

Connecting the Dots: Campus Form, Student Perceptions, and Academic Performance

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The influence of the built environment on people's behavior and performance is a traditional study topic in urban design. In this article, Amir Hajrasouliha discusses the role of the campus physical environment in student perceptions and in their performance and graduation rates through an investigation of 23 CSU campuses and a survey of 446 students. The author demonstrates that both objective and perceived measures are significantly associated with student academic performance.

This article discusses a research that evaluates the role of campus built environment and its immediate surroundings on a major concern of universities: student retention and graduation. The relationship of both objective and perceived measures of physical campuses with students' academic performance was examined, using the California State University (CSU) campuses as its sample. The objective campus environment was measured by using a Campus Score scale, while the perceived campus quality and the perceived restorativeness were measured through an online survey of 446 students. The results demonstrate that both objective and perceived measures were significantly associated with students' academic performance. However, the aggregated perceived measures at the campus level were not associated with the objective measures related to campus form. The mismatch between objective and perceived measures leads to additional questions and potential research. This research provides insight to universities about the role of their physical campus in enhancing student retention and graduation rates.

Introduction

Retention and graduation rates have become a key component of measuring the performance of higher education institutions in recent years. The most common strategies to improve retention and graduation rates are financial and academic, such as revising the financial aid criteria, investing in academic and advisory services, and revising curricula and programs. However, sometimes we forget that a valuable asset for student success can be the physical campus and its surroundings. Motivational and psycho-social issues might be as important as financial and academic issues in this matter. A supportive physical learning environment can enrich students' college experience, contribute to a sense of belonging, and respond to their social and emotional needs (Kenney et al., 2005).

In recent years, many universities embraced the idea of physical planning to attract more prospective students, increase the quality of life of current students, and invest in surrounding communities (Chapman, 2006; Coulson et al., 2010; Coulson et al., 2014; Hajrasouliha & Ewing, 2016; Hajrasouliha, 2017b; Dalton et al, 2018). However, the potential impact of these built environment interventions on students' academic performance is an understudied topic. More evidence-based research is needed to connect campus design qualities with students' satisfaction and academic performance. This research is an attempt to evaluate the role of campus built environment and its immediate surroundings on a significant concern of universities: student retention and graduation.

Background Information

The theoretical foundation of this research is based on Hajrasouliha (2017a). That study applied a theoretical framework for analyzing campus form of one hundred and three universities with high research activities in the United States. Strong positive associations were found for three objective measures of campus form – (1) urbanism, (2) greenness, and (3) on-campus living – with student retention and graduation rates, after controlling for student selectivity, class size, total undergraduate enrollment, and university type. This project expands on that work in two important ways: 1) Incorporating both objective and perceived measures of campus form in the analysis, and 2) focusing on teaching-oriented institutions rather than research-oriented institutions.

Perceived measures

The physical campus can have an impact on students' satisfaction and academic performance in different ways, including through its "restorative" impact on students' mental

functioning and social relationships. Connecting the objective measures of campus form to its perceived measures reveals the affective potential of the “well-designed” campus. Research from a variety of fields, namely environmental psychology, has demonstrated the restorative potential of natural and built environments. Exposure to natural settings can reduce stress (Ulrich, 1984), promote recovery from attentional fatigue (Kaplan & Kaplan, 1989), and even improve overall health (Laumann et al., 2003). Many studies have shown that natural environments have greater restorative potential than urban environments (Hartig et al., 2003; Herzog et al., 1997; Ulrich et al. 1991). However, some studies suggest that certain urban settings have a perceived restoration potential that is equivalent to, or even greater than, natural environments (Herzog et al. 2003; Nasar & Terzano, 2010; van den Berg et al., 2014). Empirical evidence from many disciplines has supported the development of restorative urban environments, though there is little guidance for the incorporation of the restorative notion in campus settings.

In a unique study on university campuses, Hipp et al. (2016) found that students with higher perceptions of campus greenness report a better quality of life, a pathway significantly and partially mediated by perceived campus restorativeness. However, that study only focused on campus greenness, and no other built environment characteristics. In addition, exploring the relationship of perceived measures of campus form with objective measures can provide an insight into the environmental cognition of university students.

Teaching-oriented institutions

Physical campuses might play a different role in different institutions. For example, the role of research labs in students’ satisfaction and success is more central in a research university than a teaching university. Also, controlling and modelling all the external factors and macro-forces (e.g., students’ socioeconomic status, university mission, financial resources,

and student selectivity) is difficult. However, limiting samples to relatively similar institutions, politically and academically, can reduce the impact of these external factors and macro-forces to some extent (comparative analysis with most similar systems (Teune & Przeworski, 1970). Therefore, this project is focused on the California State University (CSU) system as its sample. Comprised of 23 teaching-oriented campuses, the CSU is the largest four-year public university system in the United States, which makes it a manageable scale for this study, while being broadly representative of comparable institutions.¹

In sum, the primary purpose of this study is to examine the relationship of both objective and perceived measures of physical campuses with students’ satisfaction and academic performance in teaching-oriented institutions (see Figure 1). The findings provide evidence-based insights for university administrators, and higher education researchers about investments in campus planning and development, and a better understanding of a well-designed campus in the context of academic performance.

