Evaluating Scholarly Productivity and Impacts of Landscape Architecture Faculty Using Citation Analysis

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ABSTRACT The academic field of landscape architecture has taken an increasing interest in scholarly productivity and the impact of faculty research. Quantitative measures of academic output and reputation are important assessment tools used by many academic disciplines, especially for promotion and tenure evaluation. Citation analysis, one approach used for these purposes that combines metrics for productivity and impact, is seen as an effective way to assess scholarly activity in related fields such as urban planning and tourism. Universities are increasingly employing metrics of this kind to measure faculty members' scholarly productivity and impacts alongside their teaching and service records.

This article applies citation analysis to the landscape architecture faculty in North America. Using Google Scholar data, we analyzed four citation measures (total citation counts, h-index, hI,norm, and hI,annual) for tenure-track faculty. The results show that citation activity is correlated with rank (assistant, associate, or full professor), degree type (doctorate vs. non-doctorate), and number of years since first publication, with no detectable differences between male and female scholars. We found that landscape architecture faculty ranking in the top 20% according to total citation counts accounted for 87% of total citations, and 15% of the tenure-track faculty in the field have no citation records. We believe that our methods and findings can be used as a complementary measure to assess the level of scholarly contributions at the individual and program levels.

KEYWORDS Bibliometrics, landscape architecture scholarship, research performance

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INTRODUCTION

Landscape Journal (Zube, 1980) was founded in part to foster research in landscape architecture, and that scholarship has been a central focus of ongoing discussions in the field (Gobster et al., 2010; LaGro, 1999; Riley, 1990; Nassauer, 1985). Social and environmental changes have challenged scholars in this field and related ones to generate new knowledge, expanding the knowledge base to include more innovative research that can deepen the way we think about and justify our intentions as designers and planners who serve as agents of environmental change (Swaffield & Deming, 2011).

At the same time that the field has turned to scholarly production as a means of meeting new challenges, universities are increasingly interested in accounting for faculty productivity and effectiveness, especially as it relates to budgets and resource allocation. It is therefore not surprising that scholarly productivity and faculty research impacts in landscape architecture have recently garnered attention (Brown et al., 2020; Christensen et al., 2019). Overall faculty evaluations commonly include the three areas of teaching, research, and service—with concerns about making research (including scholarship) more visible and measurable. Brown et al. (2020, p. 1) state that "research is becoming an increasingly important part of the profession" and point to an increase in the number of PhDs in recent years as an indicator. One of the assessment standards for program accreditation by the Landscape Architectural Accreditation Board (LAAB, 2021, p. 16) is that "faculty activities such as scholarly inquiry, research, professional practice, and service to the profession, university, and community are documented, peer-reviewed, and disseminated through appropriate media such as

journals, professional magazines, community, and university publications."

Universities are increasingly turning to quantitative measures to assess faculty scholarship for promotion and tenure review (Brown et al., 2020; Christensen et al., 2019; Gobster et al., 2010). One such measure is scholarly citations, which are extensively documented in the literature as a viable means of reflecting both scholarly productivity and impact (Adam, 2002; Garfield, 1972; Garfield & Merton, 1979; MacRoberts & MacRoberts, 1989, 1996; Moed, 2005).

In the field of landscape architecture, the scholarly productivity of faculty researchers can be evaluated in numerous ways. Previous studies have measured faculty performance through quantitative analysis of factors such as the total number of publications and the frequency of engagement in scholarly activities (Chen, 2013; Christensen et al., 2019; Christensen & Michael, 2014; Gobster et al., 2010; Milburn & Brown, 2016). These studies have found that faculty are publishing at a higher rate than previously, and tenure-track faculty are much more productive than tenured faculty, with productivity declining over time after the tenure promotion (Christensen et al., 2019; Milburn & Brown, 2016). Overall, approximately 20% of landscape architecture faculty are producing the majority (50%) of the scholarly work (Christensen et al., 2019; Milburn & Brown, 2016). One study of the total number of publications found no significant correlation between scholarly productivity and personal factors such as age, gender, or the school where the highest degree was achieved (Milburn & Brown, 2016). Milburn and Brown (2003), on the other hand, found a significant negative relationship between age and the number of presentations given, and they identified a positive relationship between level of education and the number of published articles and presentations.

