How Generalizable are Institutional Characteristics in CSET Studies to U.S. Higher Education? A Statistical Study

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Abstract—**This study uses distribution-to-distribution statistical tests to determine the level of similarity between the CSET offering institutions and the entire population of higher education institutions in the United States, as listed in the Carnegie data. These results show that the institutional context in which U.S. CSET education occurs is sufficiently different from higher education in the U.S. as a whole that CSET education research needs to continue as a stand-alone discipline. In particular, the large number of classifications in which the sample and population data are significantly different indicates that CSET education is a special case from higher education as a whole and thus needs its own studies.**

Keywords—*CSET education institutions, Carnegie Classification*

I. INTRODUCTION

This full paper reports the results of a statistical study to determine the level of attribute similarity between the population of institutions of higher education in the United States and a sample of over 700 of these institutions that offer computer science, engineering, and technology (CSET) education. This sample is a proxy for CSET education in the U.S. as a whole. Knowing where this sample is generalizable to the whole is important to policy makers, as they determine which evidence is appropriate in decision-making, and to CSET researchers, as they consider which literature bases are an appropriate platform on which to base their study.

This study uses distribution-to-distribution statistical tests to determine the level of similarity between the CSET offering institutions and the entire population of higher education institutions in the United States, as listed in the Carnegie Classification data. These results provide a measure of the generalizability, or lack thereof, of institutional characteristics between all of higher education and CSET offering higher education in the United States. Categories analyzed include: undergraduate and graduate instructional program classifications (e.g., degree level, focus type, graduate/undergraduate student coexistence, and graduate research orientation), undergraduate and enrollment profiles (e.g., part/full time status, level of transfers, and level of admissions selectivity), institution size, amount of residential versus commuting students, institutional control (e.g., public,

private, or for-profit), geographical region, and level of urbanization. In addition, we consider percentage of institutions that have historically served certain populations. These categories represent the majority of the Carnegie classification data and were selected to represent organizational attributes more frequently seen in the context of CSET education research studies.

II. SOURCES AND METHODS

A. Data

As part of a larger study [1] of organizational infrastructure that does (or does not) support CSET education research, we determined the subset of the institutions of higher education in the United States with CSET education by including the college or university if it offers at least one ABET-accredited programs regardless of commission (i.e. engineering, engineering technology, applied science, and computing) as of September, 2018. We selected this sample as a proxy for CSET education in the United States because it has defined edges to the sample while also including significant variety in institution type. This sample of over 700 public and private institutions includes two-year colleges (17%), special focus four-year institutions (2%), Baccalaureate colleges (13%), Master's colleges and universities (32%), doctoral universities (36%), inclusive institutions (25%), selective institutions (37%), and more selective institutions (38%) among the many classifications.

Category designations and population data were determined by crossing the sample institutions with the publically available Carnegie Classification data. The most recently available Carnegie Classification data is a combination of the 2015 classification data [2] with information from 2013 and 2014 and the 2018 Classification Update [3] and uses a snapshot of information from 2016 and 2017. This database contains over 4000 institutions of higher education in the United States. Each institution is classified using a host of variables and data from public sources, the College Board, the National Science Foundation [4, 5], and IPEDS (the Integrated Postsecondary Data System) [6, 7]. The areas of classification are broad and include:

- instructional program classifications for undergraduate and graduate studies,

- enrollment profiles of admitted students,

- institution size, setting (urban, rural, suburban), and geographic region,

- control (public, private for-profit, private not-for-profit), and

- special categories, such as minority serving institutions, women's college, faith-related institution, and liberal arts colleges.

An important connection between these categories is that they are all contextual variables of the college or university. When researchers or policy makers are determining the best evidence on which to build their programs or studies, organizational contextual variables are important to understanding the strength of the adaptability between samples.

B. Methods

This statistical analysis compares the entire Carnegie Classification dataset and the institutions with ABET accredited program(s) dataset. The goal of the testing was to find correlations between the different variables within the data. To effectively find potential correlations in the data, multiple t-tests on the data sets were run. The t-tests are two-sample unequal variance tests. The Carnegie Classification data contained five times as many data points compared to the institutions with ABET accredited programs data for all variables. Data sets of the same variable were compared (e.g., Minority Serving Institutions = 1, Not = 0) within the two different data sets. The Null Hypothesis states that there is a significant relationship between the two sets of data. The Alternative hypothesis occurs when the two sets of data are unequal, the data is said to be random, there is no correlation. The results are found using a confidence level of 0.05. The results of each test were compared to the defined confidence level by their respective P two-tail value, as seen in Table I. If the P two-tail value was lower than the confidence level, the data was proven to be random, the alternative hypothesis. If the P two-tail value was higher than the confidence value, then there is a statistically significant correlation that can be made between the two data sets. Further information gathered during the t-tests such as the mean were also taken into consideration when determining an outcome or trend between the Carnegie Classification and institutions with ABET accredited program(s) data.

