, usability refers to the "appropriateness of purpose". Categorized by three factors, appropriateness of purpose can be defined as (i) the effectiveness of the users' ability to complete tasks while using technology and the quality or output of those tasks, (ii) the efficiency and the level of resources used in performing tasks, and (iii) the satisfaction or users' reaction to the use of technology (Brooke, 2014). The specific problem this research will address is the lack of African American and Hispanic American students pursuing computer science higher education by investigating the usability of technology. This serious gap also deprives America's industry of their talents, perspectives and skills. The National Science Foundation's Science and Engineering Indicators published in 2014 noted that of all employed scientists and engineers, by race, ethnicity, and occupation in 2010; 73.8% were white, but only 6% were African American and 6.7% were Hispanic American (National Science Foundation, 2014).

4 SIGNIFICANCE OF STUDY

This study will be the first of its kind to measure usability as it relates to the use of technology by these underrepresented groups. The study surveyed over 300 high school students; although all student volunteers participated in the study for statistical comparison, the focus of the findings will be to identify trends faced by our most underrepresented populations in computer science education, African Americans and Hispanic Americans. By analyzing student responses to complete routine tasks using a computer usability scale from a 20 question survey and the SUS, gaps in computer usability and system usability will be found. Normally using the SUS, testing of groups of 10 or more participants is usually adequate; with over 300 respondents the results will be substantial. In fact, even with only 10 users, if there are major differences with the users, there will be a large variance relative to the mean values measured (Bevan & Macleod, 1994). This study intends to demonstrate that usability is a factor that can adversely affect or discourage these students from pursuing higher education in computer science. The limitations of this research are potential weaknesses in the study and based on factors that cannot be controlled.

5 CURRENT STATUS OF STEM EDUCATION

Approximately 15.9% of Hispanic students aiming to obtain a STEM degree accomplish that goal, higher than other minorities but lower than the AAPI and White populations. Moreover, empirical studies show that Hispanics continue to be severely underrepresented among STEM graduates. Albeit Hispanics accounted for roughly 14.8% of the national population in 2006, they garnered only 7.7% of bachelor's degrees attained in the fields of science and engineering, as seen in Figure 2 below (ASHE Higher Education Report, 2011). This is the largest gap between national population and earned degrees among all racial groups.

Meanwhile, among those aiming to finish STEM degrees, Native Americans (14%) fare only somewhat better than Blacks (13.2%)and slightly worse than Hispanics (15.9%) (ASHE Higher Education Report, 2011). Nevertheless, they significantly lag behind AAPIs (67%) and Whites (60%) (ASHE 2011). Certain studies show that Native Americans remain underrepresented among those attaining science and engineering degrees (ASHE Higher Education Report, 2011).

6 DATA ANALYSIS AND FINDINGS

The findings are presented as follows. First, the participant demographics, including population and sample, are examined. Second the knowledge base statistics are presented. Third, the knowledge base analysis to address the research questions is described. Next, the System Usability Scale (SUS) results are reviewed. Finally, a summary of the overall findings is provided.

7 PARTICIPANT DEMOGRAPHICS – POPULATION AND SAMPLE

This study used a survey questionnaire with knowledge based questions followed by system usability questions using Google Forms and high school students using Dell Optiplex 3020 and 760 work stations running Windows 7 OS. The representative sampling size (n) was estimated at 319 respondents for this study, based on a confidence interval of 5% and a confidence level of 95%. The sample size was calculated using the System Usability Scale (SUS) Calculator . As many participants were included to increase the accuracy of the data analysis. Representing the 319 survey respondents were 96 African American students, 109 Hispanic American, 25 Asian American, 62 Caucasian American, and 27 listed as other ethnicity with 15 males and 12 females as show below in figure 3 with the distribution of the demographics represented by percentage.

8 KNOWLEDGE BASE ANALYSIS

The questions on the knowledge portion of the survey were used to show the variances between the demographic and gender of the respondents. The intent of this analysis is to address the following research questions, related with a measurement of computer usability.