More recent work has used citation analysis to assess both the quantity and quality of scholarly productivity in the fields of landscape architecture, planning, and tourism (Brown et al., 2020; McKercher, 2008; Sanchez, 2017). Citation analysis measures the frequency with which articles are cited in other papers over a period of time (Garfield, 1972). Having studies cited by other scholars is considered evidence that the work is influential and has contributed to the body of knowledge on a subject (Brown et al., 2020). It should be noted that being cited can be considered a negative if the citation points to a flaw of the cited paper or gives it a weak evaluation relative to other papers (Tahamtan & Bornmann, 2019).

We could find only one study that assessed faculty scholarly activities in the field of landscape architecture using citation analysis: Brown et al. (2020), which evaluated the citation performance of universities and scholars in the United States. Brown et al. (2020) identified the most productive landscape architecture programs using the number of citations and h-index for each faculty member. While informative, this study does not look deeply into the scholars' characteristics and research output. An extensive bibliometric literature (see Tahamtan et al., 2016) suggests that many factors influence scholarly performance, including discipline, rank, reputation, gender, structures of collaborations, and prestige of the institution—some of which are easier to measure than others.

This article provides a citation analysis for U.S. faculty in programs accredited by the LAAB and for Canadian faculty in programs accredited by the Landscape Architecture Accreditation Council (LAAC). The citation performance of scholars can be analyzed by rank, number of years since first publication, degree type, school, and gender. Brown et al. (2020) argue that identifying faculty characteristics associated with citation levels helps to clarify the sources of scholarship and the factors related to productivity. We believe that the information presented in this paper is the first of its type and can be used to assess scholarly contributions at both individual and program levels. Since as Christensen et al. (2019) state, "success for the emerging faculty nationally will rely upon effective performance within the tenure track system" (p. 23), we can expect increasing emphasis on the norms of other disciplines and expectations of quantifiable scholarly activities to be felt in the field of landscape architecture.

DATA AND METHODS

Our study focuses on 77 schools in North America, 71 of which are accredited by the LAAB in the United States and 6 of which are accredited by LAAC in Canada. Following previous studies (Brown et al.,

2020; Christensen et al., 2019; Gobster et al., 2010; Milburn & Brown, 2003b, 2016), we define landscape architecture faculty as tenure-track or tenured faculty members with the titles of assistant, associate, or full professor who teach landscape architecture courses in university programs accredited by LAAB or LAAC. Only tenure-track or tenured faculty are included here because they undergo competitive hiring and tenure and promotion review processes involving evaluations of their research and creative scholarship.

Some universities list their landscape architecture faculty among urban planning or architecture faculty. Wherever there was uncertainty regarding the program in which particular faculty members taught, we contacted the program directly for clarification. We did not screen faculty members by degree field (e.g., a professional degree in landscape architecture) because we consider landscape architecture to be highly interdisciplinary (Swaffield & Deming, 2011). Nevertheless, we acknowledge that its various subdisciplines (e.g., ecology, history, design) differ in terms of publication opportunities and expectations. We addressed this issue through the use of alternative measures (see the discussion of hI,norm index and hI,annual index below).

We found the names of a total of 504 landscape architecture faculty members as of the first quarter of 2021. Next, we took supporting information (such as title, current academic affiliation, degree type, school, and gender) from faculty webpages. Whenever this information was unavailable, we performed a Google search to find a CV or online profile (for example, on LinkedIn or ResearchGate). Note that we identified gender on the basis of names and photos alone; as a result, our judgments may have in some cases been inaccurate. Years of experience were estimated based upon the number of years that have passed since the faculty members' first publications.