TABLE I.   STATISTICAL TESTING TEMPLATE

Null Hypothesis (N0)	A - B = 0 or A = B	Significant Relation, N0
Alternative Hypothesis (Na)	A<>B	Random, Na
Sig Level/Confidence (alpha)	0.05	
Variables		
A	Carnegie Data	
B	ABET Data	
Type	Un-paired Unequal Varience T - Test	

III. RESULTS AND DISCUSSION

A. Sector

The Carnegie data includes the sector of each institution, which is a combination of organizational control (public, private for-profit, or private not-for-profit) and level of education offered (focus of either two-year programs to four-year and above programs). These combine to create six sector options.

Looking at the distribution of institutions across all six options, as seen in Table II, there is a significant difference in the means of each sample at a 0.05 confidence level. Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample. This is based on the ABET programs having a lower mean compared to the Carnegie colleges, thus we see that the ABET schools have more Public, and For-profit and Not-for-Profit Private 4 - year or above institutions.

TABLE II.   STATISTICAL DATA, CONTROL AND LEVEL, ALL CATEGORIES

1	Public, 4-year or above			
2	Private not-for-profit, 4-year or above			
3	Private for-profit, 4-year or above			
4	Public, 2-year			
5	Private not-for-profit, 2-year			
6	Private for-profit, 2-year			
t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
		Carnegie	Abet	
Mean		2.939549839	1.8174	
Variance		2.329964206	1.23233	
Observations		4665	701	
Hypothesized Mean Difference		0		
df		1140		
t Stat		23.61806005		
P(T<=t) one-tail		5.1508E-101		
t Critical one-tail		1.64619136		
P(T<=t) two-tail		1.03E-100		
t Critical two-tail		1.962047098		
All Data Options (1-6)				
P =				
5.12E-92	Random, Na			

Looking specifically at institutions classified as public, regardless of level, there is a significant difference in the means of each sample at a 0.05 confidence level, as seen in Table III. (Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample.) This is based on the institutions with ABET accredited programs having a lower mean compared to the population of Carnegie Classification institutions when only taking account 4 years and above and 2-year Public institutions. Thus the institutions with ABET accredited programs have a higher trend of Public 4 -year or above institutions then population of all the Carnegie schools. Similar analysis was completed for private 4-year and above institutions, Table IV, and private 2-year institutions, Table V. At the 0.05 confidence level, there is a small but significant difference between the sample and population, indicating that the proportion of private 4-year and above institutions in the sample data of institutions of ABET accredited programs is greater than

TABLE III.   STATISTICAL DATA, CONTROL AND LEVEL, PUBLIC INSTITUTIONS

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	ABET		
Mean	2.693430657	1.68675		
Variance	2.213931254	1.59182		
Observations	1644	498		
Hypothesized Mean Difference	0			
df	953			
t Stat	14.93541521			
P(T<=t) one-tail	8.85688E-46			
t Critical one-tail	1.64645411			
P(T<=t) two-tail	**1.77138E-45**			
t Critical two-tail	1.962456362			
1	Public, 4-year or above			
4	Public, 2-year			
P =				
1.8E-45	**Random, Na**			

the overall population. With the same confidence, there is no statistically significant difference between the sample and population data regarding private 2-year institutions.

TABLE IV.   STATISTICAL DATA, CONTROL AND LEVEL, PRIVATE, 4-YEAR AND ABOVE INSTITUTIONS

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	ABET		
Mean	2.693430657	1.68675		
Variance	2.213931254	1.59182		
Observations	1644	498		
Hypothesized Mean Difference	0			
df	953			
t Stat	14.93541521			
P(T<=t) one-tail	8.85688E-46			
t Critical one-tail	1.64645411			
P(T<=t) two-tail	**1.77138E-45**			
t Critical two-tail	1.962456362			
1	Public, 4-year or above			
4	Public, 2-year			
P =				
1.8E-45	**Random, Na**			

B. Institution Size

Institution size in the Carnegie Classification dataset describes the number of students at the institution and, for 4-year and above institutions, residential character of the area in which the institution sits. Residential character is divided in primarily non-residential, primarily residential, and highly residential. Size categories are very small (up to 500 students at a 2-year institution or 1000 students otherwise), small (500-1999 students at a 2-year institution or 1000-2999 students otherwise), medium (2000-4999 students at a 2-year institution or 3000-9999), large (5000-9999 students at a 2-year institution or 10,000 or more students otherwise), and very large (10,000 or more students at a 2-year institution; this category only applies to 2-year institutions). Institutions that enroll no undergraduate students have a separate category that does not directly reference size or setting.