The foundation of the analysis was to use the 20 item survey to build a properly constructed scale to measure computer usability skills. The first consideration the analysis answers is whether or not these 20 variables can be considered as measurements of the same construct. For such purpose, a reliability analysis was conducted for all the 20 items in the survey.

Table 1 below shows that Cronbach's Alpha for the 20 items is α =0.816, and this greater than the commonly accepted threshold of 0.7 for a reliable construct (Santos, 1999), which implies that all the twenty items are measuring the same construct and they can all the used to build a valid scale.

Table 1 Overall Reliability

Reliability Statistics - Overall	
Cronbach's Alpha	N of Items
816	20

Based on the nature of the item questions, this scale will measure computer usability skills of the respondents. All the item responses are coded as: 0 = No, 1 = Unsure, 2 = Yes). So then, the computer usability skills scale is computed by adding up the values of the 20 items (there is no need for reversal recoding, as all the questions point in the direction of having or not a certain skill, and "Yes" implies having such skill). The minimum value of the scale is 0 and the maximum value is 40.

Table 2 below shows the corresponding descriptive statistics for the scale that was constructed, with a mean of M = 28.65 (SD = 6.62).

Table 2 Descriptive Statistics

Mean	Variance	Std. Deviation	N of Items
28.65	43.814	6.619	20

On the other hand, Table 3 shows that the value of Cronbach's alpha does not change significantly by removing any of the items, which is a good indication that the scale is a validly constructed scale due to relatively higher Cronbach's alpha and that there is not much room for the improvement of alpha by removing any item.

Table 3 Chronbach's Alpha

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Do you know how to log in/out?	26.66	43.747	.032	.818
Do you know how to import a picture/spreadsheet on a Word Document?	27.98	35.364	.683	.787
Do you know how to create a spreadsheet?	27.17	40.403	.251	.816
Do you know how to rename a file or folder?	27.48	35.974	.597	.793
Do you know how to create a shortcut to a document on the desktop?	27.88	35.030	.694	.786
Do you know how to create a Power Point presentation?	26.67	43.687	.035	.818
Do you know how to set the date/time on your computer?	27.55	35.544	.625	.791
Do you know how to change the background wallpaper?	26.81	41.861	.245	.814
Do you know how to create a new folder?	27.24	37.275	.519	.799
Do you know how to create a Word Document?	26.66	43.740	.036	.818
Do you know how to change the monitor resolution?	27.96	38.429	.400	.808
Do you know how to delete a document	26.67	43.755	.011	.818
Do you know how to restore a file after it has been deleted?	27.42	37.187	.493	.801
Do you know how to format a document with 1.5 line spacing?	27.92	35.972	.616	.792
Do you know how to restore the computer?	28.17	38.546	.472	.803
Do you know how to search for a file?	26.67	43.554	.075	.818
Do you know how to print a document?	26.66	43.843	-.027	.818
Do you know how to open an existing document?	26.66	43.733	.027	.818
Do you know how to delete browsing history?	27.38	36.922	.515	.800

Do you know how to shutdown the computer?	26.66	43.960	-.098	.819

Table 4 shows the results of an ANOVA to assess research question #1. The mean computer usability skill score for African Americans is M = 25.48 (SD = 6.73), the mean computer usability skill score for Asians is M = 34.76 (SD = 4.79), the mean computer usability skill score for Whites is M = 30.05 (SD = 6.18), the mean computer usability skill score for Hispanics is M = 28.60 (SD = 5.77), and the mean computer usability skill score for Other Race is M = 31.22 (SD = 6.09).