Discussion of Procedure

The research investigated the relationship between the physical campus (objective and perceived dimensions) and student satisfaction with college life, and ultimately, academic performance. It was divided into two phases.

Phase 1 was the campus-level, Campus Score, analysis of all CSU campuses and Phase 2 is the individual-level analysis from students. In this phase, the objective measures of campus form were the foci of research, and these measures were associated with retention and graduation rate measures.

In phase 2 the perceived environment was measured through an online survey from students of specific CSU campuses, and the results were associated with their perceived satisfaction with their academic life and performance. These two phases

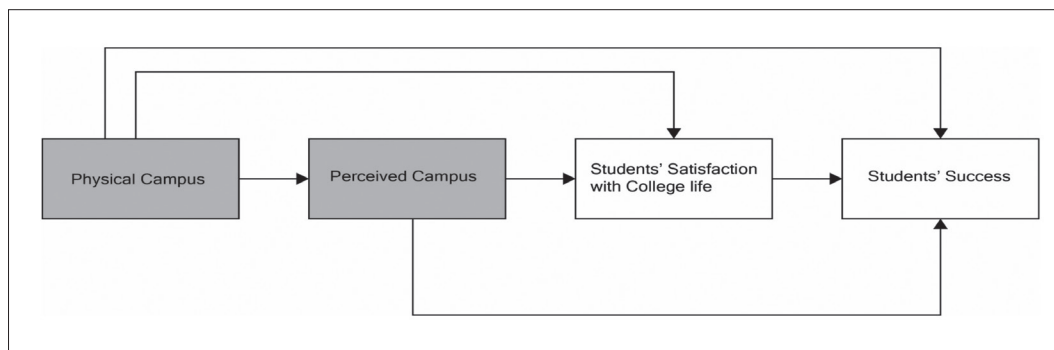


Figure 1:
The conceptual diagram

¹ 4-year public institutions without doctorate programs.

allow for connecting the physical campus qualities to their perceived qualities and explore their relationship with students' perceptions and academic performance.

Phase I: Campus-level Analysis & the Objective Environment

Generating the Campus Score for CSU campuses

In phase one, the physical campus form characteristics of 23 CSU campuses were measured, using the scale from a previous study (Hajrasouliha, 2017). Campus Score is a composite index that measures the degrees of urbanism (Urban Score), greenness (Green Score), and living on campus (Living Score) based on the standardized value of specific campus form dimensions (see Table 1).²

The size of campus enrollment was not included in Hajrasouliha's (2017) Campus Score, but the total student enrollment was shown to have significant associations with freshman retention and six-year graduation rate in that study. Therefore, this study adds total enrollment to the overall Campus Score. For consistency and convenience, all four scores are normalized with the mean of 100 and standard deviation of 50.³ In sum, the Campus Score is generated by adding Urban, Green, Living, and Size Scores, normalized with the mean of 100 and a standard deviation of 50.

Measuring University and Community Characteristics, and Academic Performance

As other studies have found basic institutional characteristics to be associated with academic performance, a dataset was collected on the age of institution, the percentage of white students, average SAT score, the percentage of students with Pell grants, and the amount of student aid per recipient come from the National Center for Education Statistics. For the community context, which may also affect student academic performance, these factors were assessed: access to food: the percentage of residents with low access to food within 0.5 mile in census tracts around campus (American Nutrition Association, food desert index), travel mode: percentage of workers who

drove alone at census tracts around campus (census data), socioeconomic characteristics: share of arts and entertainment occupations, percentage of renters, percentage of residents with bachelor degree and higher, percentage of single-family home units (census data). Academic performance measures include freshman retention rate and six-year graduation rate (National Center for Education Statistics).

Exploring the relationship of Campus Score with Universities' Characteristics and Performances

Measuring university characteristics, neighborhood context, and the Campus Score reveal whether there is an association between them, and ultimately student academic performance. Pearson Bivariate Correlation and multiple regression modeling were used to explore the relationship of Campus Score with freshman and graduation rates. In addition, Pearson Correlation was used to show the relationship of physical campus qualities (Campus Score, and its four dimensions) with the institutional characteristics. Besides, the Pearson Correlation was used to explore the relationship between campus qualities and the characteristics of their surrounding neighborhoods.