The relative value of different sources of citation data has been the subject of much discussion. Previous studies of faculty citations in related fields such as planning and tourism have relied on Google Scholar (GS) data (McKercher, 2008; Sanchez, 2017). GS is valuable because it includes publications outside of traditionally peer-reviewed journals, including dissertations, research reports, conference presentations, grant-funded research, and workshop projects (McKercher, 2008; Sanchez, 2017). This non-peer-reviewed literature, or gray literature, often has scholarly merit as well as greater reach and impact (Harzing & Van der Wal, 2007; Kousha et al., 2010; Pomerantz, 2006). Other studies have used the Web of Science, Scopus, and the Social Science Citation Index for citation analysis (Gobster et al., 2010; McKercher, 2008). But these sources primarily include peer-reviewed publications and omit other products that may have scholarly merit among disciplines like landscape architecture. GS is also an important source because it is readily available and comprehensive in its coverage. Using a single source of data can be important because of uniformity in data collection methods and reporting methodologies. The bibliometric literature includes plenty of discussion about the adequacies of different citation databases but reaches no definitive conclusions (see Harzing & Alakangas, 2016; Martín-Martín et al., 2018). Each of the databases has its strengths and weaknesses, and any analysis (including ours) should acknowledge the inevitability of error. Our review of faculty CVs and comparison to GS data did not uncover any significant omissions and suggests the data reliably cover faculty scholarship in the field.

In this bibliometric analysis, the citation data were gathered from GS. If the faculty member did not have a GS profile, we used Harzing's Publish or Perish software, a program that uses GS to collect these metrics. A total of 154 faculty members had GS profiles (30.6%), while 350 did not (69.4%). Whenever a GS profile was not available, we looked up the faculty members' publication lists from other sources such their CVs, website profiles, or ResearchGate profiles. Initial data were collected during the first quarter of 2021 and updated in September 2021.

Two primary metrics are used in the citation analysis: total citation count and h-index. High total citation counts are often treated as proxies for high levels of scholarly impact (Brown et al., 2020; McKercher, 2008; Sanchez, 2017; Stevens et al., 2019). But while measuring citation counts is a simple method for obtaining usable data points, this approach is prone to producing outliers (e.g., cases in which a few papers have a very high number of citations), and in such instances the quality or impact of research may be more difficult to ascertain (Brown et al., 2020). Combining an assessment of h-indexes

with citation counts creates a fuller account of scholarly impact (Brown et al., 2020; Hirsch, 2005).

In this study, we used the four different measures of scholarly citation activities provided by the Publish or Perish software (https://harzing.com/pophelp/metrics.htm). As noted below, they include two alternative measures (hI,norm and hI,annual) that address co-authorship effects and career length effects (respectively), both of which are mentioned as weaknesses of citation counts and h-indexes (Batista et al., 2006; Harzing et al., 2014; Koltun & Hafner, 2021).

1. **Total number of citations:** the sum of the citation counts across all papers listed in the GS platform.
2. **h-index:** a measure of impact. A person has index h if h of his/her papers have at least h citations each and the other papers have no more than h citations each. For example, if one scholar's h-index is five, it means that she has five publications that are each cited at least five times.
3. **individual h-index (hI,norm):** a measure adjusting for co-authorship effects. It first normalizes the number of citations for each paper by dividing the number of citations by the number of authors for that paper, then calculates hI,norm as the h-index of the normalized citation counts. This helps to account for co-authorship effects (and thus, arguably, differences between disciplines) (Batista et al., 2006; Koltun & Hafner, 2021).
4. **average annual increase in individual h-index (hI,annual):** a measure adjusting for career length effects and co-authorship effects. It divides the hI,norm by the number of years since the author's first publication. This helps to reduce career length effects, providing a fairer comparison between junior and senior researchers (Harzing et al., 2014).

Next, we created a database of faculty members that included their citation information and personal characteristics. At the individual level, we first looked at the most cited scholars and the overall distribution of citation counts. Then we related different citation metrics to a faculty member's number of years of publication, rank, degree type, and gender. At the program level, we described citation measures of faculty members based on their current schools. For the citation measures, we reported the median value because the distribution of citation counts is positively skewed (i.e., a small number of outliers have very high citation counts and many more faculty members have low or zero citations) (Brown et al., 2020; Sanchez, 2017). This data set is available at https://bit.ly/3HFxrSD.