Table 4 Descriptive Statistics for Computer Usability by Ethnicity

	N	**Mean**	**Std. Deviation**	**Std. Error**	**95% Confidence Interval for Mean**			
					Lower Bound	**Upper Bound**	**Min**	**Max**
African American	96	25.4792	6.72619	.68649	24.1163	26.8420	16.00	40.00
Asian	25	34.7600	4.78957	.95791	32.7830	36.7370	25.00	40.00
Caucasian - White	62	30.0484	6.18148	.78505	28.4786	31.6182	18.00	40.00
Hispanic	109	28.5963	5.76567	.55225	27.5017	29.6910	17.00	40.00
Other	27	31.2222	6.09119	1.17225	28.8126	33.6318	20.00	40.00
Total	319	28.6458	6.61924	.37061	27.9166	29.3749	16.00	40.00

Table 5 below shows that the assumption of homogeneity of variance is met, $F(4, 314) = 1.539, p = .191 > .05$.

Table 5 Homogeneity of Variances

Computer usability skill score			
Levene Statistic	**df1**	**df2**	**Sig.**
1.539	4	314	.191

The ANOVA table below shows that the null hypothesis of equal means is rejected,

$F(4, 314) = 14.709, p < .001$ This indicates that the sample data provides enough evidence

to claim that not all ethnicities have the same mean computer usability skill scores.

Table 6 ANOVA

Computer usability skill score					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	2198.693	4	549.673	14.709	.000
Within Groups	11734.278	314	37.370		
Total	13932.972	318			

Table 7 below shows the results of the Tukey Test (post-hoc). The post-hoc test results indicate that the mean computer usability skill score for Asians is significantly higher than the mean computer usability skill score for Whites, Hispanic and African Americans. On the other hand, the mean computer usability skill score for Other Race and Whites is significantly higher than the mean computer usability skill score for African Americans. No other pair difference is significant.

Table 7 Computer Usability Skill Score by Ethnicity

Tukey HSD What is your ethnicity	N	Subset for alpha = 0.05		
		1	2	3
African American	96	25.4792		
Hispanic	109	28.5963	28.5963	
Caucasian - White	62		30.0484	
Other	27		31.2222	31.2222
Asian	25			34.7600
Sig.		.118	.258	.053

A t-test for independent means was used to address the second research hypothesis. Table 8 shows that the mean computer usability score for girls is M = 28.36 (SD =6.62), and the mean computer usability score for boys is M = 28.85 (SD =6.63).

Table 8 Gender Comparison

Gender Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Computer usability skill score	Female (girl)	134	28.3582	6.61668	.57159
	Male (boy)	185	28.8541	6.63123	.48754

Table 9 shows that the assumption of equal variances is met, as shown by Levene's test, F = .011, p = .915 > .05. Under the assumption of equal variances, the t-statistic is t(317) = -0.660, p = .510 > .05, which indicates that there is not enough evidence to reject the null hypothesis.

Table 9 Levene's Test for Equality of Variances

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Computer usability skill score	Equal variances assumed	.011	.915	-.660	317	.510	-.49585	.75154	-1.97448	.98279
	Equal variances not assumed			-.660	287.082	.510	-.49585	.75127	-1.97455	.98286

Therefore, the sample data does not provide enough evidence to claim that there is a significant difference in mean computer usability score by gender. For the third question, three contrasts were estimated as shown below in Table 10.

Table 10 Contrast Coefficients

Contrast Coefficients

Contrast	Ethnicity				
	African American	Asian	Caucasian - White	Hispanic	Other
1	1	0	-2	1	0
2	1	-2	0	1	0
3	1	0	0	1	-2

Table 11 shows the results of the contrast tests. It is found that all three null hypotheses are rejected, with p = .001, p < .001 and p < .001, respectively. Also, for all three tests the t-statistic is on the left-tail.

Table 11 Contrast Tests

		Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
Computer usability skill score	Assume equal variances	1	-6.0213	1.77288	-3.396	314	.001
		2	-15.4445	2.59063	-5.962	314	.000
		3	-8.3689	2.50369	-3.343	314	.001
	Does not assume equal variances	1	-6.0213	1.80040	-3.344	102.183	.001
		2	-15.4445	2.10871	-7.324	35.025	.000
		3	-8.3689	2.50458	-3.341	33.769	.002

Therefore, it is concluded that the mean of the combined African American and Hispanic group has a mean computer usability score that is significantly lower when compared with the other ethnicities.