Phase II: Individual-level Analysis & the Perceived Environment

Data collection

An online questionnaire was developed to study student perceptions and satisfaction with their campus. The questionnaire focused on the level of students' satisfaction with different elements of the physical campus, and their academic and non-academic experience on campus. It also included essential demographic characteristics (gender and age), previous and current student academic status (self-report SAT/ACT scores, self-report GPA and year of study).

Using a scale of 1 (completely dissatisfied) to 7 (completely satisfied), students rated their satisfaction with the following aspects of campus: 1) Landscape and green features such as street trees and views of greenery; 2) Plazas and outdoor gathering places; 3) Eateries and restaurants on campus; 4) The accessibility to a variety of commercial, cultural, and entertainment opportunities within walking distance from campus; 5) Housing on campus; 6) The architecture of campus buildings; 7) Recreational facilities on campus.

The questionnaire also included a *Perceived Restorativeness Scale* (PRS) measuring five domains (Fascination, Being Away, Coherence, Compatibility, and Scope) in each campus (Abdulkarim and Nasar, 2014; Berto, 2005). This 5-item scale was adapted from the full-length version of the PRS (Hartig et al., 1991; Hartig et al., 2003). The PRS is based on the Attention Restoration Theory (ART; Kaplan, 1995) to measure an individual's perception of restorative factors in the environment.

² Urban Score is the sum of Z-scores of mass density, street network connectivity, the centrality of the campus, activity density of surrounding census tracts, intersection density of surrounding census tracts, and the negative value of the proportion of undeveloped areas in a quarter mile buffer around campus core buildings. Green Score includes the Z-scores of the density of tree canopies, the proportion of pervious open spaces, and the negative value of the percentage of surface parking areas on campus. Living score includes the percentage of freshman living on campus.

³ Since Campus Score has quadrangle relationships with retention and graduation rates (Hajrasouliha, 2017) - meaning its effect fades after a certain threshold - the maximum value of each score is set to be 150.

Table 1: Objective Measures of Campus Form.

	Description	Computation Process	Data Source
Urban Score	Mass Density	Total area of building footprints divided by campus area	Combination of available campus CAD or GIS files, refined with OpenStreetMap, Google Earth images if necessary
	Campus Connectivity	The mean value of Angular Integration analysis with radius of 3, weighted by segment length of all campus street segments (Space Syntax technique)	Census Tiger 2010, street lines
	Campus Centrality	The mean integration value of campus street segments with radius 3 divided by the average integration value of county street segment with the same radius	Census Tiger 2010, street lines
	Activity density	Population and employment density of all census tracts neighboring the campus	Longitudinal Employment Household Dynamic 2010- Census 2010
	Intersection density	Number of intersections within all census tracts neighboring the campus divided by the area of census tracts	Census Tiger 2010, street lines and census tracts
	Undeveloped Land	Percentage of undeveloped land in a quarter mile buffer around campus buildings	National Land Cover Data 2011
Green Score	Tree canopy	Density of tree canopy in a quarter mile buffer around campus buildings	National Land Cover Data 2011
	Pervious open spaces	Percentage of pervious open spaces in a quarter mile buffer around campus buildings	National Land Cover Data 2011
	Surface parking	Total area of surface parking divided by the campus area	Combination of available campus CAD or GIS files, refined with OpenStreetMap, Google Earth images if necessary
Living Score	On-campus living	Percentage of freshman students living on-campus	California State University website
Size Score	Total Enrollment	Total enrollment in 2015-16 academic year	National Center for Education Statistics - NCES

The question for Fascination was “The campus is fascinating; it allows me to discover and be curious about things”. For Being Away: “The campus, outside the classrooms, is a place which is away from everyday demands and where I would be able to relax and think about what interests me.” For Scope: “The campus is a place that provides a feeling of being in a ‘whole other world’”. For Coherence: “The campus is a place where the activities and the items (buildings, plazas, green spaces, etc.) are ordered and organized.” And for Compatibility: “In the campus, it is easy to orient and move around so that I could do what I like.” Response options were in a 1 to 7-point scale with 1 = not at all, 4 = rather much, and 7 = completely.

The questions regarding students’ satisfaction with college life were adopted from the 2016 National Survey of Student Engagement (NSSE) on a 4-point scale, and included: “Overall, how would you evaluate the quality of academic advising you have received at your institution?”; “How would you describe your satisfaction with your (both academic and nonacademic) school experiences?”; “If you could start over again, would you go to the same institution you are now attending?”; and “How likely is it that you will graduate on time?”