RESULTS

A total of 504 tenure-track faculty from the 77 LAAB and LAAC member schools are included in the study. Of those, 29.0% are ranked assistant professor, 41.3% associate professor, and 29.8% full professor (see Table 1). Female faculty members make up 46.4% of the total. Among landscape architecture schools in North America, the percentage of women faculty has increased from 33.3% in 2014 and just 25.1% in 1999 (Milburn & Brown, 2016). A large percentage of the faculty members included in the study (40.9%; $n = 504$) hold doctoral degrees (e.g., a PhD or Doctor of Design). This is similar to the findings of a 2014 study that 42.1% held doctorates, representing an increase from 27.3% in 1999 (Milburn & Brown, 2016). On average, 17 years have passed since the faculty members' first publications. Robin Moore at NCSU holds the record for publishing over the longest period of time (54 years), followed by Charles Yuill at West Virginia (51 years) and Sherene Baugher at Cornell (50 years). Overall, the median total number of citations is 36.5, and the median h-index is 3.0.

Table 2 presents the top 20 faculty members sorted by total citation counts. Most of them are full professors, with a few exceptions (4 associates and 1 assistant). The span of years spent publishing ranges from 16 to 54. The number of publications ranges from 9 to 156. Among this group, 10 are female, 4 have no doctoral degree, and 5 have no GS profile. Table 2 also shows alternative measures, including h-index, hI,norm, and hI,annual.

The distribution of citation counts among landscape architecture faculty members is right-skewed (also called positive-skewed), which means that most of the distribution is concentrated on the left side (lower citation counts) of the figure (Figure 1). The

Table 1. Descriptive Statistics

Category		Number	Percentage
Number of schools		77	—
Number of faculty members		504	—
Rank	Assistant Professor	146	29.0
	Associate Professor	208	41.3
	Full Professor	150	29.8
Gender	Female	234	46.4
	Male	270	53.6
Degree type	Non-doctorate	298	59.1
	Doctorate	206	40.9
Google Scholar profile	No	350	69.4
	Yes	154	30.6
Years since the first publication	Median	17	—
	Min/Max	1/54	—
Number of publications	Median	11	—
	Min/Max	0/162	—
Authors per paper	Median	2.21	—
	Min/Max	1/6	—
Total citations	Median	36.5	—
	Min/Max	0/13,388	—
h-index	Median	3	—
	Min/Max	0/38	—
hI,norm (individual h-index)	Median	2	—
	Min/Max	0/28	—
hI,annual (average annual increase in individual h-index)	Median	0.15	—
	Min/Max	0/1.60	—

median value of citation counts is 36.5, and the mean is 315.2. The top 20 scholars account for the majority (50.8%) of total citations, and the top 20% ($n = 100$) of landscape architecture faculty produced most of the citations (86.8%). We were not able to find any publication records for 31 faculty members. Including the 31 individuals, a total of 76 faculty members (15.1%) had no documented citations.

Next, we examined the citation measures in terms of personal attributes, including span of publication years, rank, degree type, and gender. The number of years since each faculty member's first publication was positively correlated with the h-index: $r\,(471) = 0.45$ ($p < .01$; see lefthand side of Figure 2). Longer-established faculty might have a longer amount of time to accumulate citations. The same pattern was found for total citations ($r = 0.33$; $p < .01$) and the co-authorship-adjusted h-index (hI,norm; $r = .49$; $p < .01$). After adjusting for time, the individual, average annual increase of the h-index (hI,annual) does not correlate with career length ($r\,(471) = -0.08$ ($p = .210$); see righthand side of Figure 2).

Citation measures were also summarized by rank. The median number of publications for assistant, associate, and full professors were 7, 10, and 22.5, respectively, and the differences between each pair were statistically significant (Figure 3 and Table 3). The median total citations were 8 (assistant), 35 (associate), and 190 (full), respectively, but the post hoc test of a one-way ANOVA shows that the difference was not statistically significant ($p = .65$) between assistant and associate professor groups. All pairwise differences of both h-index and hI,norm were statistically significant. The differences in total citations, h-index, and hI,norm were larger between full and associate professors than between associate and assistant professors.