TABLE V.   STATISTICAL DATA, CONTROL AND LEVEL, PRIVATE, 2-YEAR INSTITUTIONS

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	ABET		
Mean	2.30464135	2.10448		
Variance	0.211924418	0.09403		
Observations	2370	201		
Hypothesized Mean Difference	0			
df	283			
t Stat	8.479460881			
P(T<=t) one-tail	6.35445E-16			
t Critical one-tail	1.650255746			
P(T<=t) two-tail	**1.27089E-15**			
t Critical two-tail	1.968381923			
2	Private not-for-profit, 4-year or above			
3	Private for-profit, 4-year or above			
P =				
1.3E-15	**Random, Na**			

Overall, there is a significant difference in the means of the sample at a 0.05 confidence level, shown in Table VI. Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample. This is based on the institutions with ABET accredited programs having a higher mean compared to the population of the Carnegie Classification dataset comparing the Size and Setting of the institutions, meaning the institutions with CSET programs are more likely than the higher education population as a whole to be larger and more residential.

TABLE VI.   STATISTICAL DATA, INSTITUTION SIZE, ALL CATEGORIES

2015 Size and Setting Classification				
0	(Not classified)	10	Four-year, small, primarily residential	
1	Two-year, very small	11	Four-year, small, highly residential	
2	Two-year, small	12	Four-year, medium, primarily nonresidential	
3	Two-year, medium	13	Four-year, medium, primarily residential	
4	Two-year, large	14	Four-year, medium, highly residential	
5	Two-year, very large	15	Four-year, large, primarily nonresidential	
6	Four-year, very small, primarily nonresidential	16	Four-year, large, primarily residential	
7	Four-year, very small, primarily residential	17	Four-year, large, highly residential	
8	Four-year, very small, highly residential	18	Exclusively graduate/professional	
9	Four-year, small, primarily nonresidential			

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	ABET		
Mean	7.69367631	11.77175		
Variance	26.144782	19.50497		
Observations	4665	701		
Hypothesized Mean Difference	0			
df	1004			
t Stat	-22.304587			
P(T<=t) one-tail	3.9294E-90			
t Critical one-tail	1.64637274			
P(T<=t) two-tail	**7.8588E-90**			
t Critical two-tail	1.96232961			
All Data Options (1-18)				
P =				
2.97425E-81	**Random, Na**			

Looking solely at the 2-year institutions, as in Table VII, there is a significant difference in the means of each sample at a 0.05 confidence level. Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample. This is based on the institutions with ABET accredited programs having a higher mean compared to population of the Carnegie Classification dataset comparing the Size and Setting of the various sizes of the two year institutions. Based on the means, the institutions

TABLE VII.   STATISTICAL DATA, INSTITUTION SIZE, 2-YEAR INSTITUTIONS

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	ABET		
Mean	2.23495883	3.508621		
Variance	1.35857432	0.773838		
Observations	1579	116		
Hypothesized Mean Difference	0			
df	146			
t Stat	-14.676271			
P(T<=t) one-tail	7.8278E-31			
t Critical one-tail	1.65535734			
P(T<=t) two-tail	1.5656E-30			
t Critical two-tail	1.97634565			
0	(Not classified)	3	Two-year, medium	
1	Two-year, very small	4	Two-year, large	
2	Two-year, small	5	Two-year, very large	
P =				
1.47029E-30	Random, Na			

TABLE IX.   STATISTICAL DATA, UNDERGRADUATE ENROLLMENT SELECTIVITY, ALL CATEGORIES

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	Abet		
Mean	1.58364	2.139219		
Variance	0.581465	0.609837		
Observations	2714	589		
Hypothesized Mean Difference	0			
df	849			
t Stat	-15.7165			
P(T<=t) one-tail	2.39E-49			
t Critical one-tail	1.64665			
P(T<=t) two-tail	4.780E-49			
t Critical two-tail	1.962762			
P =				
4.806E-49	Random, Na			

with ABET accredited programs in 2-year institutions are likely to be larger than the 2-year institutions in the whole population of the Carnegie Classification dataset.