The online questionnaire was conducted during the Winter and Spring semester/quarter of 2017. Participants were offered an incentive in the form of a drawing for three \$100

iTunes gift cards. While the online survey was posted on the Facebook page of 14 universities, 9 universities declined participation. Fewer than 10 responses per campus were received from 8 campuses. In one campus, Cal Poly SLO, the online survey was emailed directly to a group of students in Architecture, Engineering, and Business colleges. In total 446 responses were collected and, 269 from Cal Poly Students.

Exploring the relationship of perceived campus qualities with students’ satisfaction and academic performances

The Pearson Correlation was used to test the relationships between the perceived physical qualities (*Perceived Campus Quality*) and the perceived psychological quality (*Perceived Restorativeness*). Multiple regression modeling was used to investigate the relationship of both perceived qualities with students’ satisfaction and success. Students’ satisfaction with their academic and non-academic experience, the likelihood of selecting the same institution if they could start over again, and the likelihood of their graduation on time were modeled with the following predictor variables: *Perceived Campus Quality*, *Perceived Restorativeness*, satisfaction with academic advising, and GPA (until that point).

As the majority of respondents were from Cal Poly, two options were considered for the modeling phase: a) modeling the out-

come variables once with Cal Poly sample and once with the other universities, and b) to use a dummy variable for Cal Poly students. Both approaches were tested, and the results were identical regarding the sign and significance of predictors. For the sake of simplicity, only the results of using a dummy variable are presented.

Comparing the objective and perceived campus form measures

Aggregate perceived measures were compared at the campus level for the six campuses with more than ten respondents. These six campuses are Pomona, San Luis Obispo, San Jose, Sacramento, Sonoma, and Stanislaus. Comparing the perceived measures at the institutional level with the objective measures shows their match/mismatch status, and therefore, tests the validity of using the perceived campus measures at the institutional level for predicting students' satisfaction and academic performance.

Results

The Objective Campus and its Associations

The final ranking of all 23 campuses with their scores is presented in Table 2. There was a positive correlation between Campus Score ($M = 100$, $SD = 50$) and six-year graduation rate ($M = 48.49$, $SD = 9.89$), $r = .561$, $p < .01$, $n = 23$. The amount of variance explained by Campus Score is 31.5 percent.

Several tests showed relationships with the six-year graduation rate. Multiple regression analysis showed that Campus Score and university acceptance rate (a proxy for student selectivity), together, significantly predicted students' six-year graduation rate. The results of the regression indicated the two predictors explained 46.8 percent of the variance ($R^2 = .468$, $F(2,20) = 10.690$, $p = .001$). Campus Score significantly predicted graduation rate ($\beta = .420$, $p = .018$), as did acceptance rate ($\beta = -.471$, $p = .009$). Also, a multiple linear regression was calculated to predict six-year graduation rate based on Campus Score and freshman retention rate. A significant regression equation was found ($R^2 = .515$, $F(2,20) = 12.674$, $p < .001$). Campus Score ($\beta = .377$, $p = .027$) and freshman retention rate ($\beta = .527$, $p = .003$) significantly predicted graduation rate.

Multiple regression analysis was used to test if Campus Score and university acceptance rate, significantly predicted students' freshman retention rate. The results of the regression indicated the two predictors explained 26.8 percent of the variance ($R^2 = .268$, $F(2,20) = 5.035$, $p = .017$). While there was no significant association between Campus Score ($\beta = .203$, $p = .300$) and freshman retention rate, acceptance rate ($\beta = -.484$, $p = .020$) had a significant association with freshman retention.

Next, it was tested whether the strong observed association between Campus Score and graduation rate may reflect underlying associations between Campus Score and other university and neighborhood characteristics. Table 3 shows these associations with a number of university and neighborhood characteristics. Campus Score was positively associated with the average SAT score of students ($M = 981.83$, $SD = 87.9$, $r = .734$, $p < .001$), the percentage of white students ($M = 27.9$, $SD = 13.58$, $r = .630$, $p < .001$), and negatively associated with the established year of institutions – positively with the age- ($M = 1940$, $SD = 36.3$, $r = -.518$, $p = .011$), the percentage of students with Pell Grants ($M = 45.9$, $SD = 10.2$, $r = -.762$, $p < .001$), and the amount of student aid per recipient ($M = 8998$, $SD = 620$, $r = -.528$, $p < .001$). Besides, Campus Score was negatively associated with the percentage of residents with low access to food within 0.5 miles in the surrounding census tracts of campuses ($M = 59.17$, $SD = 22$, $r = -.471$, $p = .023$). It was also negatively associated with the percentage of workers drove alone to work ($M = 73.2$, $SD = 10.2$, $r = -.519$, $p = .011$), the percentage of single-family units ($M = 69.89$, $SD = 16.59$, $r = -.492$, $p = 0.017$), and positively associated with the percentage of renter occupant units in the surrounding census tracts ($M = 50.24$, $SD = 20.72$, $r = .500$, $p = .015$). Campus Score was positively associated with the share of arts, design, entertainment, sports, and media occupations ($M = 11.41$, $SD = 3.88$, $r = .648$, $p < .001$), and the percentage of residents with a bachelor degree or higher in the surrounding census tracts ($M = 36.70$, $SD = 13.51$, $r = .479$, $p = .021$).