On the other hand, hI,annual values were comparable across the three ranks (Figure 3), and a statistically significant difference was found only in the associate-full group pair. Across all measures and ranks, box plots show evidence of skewed distributions (indicating the presence of outliers).

A total of 206 faculty members (40.9%) included in the study hold doctoral degrees (PhD or Doctor of Design) (Table 4). Among the non-doctorate degree holders, 246 hold MLAs or MsLAs terminal degrees. Doctoral degree holders have almost eighteen-fold higher median citation counts than members of the other group (180.0 vs. 10.5), and this pattern was consistently observed across all ranks (Table 4).

Table 2. Top 20 Faculty Members by Total Citations (as of September 2021)

Name	Rank	Current School	Years of Pubs	# Pubs	Authors per Paper	Citations	h-index	hI,norm	hI,annual	Gender	Final Degree	Degree School & Year	GS Profile
William C. Sullivan	Full	UIUC	39	106	3.42	13,388	36	26	0.67	M	PhD	U. of Michigan (1991)	Y
Joan Nassauer	Full	U. of Michigan	43	147	2.99	9,747	38	28	0.65	F	MLA	Iowa State (1978)	Y
Chanam Lee	Full	Texas A&M	19	139	4.32	5,725	31	18	0.95	F	PhD	U. of Washington (2004)	Y
Robin Moore	Full	NCSU	54	156	2.68	5,372	38	28	0.52	M	MCP	MIT (1966)	Y
Lynne Manzo	Full	U. of Washington	34	66	2.11	5,291	18	15	0.44	F	PhD	CUNY (1994)	N
Robert L. Ryan	Full	UM Amherst	26	83	2.42	5,064	26	21	0.81	M	PhD	U. of Michigan (1997)	N
Robert Brown	Full	Texas A&M	39	113	3.19	4,652	32	20	0.51	M	PhD	U. of Guelph (1985)	Y
Steve Wheeler	Full	UC Davis	26	128	1.81	4,634	23	21	0.81	M	PhD	UC Berkeley (2000)	N
David Moreno-Mateos	Assistant	Harvard	16	61	4.52	3,075	24	15	0.94	M	PhD	U. of Alcala, Spain (2008)	Y
MaryCarol Hunter	Associate	U. of Michigan	41	38	2.47	2,827	24	19	0.46	F	PhD	SUNY (1981)	Y
Brian Deal	Full	UIUC	25	134	3.39	2,603	26	13	0.52	M	PhD	UIUC (2003)	Y
Laura Lawson	Full	Rutgers	40	61	2.16	2,500	17	13	0.33	F	PhD	UC Berkeley (2000)	Y
Byoung-Suk Kweon	Associate	U. of Maryland	29	36	3.42	2,304	15	12	0.41	F	PhD	UIUC (NA)	Y
Elizabeth Brabec	Full	UM Amherst	35	76	2.61	2,176	15	12	0.34	F	MLA	U. of Guelph (1984)	Y
Susan Herrington	Full	UBC	27	88	1.74	2,076	21	18	0.67	F	MLA	Harvard (1991)	N
Robert Corry	Full	U. of Guelph	27	64	3	1,990	18	14	0.52	M	PhD	U. of Michigan (2002)	Y
Iryna Dronova	Associate	UC Berkeley	17	83	4.66	1,901	20	12	0.71	F	PhD	UC Berkeley (2012)	Y
John Radke	Associate	UC Berkeley	44	76	3.63	1,864	17	12	0.27	M	PhD	UBC (NA)	Y
Jeff Hou	Full	U. of Washington	27	126	2.04	1,829	18	16	0.59	M	PhD	UC Berkeley (2001)	Y
D. Fairchild Ruggles	Full	UIUC	41	153	1.42	1,811	18	17	0.41	F	PhD	UPenn (1991)	N