Switching our focus to 4-year and graduate institutions, shown in Table VIII, there is a significant difference in the means of each sample at a 0.05 confidence level. Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample. This is based on the institutions with ABET accredited programs having a higher mean compared to the population of the Carnegie Classification dataset comparing the Size and Setting of the various sizes and locations of the four year institutions. Thus, the institutions with ABET accredited programs are more likely to be medium or large four year institutions in both residential or nonresidential areas than the population of the Carnegie Classification dataset as a whole.

C. Undergraduate Enrollment Selectivity

Selectivity in undergraduate enrollment is determined from the average ACT score of the entering freshmen class in the snapshot data year. It is important to note that this classification is only assigned to 4-year and above institutions that are not

TABLE VIII.   STATISTICAL DATA, INSTITUTION SIZE, 4-YEAR AND EXCLUSIVELY GRADUATE INSTITUTIONS

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	ABET		
Mean	10.4867142	13.41026		
Variance	15.7766468	6.975237		
Observations	3086	585		
Hypothesized Mean Difference	0			
df	1152			
t Stat	-22.398966			
P(T<=t) one-tail	7.7933E-93			
t Critical one-tail	1.64617741			
P(T<=t) two-tail	1.559E-92			
t Critical two-tail	1.96202538			
6	Four-year, very small, primarily nonresidential	11	Four-year, small, highly residential	
7	Four-year, very small, primarily residential	12	Four-year, medium, primarily nonresidential	
8	Four-year, very small, highly residential	13	Four-year, medium, primarily residential	
9	Four-year, small, primarily nonresidential	14	Four-year, medium, highly residential	
4	Two-year, large	15	Four-year, large, primarily nonresidential	
5	Two-year, very large	16	Four-year, large, primarily residential	
10	Four-year, small, primarily residential	17	Four-year, large, highly residential	
		18	Exclusively graduate/professional	
P =				
1.55587E-92	Random, Na			

graduate student only. Given the number of institutions that have shifted to "test optional" admissions, the Carnegie Classification team uses the percentage of applied students who are admitted as well. Both of the measures have limitations.

There is a significant difference in the means of each sample at a 0.05 confidence level. Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample. This is based on the institutions with ABET accredited programs having a higher mean compared to the population of the Carnegie Classification dataset comparing the selectivity data of the institutions. The mean of the institutions with ABET accredited programs data demonstrates a higher mean, above a 2, and thus are more likely to be more selective than the population, as shown in Table IX.

D. Institution Control

Institutional control refers to legal organizational form of the institution. Public institutions are funded, to varying extents, through the government, usually at the state level. The funding used for this determination includes state or federal appropriations, but not federal student financial aid. Public institutions may be part of a larger state system, though that is not required. Private institutions do not receive direct governmental appropriations and thus are primarily funded through other sources, such as endowment, religious organization, and/or tuition. Private institutions may be structured as for-profit or not-for-profit organizations.

Shown in Table X, there is a significant difference between the sample and population institutional control data at all confidence levels. Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample. The institutions with ABET accredited programs are much more frequently public institutions compared to the population of the Carnegie Classification dataset. This is particularly interesting as there are more private institutions, particularly in the not-for-profit space, than public institutions in U.S. higher education.

TABLE X. STATISTICAL DATA, INSTITUTIONAL CONTROL, ALL CATEGORIES

t-Test: Two-Sample Assuming Unequal Variances	conf = 0.01	
	Random, Na	
	Carnegie	ABET
Mean	1.924116	1.3209
Variance	0.623314	0.28111
Observations	4665	70
Hypothesized Mean Difference	0	
df	1224	
t Stat	26.0851	
P(T<=t) one-tail	6.1E-120	
t Critical one-tail	2.329398	
P(T<=t) two-tail	1.2E-119	
t Critical two-tail	2.579852	

E. Instisutional Locale

Institutional locale refers to the level of urbanization of the area in which the institution is located. The highest level of urbanization is called "city", with the area related to but outside the city called "suburb". An area that is not large enough to be classified a city but still somewhat urbanized is called a "town". The remaining areas, with no urbanization, are called "rural". Cities and suburbs are subdivided by size, or small, medium, and large. Towns and rural areas are subdivided by distance from larger urbanized areas as on the fringes of the city or suburban area, distant from the primary urbanization, or in a remote area.