The Perceived Campus and its Associations

Another hypothesis (Ulrich, 1984; Kaplan and Kaplan, 1989) to explain the influence of the physical campus on graduation rates is that it may provide a supportive environment for students taking a break and restoring their ability to study or work effectively on a demanding project. In other words, a well-designed campus can facilitate recovery from mental fatigue, and contribute to decreased stress, which can lead to better academic performance. To test this hypothesis, the perceived restorative quality of campus environments was measured with PRS-5 scale (Berto, 2005).⁴

First, the relationships of the *Perceived Restorativeness* and students' satisfaction with different campus form elements were explored. *Perceived Restorativeness* was positively associated with students' satisfaction with – ordered by the strength of association – “plazas and outdoor gathering places” ($r = .590$, $p < .001$), “the architecture of campus buildings”

⁴ With the sample size of 446 respondents, five questions relating to perceived restoration were factor analyzed using principal component analysis. The analysis yielded one factor explaining a total variance of 59.62 percent. All five questions were loaded on the principal component with the strong primary loading of more than .7.

Table 2: Ranking CSU universities based on their Campus Score.

CSU Campus	Rank	Urban Score	Green Score	Living Score	Size Score	Campus Score
Chico	1	146	150	124	88	175
San Luis Obispo	2	61	150	150	103	167
San Diego	3	99	60	140	150	155
San Francisco	4	135	109	100	140	153
San Jose	5	150	55	113	150	151
Sonoma	6	91	116	150	53	141
Humboldt	7	60	150	150	49	140
Monterey Bay	8	60	150	150	41	136
Maritime	9	75	150	138	17	121
Northridge	10	150	85	62	150	117
Pomona	11	44	133	93	116	102
Long Beach	12	117	51	80	150	102
San Marcos	13	53	57	150	65	100
Channel Islands	14	28	137	125	41	92
Fullerton	15	117	57	62	150	88
East Bay	16	108	88	84	76	84
Sacramento	17	87	48	61	139	62
Los Angeles	18	126	65	30	132	56
Stanislaus	19	108	88	62	51	51
Fresno	20	113	59	43	112	50
San Bernardino	21	54	110	41	94	36
Dominguez Hills	22	121	30	44	76	24
Bakersfield	23	54	65	35	50	12

Table 3: The correlations of Campus Score with university and community.

		Urban Score	Green Score	Living Score	Size Score	Campus Score
University Characteristics	Established year of institution	-.565**	-0.101	-0.166	-0.372	-.518*
	Average SAT score of students	-0.1	.460*	.713**	0.1	.734**
	Percentage of white students	-0.291	.698**	.813**	-0.334	.630**
	Student aid per recipient	-0.029	-0.257	-.522*	-0.074	-.528**
	Students with Pell Grants	0.022	-0.381	-.768**	-0.007	-.762**
	Spending per completion	-0.355	.584**	.460*	-.591**	0.214
Surrounding neighborhood characteristics	Percentage of residents with low access to food at 0.5 mile	-.458*	-0.065	-0.256	-0.354	-.471*
	Percentage of workers drove alone to work	-0.286	-.518*	-0.35	-0.001	-.519*
	Share of arts, design, entertainment, sports, and media occupations	.218	.442*	.540**	0.046	.648**
	Percentage of residents with Bachelor degree and higher	-0.069	0.195	0.377	0.345	.479*
	Percentage of renter occupied units	0.244	.433*	.436*	-0.043	.500*
	Percentage of Single family units	-0.275	-0.375	-.436*	0.056	-.492*
*. Correlation is significant at the 0.05 level (2-tailed).						
**. Correlation is significant at the 0.01 level (2-tailed).						

($r=.583$, $p<.001$), “landscape and green features such as street trees and views of greenery” ($r=.504$, $p<.001$), “housing on campus” ($r=.420$, $p<.001$), “the accessibility to a variety of commercial, cultural, and entertainment opportunities within walking distance from campus” ($r=.418$, $p<.001$), “eateries and restaurants on campus” ($r=.402$, $p<.001$), and “recreational facilities” ($r=.245$, $p<.001$).

The *Perceived Campus Quality* was generated using these seven campus elements.⁵ There was a strong positive association between the *Perceived Campus Quality* and the *Perceived Restorativeness* ($r=.698$, $p<.001$). This finding suggests that students’ satisfaction with various campus form dimensions - and not only campus greenness - is associated with the perceived restorativeness.