Usability Scale Analysis

The system usability scale measures usability, in this study "usability" refers to the "appropriateness of purpose." Categorized by three factors, appropriateness of purpose can be defined as (i) the effectiveness of the users' ability to complete tasks while using technology and the quality or output of those tasks, (ii) the efficiency and the level of resources used in performing tasks, and (iii) the satisfaction or users' reaction to the use of technology (Brooke, 2014). Table 12 describes the 10 questions that make up the SUS.

Table 12 System Usability Scale

1	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think that I would need the support of a technical person to be able to use this system.
5	I found the various functions in this system were well integrated.

6	I thought there was too much inconsistency in this system.
7	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.
9	I felt very confident using the system.
10	I need to learn a lot of things before I could get going with this system.

Note: The SUS uses the following response format:

Strongly Disagree 1 2 3 4 5 Strongly Agree

Interpreting a SUS Score

The SUS score is converted into a grade, research done by Bangor, et al, 2009, below shows the rating scale on Table 13.

Table 13 SUS Grade Conversion (Adapted from Bangor et al. 2009)

Raw SUS Score	Grade Scale	Acceptability Range	Adjective
90-100	A	Acceptable	Best Imaginable
80-90	B		Excellent
70-80	C		Good
60-70	D	Marginal	OK
50-60	F		
40-50		Not Acceptable	Poor
30-40			
20-30			Worst Imaginable
10-20			
0-10			

SUS grading is based on a curve developed by Jeff Sauro and Jim Lewis to update the grades based on normal distribution of the SUS scores. They assigned an equal number of “A’s as F’s and B’s as D’s with the bulk receiving C’s” (Lewis & Sauro, 2009). They also added plus and minus to the letter grades to offer the varying levels as shown in Table 14 below.

Table 14 Sauro & Lewis SUS Grading Scale (Sauro, 2011)

SUS Score	Percentile	Grade
84.1-100	96-100	A+
80.8 – 84.0	90-95	A
78.9 – 80.7	85-89	A-
77.2 – 78.8	80-84	B+
74.1 – 77.1	70-79	B
72.6 – 74.0	65-69	B-
71.1 - 72.5	60-64	C+
65.0 -71.0	41-59	C
62.7 - 64.9	35-40	C-
51.7 - 62.6	15-34	D
< 51.7	0-14	F

9 RELIABILITY AND VALIDITY

According to the practical guide, once a set of subscales exist, assessment of reliability (basically repeatability) using a measure of internal reliability called coefficient alpha or Cronbach's alpha (Sauro, 2011). According to Sauro, this is the measures of how consistently users respond to items in the questionnaire. The highest possible score is 1.00, with .70 considered to be the lower boundary of acceptable internal reliability (Nunnally 1978). If the total questionnaire or subscales have low internal reliability (Cronbach's alpha < .70), then questions and subscales are added and removed until the reliability becomes acceptable.

10 USABILITY AND LEARNABILITY

There are in fact two significant factors in SUS. They are "usability" and what is referenced and measured as "learnability." There are eight items on the survey question to determine usability while the other two are used to measure learnability. The learnability items are numbers 4 and 10 ("I think I would need the support of a technical person to be able to use this system" and "I needed to learn a lot of things before I could get going with this system").

As noted by Sauro, "To compute the learnability and usability scores:"

1. Scale your scores from 0 to 4 as with the regular SUS (being sure to reverse the negative items).

2. For the learnability scale: total the scores for items 4 and 10 and multiply the result by 12.5. (This scales the results from 0 to 100.)

3. For the usability scale: Total the scores for the other 8 items and multiply the result by 3.125. (This scales the results from 0 to 100.)

11 SUS FINDINGS

The SUS Calculator results for the overall number of respondents to the survey are as shown below in Table 15 which includes the mean SUS score of 76.4, standard deviation of 12.3, number of respondents (319) and internal reliability of 0.826 which is categorized by good on the calculator. In addition, the scales for SUS, Usability and Learnability are listed for comparison.

