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

Amir Hajrasouliha, *California Polytechnic State University, San Luis Obispo*

Report from the Recipient of the 2016–2017 Perry Chapman Prize

Connecting the Dots:

Campus Form, Student Perceptions, and Academic Performance

AMIR HAJRASOULIHA, PH.D.

SCUP Society for College and University Planning

HIDEO SASAKI FOUNDATION

THE PERRY CHAPMAN PRIZE

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

by Amir Hajrasouliha, Ph.D.

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WHAT IS INTEGRATED PLANNING?

Integrated planning is a sustainable approach to planning that builds relationships, aligns the organization, and emphasizes preparedness for change.

ABOUT THE PERRY CHAPMAN PRIZE

(Source: www.scup.org)

The Hideo Sasaki Foundation, under the auspices of the Society for College and University Planning (SCUP), seeks to honor the intellectual contributions of M. Perry Chapman.

As a recipient of SCUP's K. C. Parsons Founders' Award for Distinguished Achievement in Higher Education Planning, Perry Chapman was committed to developing and sharing knowledge to advance integrated planning and interdisciplinary collaboration in higher education.

Perry Chapman's influence on campus planning and design spanned more than four decades.

He affected colleagues, institutions, firms, and community organizations through his insight, mentoring, writing, and speaking.

He raised the standard of planning theory through research and analysis of the relationship between the campus as a place and its impact on learning and community.

SCUP is grateful to the Hideo Sasaki Foundation for its support of the Perry Chapman Prize. A prize of $10,000 was awarded annually through 2016.

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INTRODUCTION

Retention and graduation rates have become key components in 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 financial aid criteria, investing in academic and advisory services, and revising curricula and programs. But sometimes we forget that the physical campus and its surroundings can be a valuable asset in improving student success. Motivational and psychosocial 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 their sense of belonging, and respond to their social and emotional needs (Kenney, Dumont, and Kenney 2005).

In recent years, many universities have 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, Roberts, and Taylor 2010, 2014; Dalton, Hajrasouliha, and Riggs 2018; Hajrasouliha 2017b; Hajrasouliha and Ewing 2016). 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 to students' satisfaction and academic performance. This research is an attempt to evaluate the role of the campus built environment and its immediate surroundings on a major 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 to 103 universities with high research activity in the United States. Strong positive associations with student retention and graduation rates were found for three *objective measures* of campus form—(1) urbanism, (2) greenness, and (3) on-campus living—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 objective measures of campus form to 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 and Kaplan 1989), and even improve overall health (Laumann, Gärling, and Stormark 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, Maguire, and Nebel 2003; Nasar and Terzano 2010; van den Berg, Koole, and van der Wulp 2003). 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. Exploring the relationship between perceived measures of campus form and objective measures could provide insight into the environmental cognition of university students.

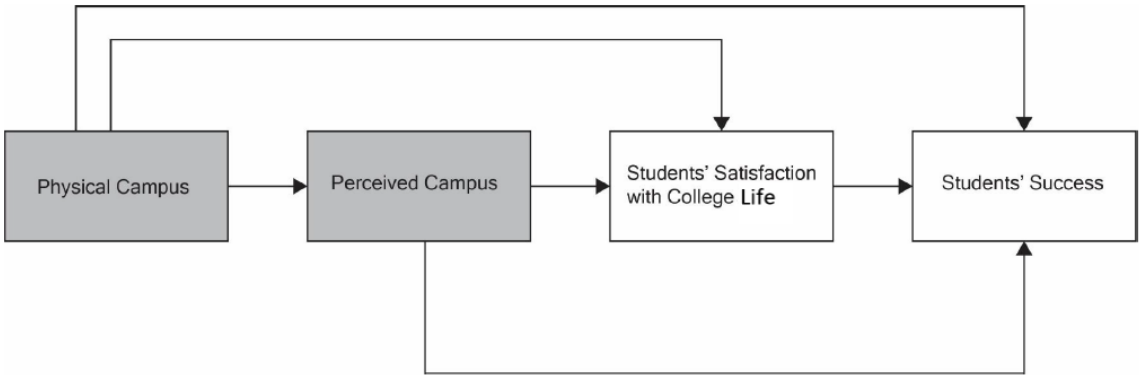
TEACHING-ORIENTED INSTITUTIONS

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. In addition, controlling and modeling all external factors and macro forces (e.g., students' socioeconomic status, university mission, financial resources, 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—Przeworski and Teune 1970). Therefore, this project focuses on the California State University (CSU) system as its sample. Composed of 23 teaching-oriented campuses, CSU is the largest four-year public university system in the United States, which makes it of manageable scale for this study while being broadly representative of comparable institutions.[1]

In sum, the main purpose of this study is to examine the relationship between both objective and perceived measures of physical campuses and students' satisfaction and academic performance in teaching-oriented institutions (figure 1). The findings will 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.