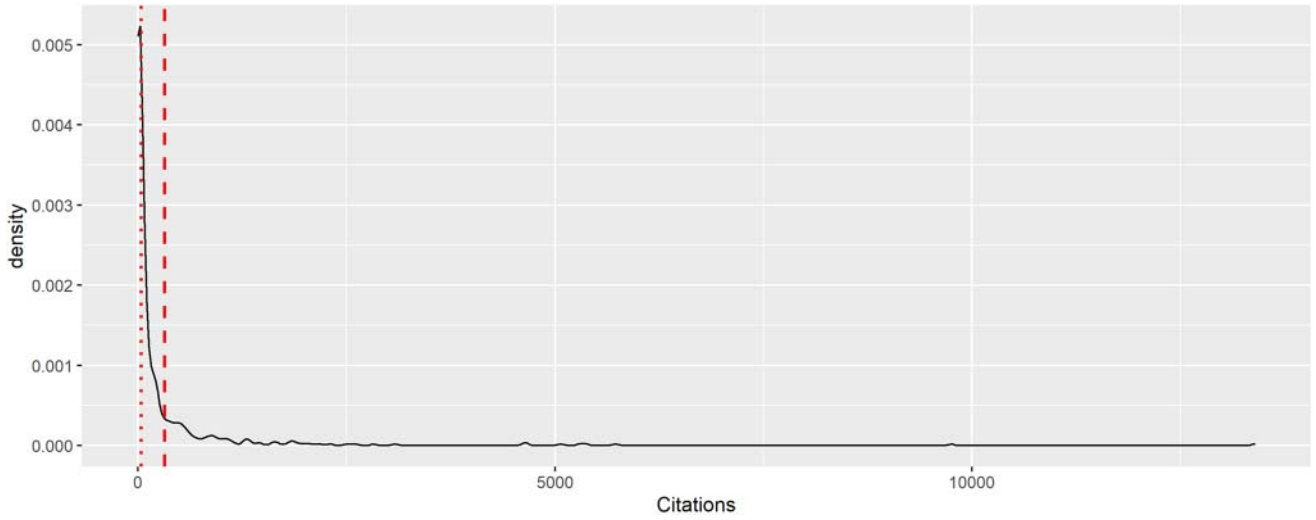

Figure 1
Distribution of citation counts. (Note: a dotted line on the left represents the median (36.5), and a dashed line on the right represents the mean (315.2); Density on the y-axis means a probability differential based on the kernel density estimation).