Table 15 SUS Results for Overall Survey

Mean SUS Score	76.4			
StDev	12.3			
(n)	319	*Coding Check:*	Values appear to be coded correctly from 1 to 5	
Cronbach Alpha	0.826	*Internal Reliability:*	Good	
Scales				
SUS	**Usability**	**Learnability**		
76.4	76.2	77.2		

Table 16 displays the raw SUS score as converted into a percentile rank according to the products tested, in this case all products for the SUS benchmark and the corresponding grades as determined by the corresponding scale. The raw SUS score (76.4) indicates that the operating system used for this study has a higher SUS score than 77.8% of all products tested. For the purpose of this study, we will compare the Sauro & Lewis grading scale. Using that scale the usability grade calculated is a "B."

Table 16 Raw SUS Score to a Percentile Rank and Grade for Overall Survey

Input		**Results**	
Raw SUS Score	76.4	Percentile Rank:	77.8
SUS Benchmark	All Products Tested	Adjective :	Good
		Grade (Bangor):	C
		Grade (Sauro & Lewis):	B
		Acceptability:	Acceptable

SUS Results for Male Participants

For the 185 males participating in the overall study, Table 17 includes the mean SUS score of 76.4, standard deviation of 12.6, number of respondents (185) and internal reliability of 0.832 which is categorized by good on the calculator. In addition, the scales for SUS, Usability and Learnability are listed for comparison. Note: the SUS score in the male category is the same as the overall SUS score for the study, but the standard deviation goes up slightly along with learnability from the overall study.

Table 17 SUS Results for Males in Overall Survey

Mean SUS Score	76.4			
StDev	12.6			
(n)	185	*Coding Check:*	Values appear to be coded correctly from 1 to 5	
Cronbach Alpha	0.832	*Internal Reliability:*	Good	
Scales				
SUS	**Usability**	**Learnability**		
76.4	76.0	78.0		

Table 18 displays the raw SUS score from the male participants as converted into a percentile rank according to the products tested, in this case all products for the SUS benchmark and the corresponding grades as determined by the corresponding scale. The raw SUS score (76.4) indicates that the operating system used for this study has a higher SUS score than 77.8% of all products tested. The Sauro & Lewis grade is a "B" same as the overall study.

Table 18 Raw SUS Score to a Percentile Rank and Grade for Males in Overall Survey

Input		Results	
Raw SUS Score	76.4	Percentile Rank:	77.8
SUS Benchmark	All Products Tested	Adjective :	Good
		Grade (Bangor):	C
		Grade (Sauro & Lewis):	B
		Acceptability:	Acceptable

SUS Results Female Participants

For the 134 females participating in the overall study, Table 19 includes the mean SUS score of 76.3, standard deviation of 12.6, number of respondents (134) and internal reliability of 0.820 which is categorized by good on the calculator. In addition, the scales for SUS, Usability and Learnability are listed for comparison. Note: the SUS score in the female category is lower than the overall SUS score for the study and the learnability goes down considerably.

Table 19 SUS Results for Females in Overall Survey

Mean SUS Score	76.3		
StDev	12.0		
(n)	134	*Coding Check:*	Values appear to be coded correctly from 1 to 5
Cronbach Alpha	0.820	*Internal Reliability:*	Good
Scales			
SUS	**Usability**	**Learnability**	
76.3	76.4	76.1	

Table 20 displays the raw SUS score from the female participants as converted into a percentile rank according to the products tested, in this case all products for the SUS benchmark and the corresponding grades as determined by the corresponding scale. The raw SUS score (76.3) indicates that the operating system used for this study has a higher SUS score than 77.5% of all products tested. The Sauro & Lewis grade is a “B” same as the males and overall studies.

Table 20 Raw SUS Score to a Percentile Rank and Grade for Females in Overall Survey

Input		Results	
Raw SUS Score	76.3	Percentile Rank:	77.5%
SUS Benchmark	All Products Tested	Adjective :	Good
		Grade (Bangor):	C
		Grade (Sauro & Lewis):	B
		Acceptability:	Acceptable

Table 21 displays how each group of respondents scored accordingly by Grade, SUS Score, Usability, Learnability, and Reliability. This table shows the differences between demographic including those between gender.