1 Four-year public institutions without doctoral programs.

Figure 1 **The Conceptual Diagram**



DISCUSSION OF PROCEDURE

This research investigates the relationship between the physical campus (objective and perceived dimensions) and student satisfaction with college life and, ultimately, academic performance.

This research has two phases. Phase 1 is the campus-level (Campus Score) analysis of all CSU campuses, and Phase 2 is the individual-level analysis of students. In Phase 1 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 of students on certain CSU campuses, and the results were associated with their perceived satisfaction with their academic life and performance. These two phases allow for connecting the physical campus qualities to their perceived qualities to explore their relationship with students' perceptions and academic performance.

PHASE 1: CAMPUS-LEVEL ANALYSIS AND OBJECTIVE ENVIRONMENT MEASURES

GENERATING THE CAMPUS SCORE FOR CSU CAMPUSES

In Phase 1, the physical campus form characteristics of 23 CSU campuses were measured using the scale from Hajrasouliha (2017a). *Campus Score* is a composite index that measures the degree of urbanism (Urban Score), greenness (Green Score), and living on campus (Living Score) based on the standardized value of certain campus form dimensions (table 1).[2]

The size of campus enrollment was not included in Hajrasouliha's (2017a) Campus Score, but total student enrollment was shown to have significant associations with freshman retention and six-year graduation rates in that study. Therefore, this study adds total enrollment (Size Score) to the overall Campus Score. For consistency and convenience purposes, 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 the Urban, Green, Living, and Size Scores, normalized with the mean of 100 and 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 data set was collected on the age of the institution, percentage of White students, average SAT score, percentage of students with Pell Grants, and amount of student aid per recipient (data 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: percentage of residents with low access to food within 0.5 mile in census tracts around campus (from the American Nutrition Association food desert index); travel mode: percentage of workers who drove alone at census tracts around campus (from census data); and socioeconomic characteristics: share of arts and entertainment occupations, percentage of renters, percentage of residents with bachelor's degree or higher, and percentage of single-family home units (from census data). Academic performance measures included freshman retention rate and six-year graduation rate (from the National Center for Education Statistics).

2 Urban Score is the sum of the Z-scores of mass density, street network connectivity, campus centrality, 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 density of tree canopies, proportion of pervious spaces, and the negative value of the percentage of surface parking areas on campus. Living Score includes the percentage of freshmen living on campus.

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

Table 1 **Objective Measures of Campus Form**

Score	Description	Computation Process	Data Source
Urban Score	Mass density	Total area of building footprint 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 of 3 divided by the average integration value of country 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
Green Score	Undeveloped land	Percentage of undeveloped land in a quarter-mile buffer around campus buildings	National Land Cover Data 2011
	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)

EXPLORING THE RELATIONSHIP BETWEEN CAMPUS SCORE AND UNIVERSITY CHARACTERISTICS AND PERFORMANCE

Measuring university characteristics, neighborhood context, and Campus Score reveals whether there is any association among them and, ultimately, student academic performance. Pearson bivariate correlation and multiple regression modeling were used to explore the relationship between Campus Score and freshman retention and graduation rates. In addition, Pearson correlation was used to show the relationship between physical campus qualities (Campus Score and its four dimensions) and institutional characteristics. Further, Pearson correlation was used to explore the relationship between campus qualities and the characteristics of the surrounding neighborhoods.

PHASE 2: INDIVIDUAL-LEVEL ANALYSIS AND PERCEIVED ENVIRONMENT MEASURES

DATA COLLECTION

An online questionnaire was developed to study students' perceptions of 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 experiences on campus. It also included basic demographic characteristics (gender and age) and previous and current academic status (self-reported SAT/ACT scores, self-reported 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) accessibility to a variety of commercial, cultural, and entertainment opportunities within walking distance from campus; (5) housing on campus; (6) architecture of campus buildings; and (7) recreational facilities on campus.

The questionnaire also included a Perceived Restorativeness Scale (PRS) that measured five domains—Fascination, Being Away, Coherence, Compatibility, and Scope—on each campus. This study used the five-item version of the PRS (Abdulkarim and Nasar 2014; Berto 2005) adapted from the full-length version of the PRS (Hartig, Mang, and Evans 1991; Hartig et al. 2003). The PRS is based on the Attention Restoration Theory (Kaplan 1995) that measures an individual's perception of restorative factors in the environment.