Looking specifically at the institutions located in cities, shown in Table XI, there is significant difference between the sample and population datasets. At a confidence level of 0.05, the null hypothesis must be rejected. This means that there is a significant difference between the means of the two sets of data. Through this outcome, we can make the assumption that population of the Carnegie Classification dataset are more frequently within large cities, while the institutions with ABET accredited programs are within smaller cities on average.

When we analyze suburban institutions, we again have a significant difference between the sample and population data. At a confidence level of 0.05, the null hypothesis must be rejected. This means that there is a significant difference between the means of the two sets of data. This data, shown in Table XII, was much closer to being able to accept the null hypothesis, but it still shows that the suburbs containing institutions of higher education as a whole are more frequently

TABLE XI. STATISTICAL DATA, INSTITUTIONAL LOCALE, CITY

t-Test: Two-Sample Assuming Unequal Variances	conf = 0.05	
	Random, Na	
	Carnegie Cit	ABET City
Mean	11.78148	11.9300
Variance	0.711668	0.73535
Observations	2279	38
Hypothesized Mean Difference	0	
df	519	
t Stat	-3.15509	
P(T<=t) one-tail	0.000849	
t Critical one-tail	1.647795	
P(T<=t) two-tail	0.001698	
t Critical two-tail	1.964545	

TABLE XII. STATISTICAL DATA, INSTITUTIONAL LOCALE, SUBURBS

t-Test: Two-Sample Assuming Unequal Variances	conf = 0.05	
	Random, Na	
	Carnegie Suburbs	ABET Suburbs
Mean	21.20654716	21.33928571
Variance	0.274777694	0.429106074
Observations	1283	168
Hypothesized Mean Difference	0	
df	196	
t Stat	-2.52281241	
P(T<=t) one-tail	0.006218384	
t Critical one-tail	1.652665059	
P(T<=t) two-tail	0.012436768	
t Critical two-tail	1.972141222	

larger than the suburbs containing institutions with ABET accredited program(s).

Distinct from the city and suburb data, analysis of the institutions in towns, shown in Table XIII, is not statistically different. The p two-tail value is large than the confidence level, this means that the null hypothesis cannot be rejected. Both institutions with ABET accredited programs and the institutions in the Carnegie Classification population as a whole are heavily located within the fringes of a town setting.

Institutions in rural settings, shown in Table XIV and similar to city and suburban locales, are significantly different between the sample and population datasets. At a confidence level of 0.05, the null hypothesis must be rejected. This means that there is a significant difference between the means of the two sets of data. When analyzing rural institutions, those with ABET accredited programs are much more frequently within the fringe compared to institutions in the Carnegie Classification data as a whole, which is much more heavily towards distant and remote.

TABLE XIII. STATISTICAL DATA, INSTITUTIONAL LOCALE, TOWN

t-Test: Two-Sample Assuming Unequal Variances	conf = 0.05	
	Significant Relation, N0	
	Carnegie Town	ABET Town
Mean	32.2245827	32.11711712
Variance	0.454045228	0.486158886
Observations	659	111
Hypothesized Mean Difference	0	
df	147	
t Stat	1.50944322	
P(T<=t) one-tail	0.066665988	
t Critical one-tail	1.655285437	
P(T<=t) two-tail	0.133331976	
t Critical two-tail	1.976233309	

TABLE XIV. STATISTICAL DATA, INSTITUTIONAL LOCALE, RURAL

t-Test: Two-Sample Assuming Unequal Variances	conf = 0.05	
	Random, Na	
	Carnegie Rural	ABET Rural
Mean	41.45124717	41.19444444
Variance	0.484549577	0.218253968
Observations	441	36
Hypothesized Mean Difference	0	
df	49	
t Stat	3.034602451	
P(T<=t) one-tail	0.001924009	
t Critical one-tail	1.676550893	
P(T<=t) two-tail	0.003848018	
t Critical two-tail	2.009575237	

F. Special Populations

Some institutions have historically served a particular population, such as women's colleges and institutions with a significant population of students who are Hispanic. Other institutions are members of an organization representing a particular population, for example the Council of Public Liberal Arts Colleges, or are otherwise connected to a particular demographic, such as faith-based institutions. These are institutions that serve special populations. We analyzed three types of these institutions: Hispanic serving institutions, minority serving institutions, and women's colleges.