Second, multiple regression analysis was used to test if *Perceived Restorativeness* and *Perceived Campus Quality* significantly predicted students’ satisfaction with their academic and non-academic school experiences. Multiple models were built to test these relationships (see Table 4). In Model 1, when students’ satisfaction with school experience was predicted it was found that GPA ($\beta = .19$, $p < .01$), perceived academic advising quality ($\beta = .35$, $p < .01$) and being a Cal Poly student ($\beta = .17$, $p < .01$) were significant predictors. The overall model fit was $R^2 = 0.18$. *Perceived Campus Quality* was added as a predictor in Model 2. It was found that *Perceived Campus Quality* was a significant predictor ($\beta = .40$, $p < .01$). The overall model fit improved to $R^2 = .33$. In Model 3, *Perceived Restorativeness* was added to Model 1. This variable was also a significant predictor ($\beta = .47$, $p < .01$), and improved model fit to $R^2=.38$. In Model 4, both *Perceived Campus Quality* and *Perceived Restorativeness* were added as predictors to Model 1. The result showed that all variables were still significant predictors, yet the overall model fit didn’t change from $R^2=.38$.

A similar modeling process was used to predict whether students would go to the same institution they are now attending if they could start over again. Table 5 shows the results. In Model 1 it was found that perceived academic advising quality ($\beta = .28$, $p < .01$) and being Cal Poly student ($\beta = .28$, $p < .01$) were significant predictors, but GPA was not ($\beta = .06$, $p = .24$). The overall model fit was $R^2 = 0.15$. In Model 2, it was found that *Perceived Campus Quality* was a significant predictor ($\beta = .35$, $p < .01$) and the overall model fit improved to $R^2 = .26$. In Model 3, *Perceived Restorativeness* was added to Model 1, and it was found to be a significant predictor ($\beta = .35$, $p < .01$), with the overall model fit of $R^2=.25$. In Model 4,

Perceived Campus Quality and *Perceived Restorativeness* were added to Model 1. Both variables were significant predictors, and the overall fit of the model was $R^2 = .28$

A series of multiple regression models were tested to predict how likely it is that they graduate on time. No variable was found to be a significant predictor. *Perceived Campus Quality* had no association with graduating on time ($r=.04$, $p=.40$), as did *Perceived Restorativeness* ($r=.03$, $p=.47$). However, relatively weak but significant association was found between GPA and *Perceived Campus Quality* ($r=.12$, $p=.02$), and *Perceived Restorativeness* ($r=.10$, $p=.03$).

The Objective vs Perceived Campus

The aggregated *Perceived Campus Quality* and *Perceived Restorativeness* at the campus level were compared with *Campus Score* for the six campuses with more than 10 respondents. These six campuses are Pomona, San Luis Obispo, San Jose, Sacramento, Sonoma, and Stanislaus.⁵

Figure 2 shows a clear mismatch between *Campus Score* and the aggregated perceived measures. For example, the San Luis Obispo and San Jose campuses had the highest *Campus Scores*, while they received the lowest perceived scores. In contrast, the Sacramento and Stanislaus campuses had high perceived scores and low *Campus Scores*. This inconsistency exists for all campus form attributes. For example, the objective greenness measure showed that Cal Poly San Luis Obispo has one of the greenest campuses regarding landscaping and tree canopies. However, Cal Poly SLO received a very low score regarding perceived greenness compared to the other CSU campuses.

Conclusions

This study explored how planning the physical environment can support an institution’s goals concerning academic performance. Although the physical environment is not the primary factor at play in addressing academic performance, it does have a substantial supporting role. This study found *Campus Score* explains 31.5 percent of the variance in the six-year graduation rate of CSU campuses. This is a reasonably strong association, although it was found to be stronger in Hajrasouliha (2017), where the amount of variance in the six-year graduation rate of 103 research universities explained by *Campus Score* was 66 percent. The difference can be explained by the scope of research (national vs. state), and the type of institutions (research vs. teaching-oriented); research institutions generally have more diverse student bodies, are significantly larger and

⁵ Which were factor analyzed using principal component analysis. The analysis yielded one factor explaining a total variance of 43.76 percent. This component can be labeled as the *Perceived Campus*

⁶ The perceived measures were normalized to the mean of 100 and standard deviation of 50 before aggregation for consistency with *Campus Score*.

Table 4: Summary of multiple regression analysis for variables predicting students' satisfaction with both academic and non-academic school experience (N=446).