Table 21 Overall Grade, SUS Score, Usability, Learnability and Reliability Results

Demographics	Grade	SUS Score	Usability	Learnability	Reliability
Overall	**B**	**76.4**	**76.1**	**77.2**	**.826**
Males	B	76.4	76.0	78.0	.832
Females	B	76.3	76.4	76.1	.820
African American	**C+**	**71.1**	**71.1**	**71.2**	**.865**
Males	C+	71.8	71.8	71.9	.867
Females	C	70.0	70.0	70.2	.861
Hispanic American	**B+**	**77.2**	**76.8**	**78.9**	**.750**
Males	B	75.8	75.3	77.7	.781
Females	B+	78.7	78.3	80.1	.697
Caucasian American	**A-**	**80.2**	**79.9**	**81.7**	**.758**
Males	A	81.4	80.9	83.6	.721
Females	B+	77.8	77.8	77.5	.806
Asian American	**A**	**81.0**	**81.4**	**79.5**	**.822**
Males	A	81.3	80.7	83.6	.834
Females	A-	80.6	82.6	72.2	.846
Others	**A-**	**78.9**	**78.7**	**79.6**	**.802**
Males	B+	77.2	76.3	80.8	.789
Females	A	81.0	81.8	78.1	.822

Figure 1 below provides a SUS Score, usability and learnability comparison with side-by-side differences between demographics. It is clearly noticeable that African Americans and Hispanic Americans have lower scores than the other groups; however, the scores from the African American respondents represent the largest gap.

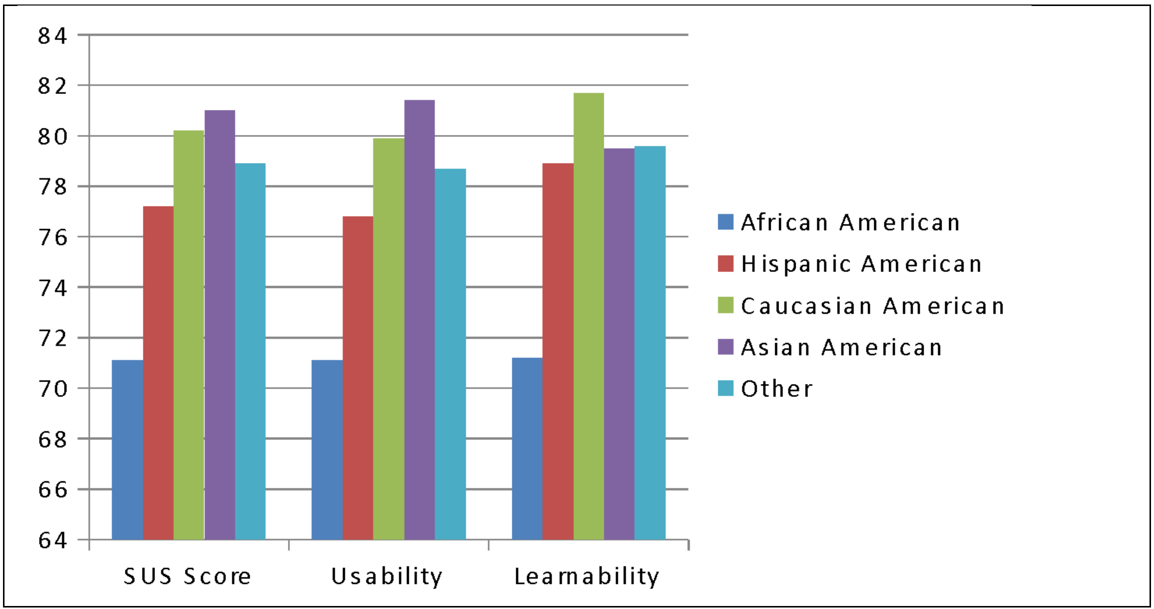

Figure 1 SUS Score, Usability and Learnability Result Comparison

Figure 2 below represents the letter grade distributions by demographics. Once again the largest gap is found between African American respondents and the other participants in the study. The letter grades in the chart represent both male and female grades provided by the SUS calculator.