Hispanic-Serving institutions, or HSIs, have no statistical difference between the sample and population datasets. As shown in Table XV, there is a significant relationship in the means of the sample and population at a 0.05 confidence level. Due to a higher p-value than our alpha, we can accept the null hypothesis that there is no significant difference in the means of each sample. Thus it can be concluded there is a relationship between all the population of all Carnegie classification institutions that are HSIs and institutions with ABET accredited programs that are HSIs. However, neither the population of Carnegie Classification institutions as a whole nor institutions with ABET accredited programs are heavily Hispanic-Serving.

For those institutions classified as Minority-Serving institutions, or MSIs, there is a significant difference in the means of each sample at all confidence levels, as shown in Table XVI. Due to a lower p-value than our alpha, we must reject the null hypothesis that there is no significant difference in the means of each sample. The institutions with ABET accredited programs are much more frequently MSIs compared to the Carnegie Classification population as a whole. This is likely connected to the structural oppression in the original creation of Historically Black Colleges and Universities [8].

The final special population we analyzed is women's colleges. As shown in Table XVII, at a confidence level of 0.05, the null hypothesis must be rejected. This means that there is a significant difference between the means of the two sets of data. This means that institutions with ABET accredited programs are

TABLE XV.   STATISTICAL DATA, SPECIAL POPULATIONS, HISPANIC-SERVING INSTITUTIONS

t-Test: Two-Sample Assuming Unequal Variances			Conf	0.05
	Carnegie	Abet		
Mean	0.066667	0.077033		
Variance	0.062236	0.0712		
Observations	4665	701		
Hypothesized Mean Difference	0			
df	894			
t Stat	-0.96702			
P(T<=t) one-tail	0.166897			
t Critical one-tail	1.64656			
P(T<=t) two-tail	0.333794			
t Critical two-tail	1.962621			
P =				
0.333794	Significant Relation, N0			

TABLE XVI.   STATISTICAL DATA, SPECIAL POPULATIONS, MINORITY-SERVING INSTITUTIONS

t-Test: Two-Sample Assuming Unequal Variances	conf = 0.01	
	Random, Na	
	Carnegie	ABET
Mean	0.13612	0.179743
Variance	0.117617	0.147646
Observations	4665	701
Hypothesized Mean Difference	0	
df	876	
t Stat	-2.84062	
P(T<=t) one-tail	0.002303	
t Critical one-tail	2.330612	
P(T<=t) two-tail	0.004607	
t Critical two-tail	2.581453	

TABLE XVII.   STATISTICAL DATA, SPECIAL POPULATIONS, WOMEN'S COLLEGES

t-Test: Two-Sample Assuming Unequal Variances	conf = 0.05	
	Random, Na	
	Carnegie	ABET
Mean	0.008789	0.002853
Variance	0.008713	0.002849
Observations	4665	701
Hypothesized Mean Difference	0	
df	1445	
t Stat	2.43712	
P(T<=t) one-tail	0.007462	
t Critical one-tail	1.645909	
P(T<=t) two-tail	0.014925	
t Critical two-tail	1.961607	

much less frequently women's colleges than institutions of higher education as a whole.

IV. CONCLUSIONS AND FUTURE WORK

When we started this study, we were looking to discover the limits of generalization from research on CSET education to higher education as a whole. Our idea was to find where we could expand the story of our CSET education research results to the larger higher education community. What we found is that the limits are so narrow, the story from the data is actually in the opposite direction: the institutional context in which U.S. CSET education occurs is sufficiently different from higher education in the U.S. as a whole that CSET education research needs to continue as a stand-alone discipline in order to continue the pathway of improvement. For policy makers, this means that assessments, definitions, and forms of high-impact practices which are known to positive innovations in higher education in the U.S. as whole should be systematically vetted for U.S. CSET education prior to wholesale adoption. For CSET education researchers, this work helps explain differences in research results between U.S. CSET education and higher education in the U.S. as a whole as well as suggest organizational context variables that may describe why these differences exist.

We will continue this work in two forms. First, we are expanding our analysis to consider each ABET commission individually. We are intrigued with the similarities and differences in the institutional contexts where engineering, engineering technology, and computer science education occur. Second, we and, we hope, other researchers interested in

impacting governmental policy on CSET education at all levels will use this data to clarify the limitations of their research results and encourage more resources to be earmarked for research, innovation, and application in this discipline.

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