Variable	Model 1			Model 2			Model 3			Model 4		
	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Perceived quality of academic advising	.21	.03	.35**	.15	.03	.25**	.12	.03	.20**	.12	.03	.20**
GPA	.22	.05	.19**	.17	.05	.15**	.17	.05	.16**	.16	.05	.15**
Dummy variable for Cal Poly Students	.20	.05	.17**	.29	.05	.25**	.27	.05	.24**	.30	.05	.26**
Perceived Campus Quality				.24	.03	.40**				.11	.03	.20**
Perceived Restorativeness							.27	.03	.47**	.19	.03	.32**
R ²	.18			.33			.38			.38		
F for change in R ²	27.79**			44.47**			54.86**			44.52**		

*p < .05. **p < .01

Table 5. Summary of multiple regression analysis for variables predicting whether they would go to the same institution if they could start over (N=446).

Variable	Model 1			Model 2			Model 3			Model 4		
	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Perceived quality of academic advising	.25	.04	.28**	.16	.04	.18**	.16	.04	.18**	.13	.04	.15**
GPA	.10	.08	.06	.04	.08	.02	.05	.08	.03	.03	.08	.02
Dummy variable for Cal Poly Students	.47	.08	.28**	.60	.08	.35**	.55	.08	.32**	.60	.08	.35**
Perceived Campus Quality				.30	.04	.35**				.18	.06	.22**
Perceived Restorativeness							.29	.04	.35**	.17	.06	.20**
R ²	.15			.26			.25			.28		
F for change in R ²	20.96**			29.84**			30.36**			26.37**		

*p < .05. **p < .01

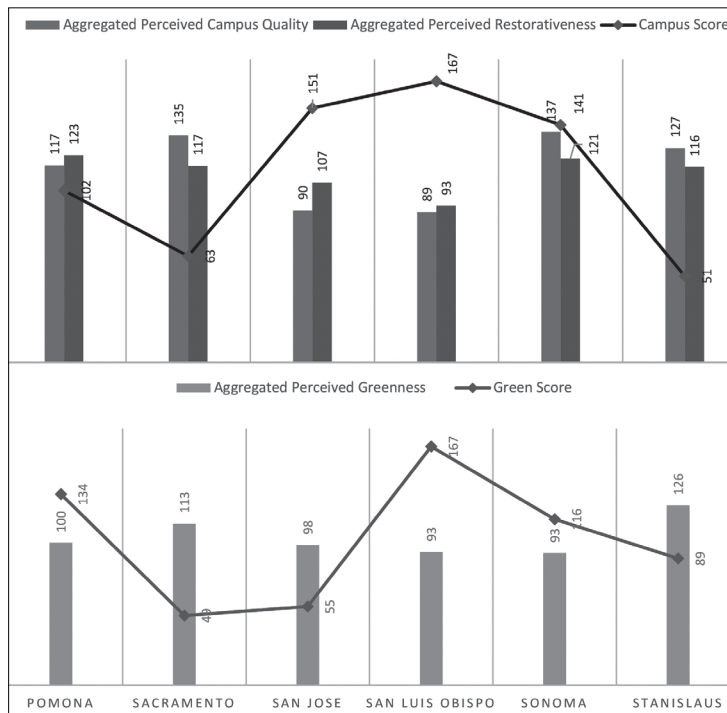


Figure 2: Comparisons between six CSU campuses. Above: Campus Score (line) against perceived measures (bars). Below: Green Score (line) against perceived greenness (bar).

more complex than the CSU campuses. Also, no significant association was found between Campus Score and freshman retention rate at CSU campuses, while the other study found a strong association for research universities.

On the other hand, Campus Score had significant associations with a number of university and community characteristics. Universities with higher Campus Scores tend to be older institutions with more white students, higher SAT scores, lower levels of financial aid per recipient, and lower number Pell grant recipients. Furthermore, universities with higher Campus Score are generally located in communities with better access to fresh food, art and recreational facilities, more residents with a bachelor degree, less auto-oriented, and less single family homes. The fact that campuses with lower Campus Score belong to intuitions that have more in-need students (financially and academically) and are located in less advantageous communities might be a unique situation to the CSU system. Further research can show whether this pattern exists in other States or not.

The most unanticipated result was the nature of the relationship between objective and perceived measures. It was expected that campuses with a higher score of objective measures, earn higher perceived qualities leading to higher students' satisfaction and academic performance in those campuses. For the first part of this hypothesis, contrary evidence tells us otherwise. Campuses with higher Campus Scores received lower scores for perceived campus quality and perceived restorativeness and vice versa. One explanation for this perplexing mismatch is that students' expectations can be

vastly different among different institutions. For instance, San Luis Obispo is one of the greenest cities in California with scenic landscapes and spectacular trails. In this context, Cal Poly SLO campus greenness may not be perceived as satisfactory by the greenness-saturated eyes of students (see Figure 3), while a lower amount of campus greenness in the urbanized context of San Jose may be more valued. This is only speculation, and more research is needed in this area.