The item used 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 on a one- to seven-point scale, where 1 = not at all, 4 = rather much, and 7 = completely.

Questions regarding students' satisfaction with college life were adopted from the 2016 National Survey of Student Engagement (NSSE) with response options on a four-point scale. Questions 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 non-academic) 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 in the Winter/Spring semester/quarter of 2017. An incentive in the form of a drawing for three $100 iTunes gift cards was offered to participants. The online survey was posted on the Facebook page of 14 universities (nine universities declined to post the survey on their Facebook page). Fewer than 10 responses per campus were received from eight of the campuses. On one campus, Cal Poly San Luis Obispo, the online survey was e-mailed directly to a group of students in the Architecture, Engineering, and Business Colleges. In total, 446 responses were collected; 269 were from Cal Poly students.

EXPLORING THE RELATIONSHIP OF PERCEIVED CAMPUS QUALITIES WITH STUDENTS' SATISFACTION AND ACADEMIC PERFORMANCE

Pearson correlation was used to test the relationships between the perceived physical qualities (Perceived Campus Quality) and the perceived psychological quality (Perceived Restorativeness). Then 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 experiences, the likelihood of selecting the same institution if students could start over again, and the likelihood of students' graduation on time were modeled with the following predictor variables: Perceived Campus Quality, Perceived Restorativeness,

satisfaction with academic advising, GPA until this point, and a dummy variable representing Cal Poly students.[4]

COMPARING THE OBJECTIVE AND PERCEIVED CAMPUS FORM MEASURES

Aggregate perceived measures were compared at the institutional level for the six campuses with more than 10 respondents. Those six campuses were Pomona, San Luis Obispo, San Jose, Sacramento, Sonoma, and Stanislaus. Comparing the perceived measures at the institutional level to the objective measures shows their match/mismatch status and therefore tests the validity of using the perceived campus measures at the institutional level to predict 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 showed 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 (β = .420, p = .018), as did acceptance rate (β = -.471, p = .009). In addition, a multiple linear regression was calculated to predict six-year graduation rate based on Campus Score and freshman retention rate, and a significant regression equation was found (R^2 = .515, F(2,20) = 12.674, p < .001). Campus Score (β = .377, p = .027) and freshman retention rate (β = .527, p = .003) significantly predicted graduation rate.

Multiple regression analysis was used to test if Campus Score and university acceptance rate significantly predicted freshman retention rate. The results of the regression showed 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 (β = .203, p = .300) and freshman retention rate, acceptance rate (β = -.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 might 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) and the percentage of White students (M = 27.9, SD = 13.58, r = .630, p < .001) and negatively associated with the established year of the institution—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). In addition, Campus Score was negatively associated with the percentage of residents with low access to food at 0.5 mile in the surrounding census tracts (M = 59.17, SD = 22, r = -.471, p = .023). It was also negatively associated with the percentage of workers who drove alone to work (M = 73.2, SD = 10.2, r = -.519, p = .011) and the percentage of single-family units (M = 69.89, SD = 16.59, r = -.492, p = 0.017) and

4 Since more than half of respondents were Cal Poly students, two options were considered for the modeling phase. One option was modeling the outcome variables once with the Cal Poly sample and once with the other universities, and the other option was to use a dummy variable for Cal Poly students. Both approaches were tested, and the results were identical in terms of the sign and significance of predictors. For the sake of simplicity, only the results of using a dummy variable are presented.

positively associated with the percentage of renter-occupied units in the surrounding census tracts (M = 50.24, SD = 20.72, r = .500, p = .015). Campus Score was also 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's degree or higher in the surrounding census tracts (M = 36.70, SD = 13.51, r = .479, p = .021).

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 **Correlations of Campus Score with University and Community Characteristics**

		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 who 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's degree or 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).

THE PERCEIVED CAMPUS AND ITS ASSOCIATIONS

Another hypothesis (Kaplan and Kaplan 1989; Ulrich 1984) 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 restore 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 using the PRS-5 scale (Berto 2005).[5]

First, the relationships between Perceived Restorativeness and students' satisfaction with different campus form elements were explored. Perceived Restorativeness was positively associated with students' satisfaction with—ordered by strength of association—"plazas and outdoor gathering places" ($r = .590$, $p < .001$); "the architecture of campus buildings" ($r = .583$, $p < .001$); "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" ($r = .245$, $p < .001$).