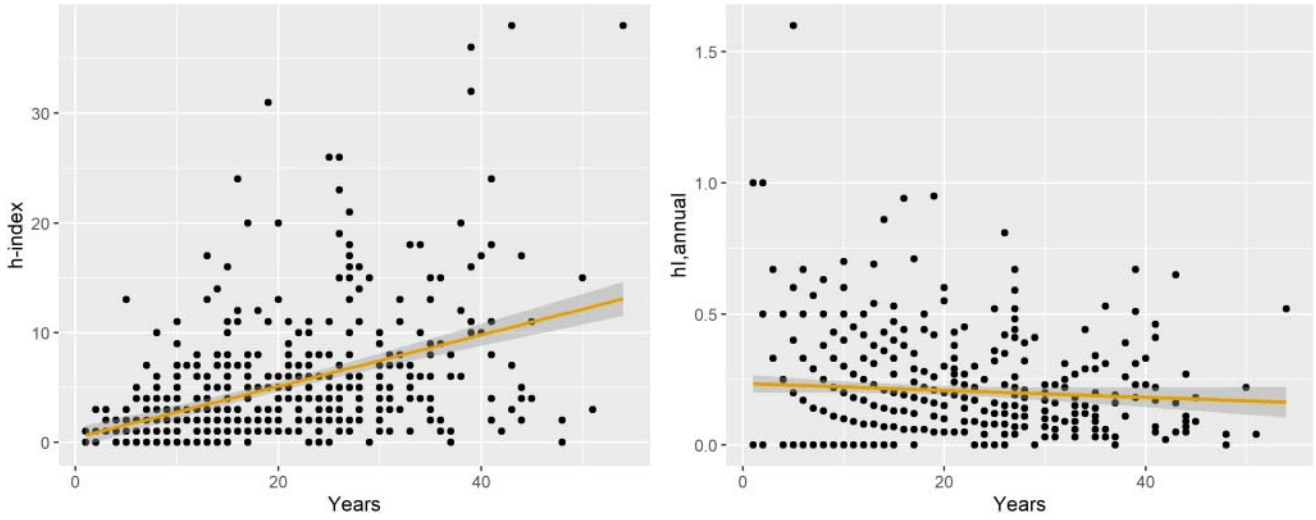

Figure 2
Scatter plots between years of publication and h-index (left) and h-index adjusted for time and co-authorship (right).

In this study, 46.4% of faculty are female. The ranks of professor and associate professor are predominantly occupied by males, suggesting that historically, more men were hired as landscape architecture faculty (Table 5). But the proportion of female assistant professors to men (82 to 64) shows an opposite trend in which more recent hires are increasingly female. We looked to see if there was a difference in citation measures between female and male faculty but did not observe a significant difference between genders. The *t*-statistics between the two groups were –0.36 ($p = .72$) for number of publications, –0.36 ($p = .72$) for citation counts, –0.36 ($p = .72$) for h-index, 0.20 ($p = .84$) for hI,norm, and 0.89 ($p = .38$) for hI,annual. In addition, controlling for rank, none of the four citation measures were significantly different for female and male faculty.

In Table 6, the top 20 schools (out of 77) are ranked by median number of citations, with the top three schools identified as: 1) Michigan State University, 2) Texas A&M University, and 3) University of Maryland. When sorted by h-index, the University of Wisconsin–Madison moves to second place. By hI,annual (adjusting for time and co-authorship), the

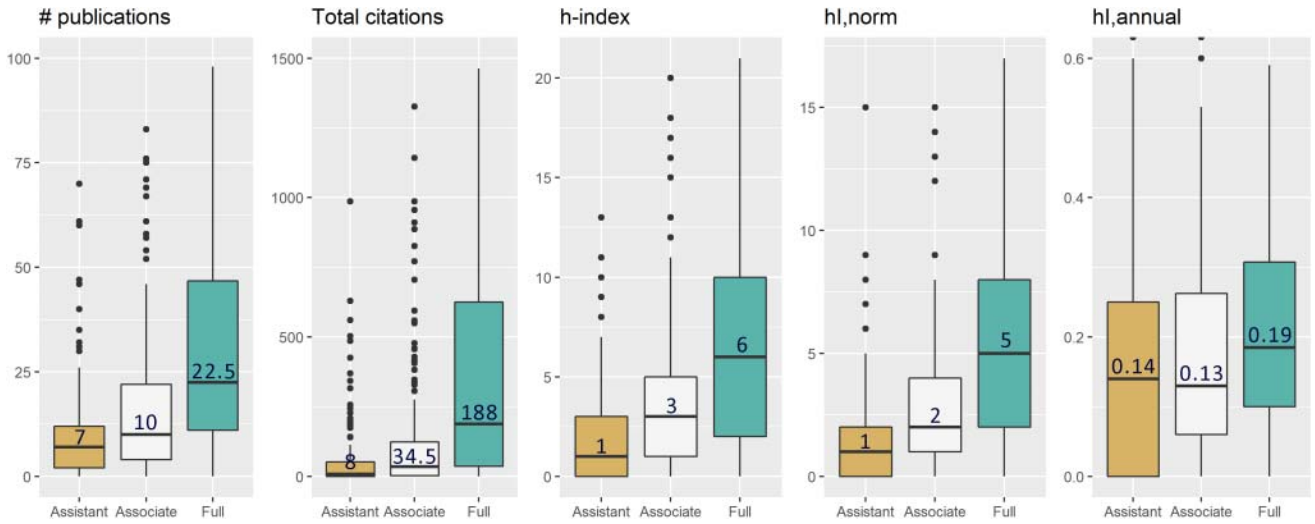

Figure 3
Box plots of scholarly activity by rank. (Note: median values are labeled, and the lower and upper hinges correspond to the 25th and 75th percentiles.)