The other explanation is the challenge of measuring design qualities. For example, Campus Score considers objective measures such as tree canopies, and impervious open spaces, but fell short in measuring design attributes such as aesthetic qualities and nuanced preferences. Visibility and accessibility are also important factors. For example, a small but well-designed landscape at the heart of campus can have a more positive impact on students' perception than a beautiful arboretum far from campus core (see Figure 4).

Although Campus Score is a good proxy of physical campus quality, it shouldn't be confused with a measure for campus image and identity. That said, the results suggest that objective qualities may have a direct impact on students' performance, not necessarily through their perceived image of campus. For example, living on campus may improve their academic performance, relatively independent of whether students have a positive view about living on campus or not. At the same time, the results suggest that students' perception of their campus is also associated with their college life satisfaction and performance. This study showed that perceived campus quality and perceived restorativeness were significant predictors of i)

Figure 3: The Cal Poly campus periphery (left) and a typical space on campus (right).
Cal Poly campus is green, but not as scenic as San Luis Obispo itself.



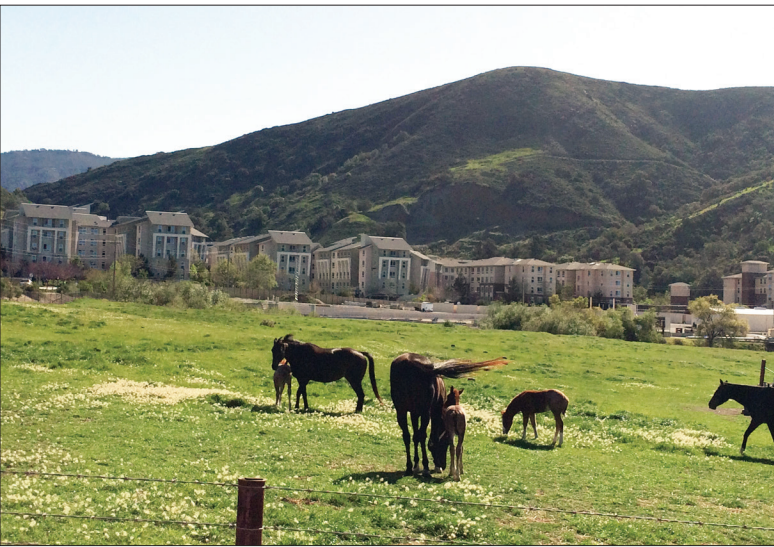


Figure 4: On-campus housing (left) and the Leaning Pine Arboretum on campus (right); both are located far from the campus core.

students satisfaction with both academic and non-academic school experience, ii) whether they would choose the same institution if could start over, and iii) students' GPA.

Another interesting finding is related to the relationship of the perceived quality of campus elements and Perceived Restorativeness. Students with higher perceived campus quality reported greater perceived restorativeness from campus environment. Interestingly, plazas and gathering spaces (social spaces) had a stronger association with perceived restorativeness than campus greenness. Besides, Perceived Restorativeness had a stronger association with the factorial variable (Perceived Campus Quality index, or the overall quality) than any single campus form quality. This result suggests that an overall "high quality" campus can be more restorative than solely "green" campus or "urban" campus.

Implications for Practice and the Advancement of Research

The observed mismatch between objective and perceived measures leads to additional questions and potential research. Perhaps campus culture is a mediator in this relationship. Conducting *Campus Climate*⁷ surveys on diversity, safety and sexual assault issues, in addition with *Campus Image and Identity*⁸ surveys provide a better understanding of campus culture and its association with objective measures and students' performance. An interesting research question for campus planners

would be the potential impact of specific physical campus interventions on campus culture and vice versa.

Based on this study, universities should pay more attention to develop policies regarding monitoring perceived campus qualities and objectively measuring campus qualities that improve students' satisfaction and academic performance. The policies should take into account the factors relating to all elements of campus form, and their connections to the nature of the institution, surrounding community, campus culture, and potentially the – objective and not necessarily perceived – characteristics of peer campuses. In this way, the university will have sound foundations for major campus projects, campus master planning efforts, and potential partnerships with the community.

The limitations of this work include the small number of universities, and the lack or low number of respondents from some campuses. Future research should include more universities and students. In that case, more sophisticated statistical methods such as Hierarchical Linear Modeling or Hierarchical Structural Equation Modeling could be used. Besides, it would be interesting to take account of campus culture variables to the study. Furthermore, it would be advisable to investigate the role of new technologies in both objective and perceived campus environment. Nevertheless, in the era of virtual reality and online education, the spatial dimensions of academic learning may need analytical exploration more than ever.

⁷ As an example see <https://campusclimate-stage.calpoly.edu/>

⁸ As an example see <http://opb.washington.edu/content/campus-landscape-framework-survey>

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