5 With a sample size of 446 respondents, the 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.

The Perceived Campus Quality was generated using these seven campus elements.[6] 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 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 (table 4). In Model 1, 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 of students' satisfaction with their school experience. The overall model fit was $R^2 = .18$. Perceived Campus Quality was added as a predictor in Model 2, and it was found to be 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 to Model 1. The result showed that all variables were still significant predictors, yet the overall model fit did not 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 a Cal Poly student ($\beta = .28$, $p < .01$) were significant predictors, but GPA was not ($\beta = .06$, $p = .24$). The overall model fit was $R^2 = .15$. 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 model fit was $R^2 = .28$.

6 The campus elements 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 Quality.

Table 4 **Summary of Multiple Regression Analysis for Variables Predicting Students' Satisfaction with Both Academic and Non-Academic School Experiences (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 Students 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**	

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

In addition, a series of multiple regression models was tested to predict how likely it is that students graduate on time. No variable was found to be a significant predictor. Neither Perceived Campus Quality (r = .04, p = .40) nor Perceived Restorativeness (r = .03, p = .47) had an association with graduating on time. However, a relatively weak but significant association was found between GPA and Perceived Campus Quality (r = .12, p = .02) and Perceived Restorativeness (r = .10, p = .03).

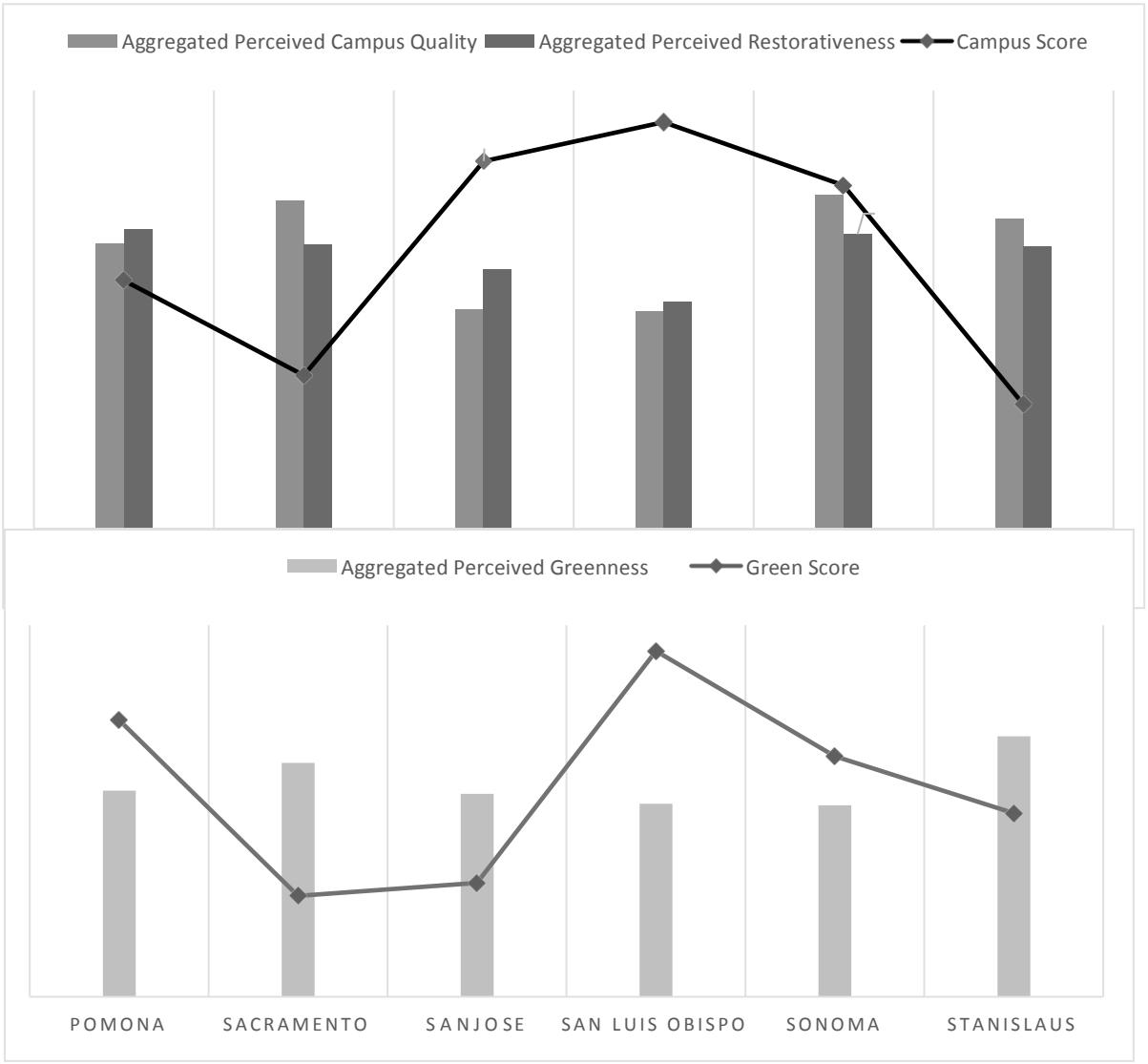
THE OBJECTIVE VS. PERCEIVED CAMPUS

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. As noted previously, those six campuses were Pomona, San Luis Obispo, San Jose, Sacramento, Sonoma, and Stanislaus.[7]

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, yet they received the lowest perceived scores. In contrast, the Sacramento and Stanislaus campuses had high perceived scores and low Campus Scores. This inconsistency existed for all campus form attributes. For example, the objective greenness measure showed that Cal Poly San Luis Obispo has one of the greenest campuses in terms of landscaping and tree canopies. However, that campus received a very low score in terms of perceived greenness compared to the other CSU campuses.

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

Figure 2 **Top: Comparing Campus Score (Line) with Perceived Measures (Bars) for Six CSU Campuses; Bottom: Comparing Green Score (Line) with Perceived Greenness (Bar)**



CONCLUSIONS

This study explored how planning the physical environment can support an institution's goals with respect to academic performance. Although the physical environment is not the primary factor at play in addressing academic performance, it does have a substantial supportive role. This study found that Campus Score explains 31.5 percent of the variance in the six-year graduation rate of CSU campuses. This is a fairly strong association, although it was found to be stronger in Hajrasouliha (2017a), 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 studied (research vs. teaching oriented); research institutions generally have more diverse student bodies and are significantly larger and more complex than the CSU campuses. In addition, no significant association was found between Campus Score and the freshman retention