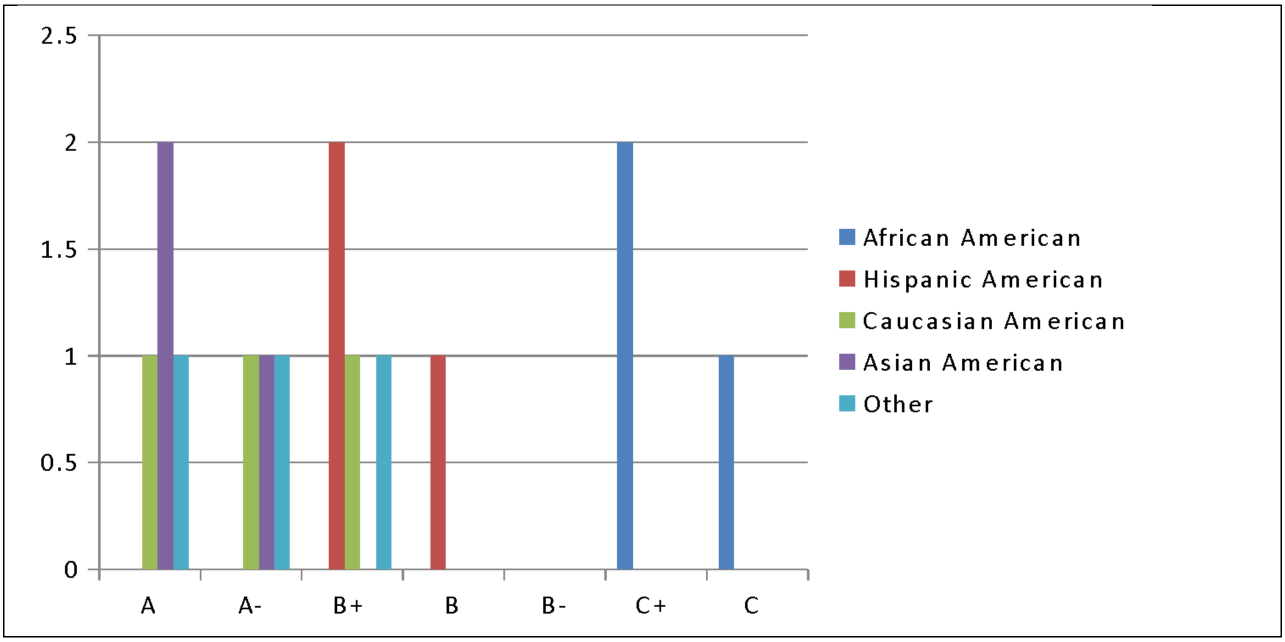

Figure 2 Grade Distributions by Respondent Demographics

The Sampling

A total of 319 high school students volunteered to participate in the study using Dell Optiplex 3020 and 760 work stations running Windows 7 OS. The school was chosen based on their diverse population as shown in Table 22.

Table 22 High School Demographic Data

Demographic Trends 2014 - 2010

		Free and Reduced Lunch		*Race and Ethnicity*							*English Language Learner*		*Special Education*	
School Year	Enrollment	Students Receiving FRL	% FRL	Hispanic	White	African American	Asian / Pacific Islander	American Indian	Multiple Races	% Minority	ELA Students	% ELA	SPED Students	% SPED
2010-11	1,605	880	54.8%	432	392	620	68	7	86	75.6%	337	21.0%	164	10.2%
2011-12	1,510	827	54.8%	435	374	547	69	7	78	75.2%	383	25.4%	142	9.4%
2012-13	1,485	804	54.1%	455	397	473	78	7	75	73.3%	383	25.8%	147	9.9%
2013-14	1,424	792	55.6%	449	387	435	78	7	68	72.8%	365	25.6%	146	10.3%
2014-15	1,359	765	56.3%	425	378	397	84	7	68	72.2%	376	27.7%	146	10.7%
Trends														
% Change Since 2010	-15.3%	-13.1%	1.5%	-1.6%	-3.6%	-36.0%	23.5%	0.0%	-20.9%	-3.4%	11.6%	6.7%	-11.0%	0.5%