rate at CSU campuses, while Hajrasouliha (2017a) 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 numbers of Pell Grant recipients. Further, universities with higher Campus Scores are generally located in communities that are less auto-oriented and have better access to fresh food, art, and recreational facilities; more residents with bachelor's degrees; and fewer single-family homes. The fact that campuses with lower Campus Scores belong to institutions that have more in-need students (financially and academically) and are located in less advantageous communities might be unique to the CSU system. Further research can show whether this pattern exists in other states.

The most unanticipated result was the nature of the relationship between objective and perceived measures. It was expected that campuses with higher scores on objective measures would earn higher scores for perceived qualities and that would lead to higher levels of student satisfaction and academic performance on those campuses. However, 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 San Luis Obispo's campus greenness may not be perceived as satisfactory by the greenness-saturated eyes of its students (figure 3), while a lower amount of campus greenness in the urbanized context of San Jose may be more valued. Obviously, this is only speculation and more research is needed in this area.

Figure 3 **Left: Cal Poly Campus Periphery; Right: A Typical Space on Campus**

The Cal Poly campus is green, but not as scenic as San Luis Obispo itself.

The other explanation relates to the challenge of measuring design qualities. For example, Campus Score considers objective measures such as tree canopies and pervious open spaces, but falls 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' perceptions than a beautiful arboretum far from the campus core (figure 4).

Figure 4 **Left: On-Campus Housing; Right: Leaning Pine Arboretum on Cal Poly Campus**

Both are located far from the campus core.

Although Campus Score is a good proxy for physical campus quality, it should not be confused with a measure for campus image and identity. That said, the results suggest that objective qualities may have direct impact on students' performance, although not necessarily through their perceived image of campus. For example, living on campus may improve students' academic performance relatively independently from whether they have a positive view of 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 (1) students' satisfaction with both academic and non-academic school experiences, (2) whether they would choose the same institution if they could start over, and (3) their GPA.

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

IMPLICATIONS FOR PRACTICE AND 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[8] surveys on diversity, safety, and sexual assault issues along with

8 As an example, see https://campusclimate-stage.calpoly.edu/.

Campus Image and Identity[9] surveys might provide a better understanding of campus culture and its association with objective measures and students' performance. An interesting research question for campus planners would concern the potential impact of certain physical campus interventions on campus culture and vice versa.

Based on this study, universities should pay more attention to the development of policies related to 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, objective and not necessarily perceived characteristics of peer campuses. In this way, universities 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 a number of 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. In addition, it would be interesting to take account of campus culture variables in the study. Further, it would be advisable to investigate the role of new technologies in both the 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.

9 As an example, see http://opb.washington.edu/content/campus-landscape-framework-survey.

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