Multiple: Students claiming 2 or more races (unless one ethnicity is Hispanic) FRL: Free and Reduced Lunch, one measure of socioeconomic status
ELLs: Students eligible for ELA services, including ELLs with a PPF 3 (parent opt out of ELA services). These ELLs are not necessarily receiving ELA services.

Data Collection and Validation

The survey questions in this study were designed to understand respondents' knowledge relative to computer use during the first 20 questions using descriptive statistics and the next 10 questions assessed their individual usability score using the SUS responses using the SUS Calculator. For the knowledge portion of the survey ANOVA, two-independent samples t-test and orthogonal contrasts were used and overall grade, SUS score, usability, learnability and reliability results from the SUS calculator were used to analyze the data.

13 RESEARCH FINDINGS

The summary of the research findings are as follows:

Research Question 1: Is there a significant difference in computer usability skill by ethnicity? H1o: There is no significant difference in computer usability skill by ethnicity, all are equal. The analysis showed the null hypothesis rejected and resulted in H1A: There is a significant difference in computer usability skill by ethnicity.

Research Question 2: Is there a significant difference in computer usability skill by gender (Boy or Girl). There was insufficient evidence in the analysis to support H2A: There is a significant difference in computer skill by gender; therefore, H2o*:* There is no significant difference in computer skill by gender, both are equal was more likely.

Research Question 3: Is there a significant difference in computer usability skill when comparing African & Hispanic Americans (combined) to the ethnic groups. Analysis results indicated H3A: There is a significant difference in computer usability skill when comparing African & Hispanic Americans (combined) to other ethnic groups was accurate. The findings did not hold true for H3o: There is no significant difference in computer usability skill when comparing African & Hispanic Americans (combined) to other ethnic groups.

14 IMPLICATIONS

Given the findings during this study, certain demographics may continue to be underrepresented in STEM fields still exists. However, more evidence will be necessary to conclude that these factors alone limit African Americans and Hispanic American from pursuing higher education in computer science. The results of the data analysis showed a significant gap in the knowledge of certain group's ability to use computer OS to complete routine tasks. The usability findings for the students using Windows 7, does not entirely suggest that similar Windows OS will mitigate usability at this level of education. The use of computers is the key to success in higher education, specifically in computer science. The insight provided by the respondents may lead to identifying trends that may discourage some students from pursuing computer science higher education and may enable educators to mitigate these factors in the future through closer examination.

15 CONCLUSIONS

The study's objective was to understand operating system usability factors limiting African Americans and Hispanic American from pursuing higher education in computer science. The focus was to assess user knowledge base given routine tasks and operating system usability using a web survey. Several key findings emerged during this research study. There was a clear difference in computer usability between African American and Hispanic American students as compared to their peers in the knowledge portion of the study. In the system usability portion, there were two major gaps identified the grades and scores assigned to African American and Hispanic American students were much lower than their counterparts; plus, the SUS score and learnability assigned to these groups were also lower. Given the results of the overall study, we have a better understanding of operating system usability factors limiting African Americans and Hispanic American from pursuing higher education in computer science.

As a recommendation for future research, given the results of the data analysis of this study, we believe there may be significant value in longitudinal studies on the effects of usability given a person's knowledge over several years during their education. Without the insight on what users have learned prior to completing a usability study, we are unable to determine what gaps could have been addressed in previous experiences with technology. Also future studies should consider a mix of qualitative and quantitative inquiry approaches to determine how students learn, when students are exposed to technology and how student experiences with technology affect their decision to pursue higher education in computer science and STEM related fields.

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