Table 3. Differences in Five Measures across the Three Ranks

	# Publications	Total Citations	h-index	hI,norm	hI,annual
One-way ANOVA	F = 39.66**	F = 20.38**	F = 38.6**	F = 46.99**	F = 3.62*
Post-hoc Tukey HSD test (group-wise mean differences)					
Associate—Assistant	*6.73**	*92.34*	*1.54**	*1.37***	*–0.01*
Full—Associate	*17.12***	*553.01***	*3.71***	*2.87***	*0.05**
Full—Assistant	*23.85***	*645.35***	*5.24***	*4.25***	*0.04*

Note: $p < .1$, *: $p < .05$, **: $p < .01$

Table 4. Citation Measures by Degree Type (Median Values)

Degree Type	Position	*n*	Number of Publications	Total Citations	h-index	hI,norm	hI,annual
Non-doctorate	Assistant Professor	86	4	2.0	1	1	0.08
	Associate Professor	131	6	10.0	2	1	0.09
	Full Professor	81	13	89.0	4	3	0.13
	Total	298	7	10.5	2	1	0.11
Doctoral	Assistant Professor	60	12	59.0	3	3	0.23
	Associate Professor	77	20	123.0	5	4	0.24
	Full Professor	69	40	431.0	8	7	0.23
	Total	206	21	180.0	5.5	4	0.23

Table 5. Citation Measures by Gender (Median Values)

Gender	Position	*n*	Number of Publications	Total Citations	h-index	hI,norm	hI,annual
Female	Assistant Professor	82	7.0	8.5	1	1	0.14
	Associate Professor	89	9.0	35.0	3	2	0.13
	Full Professor	63	27.0	207.0	6	5	0.20
	Total	234	11.5	36.0	3	2	0.17
Male	Assistant Professor	64	6.5	7.5	1	1	0.14
	Associate Professor	119	10.0	34.0	3	2	0.12
	Full Professor	87	18.0	174.0	5	4	0.16
	Total	270	10.5	36.5	3	2	0.14

top three schools are the University of Michigan, Michigan State University, and the University of Arizona. Finally, by the median number of publications, the top three schools are Michigan State University, the University of Washington, and Rutgers. Of the top 20 schools, two are in Canada. All 20 are public universities.

The ranking of schools' citation activities correlates with individual-level factors, such as professional rank and degree type. For example, the top five schools in Table 6 have a higher proportion of full professors (14 out of 37 faculty members in total) and doctoral-degree holders (29 out of 37), compared with the schools ranked 16th to 20th in Table 6 (11 full professors and 14 doctorates out of 38).

DISCUSSION AND CONCLUSIONS

As universities experience increasing pressure to account for productivity in the face of competition and declining budget resources, academic programs and departments must expect escalating demands that they "prove their worth." In the realm of research activity, funding dollars and expenditures provide a means of measuring productivity, but other scholarly contributions represent a challenge in this regard, particularly when comparisons are made across disciplines with different orientations toward knowledge generation and dissemination. In the discipline of landscape architecture, citation analysis can aid in evaluating academics at the program and individual faculty levels and allow for comparison with other disciplines and analyses of trends. At the program level, the analysis can show which landscape architecture programs have highly productive and impactful scholars. At the individual level, the information can be used for the part of promotion and tenure evaluations that assesses the level of scholarly contributions.

Overall, scholarly impact levels for landscape architecture faculty are relatively low compared to some other fields when analyzed by GS citation measures. In urban planning, where having a doctoral degree is a standard expectation for faculty, Sanchez (2021) recorded the following median citation counts: 157 (h-index: 6) for assistant professors; 540 (h-index: 10) for associate professors; and 1,754 (h-index: 18) for full professors. By comparison, in this study, landscape architecture faculty members with doctoral degrees had median citation counts of 59 for assistant professors (h-index: 3), 123 for associate professors (h-index: 5), and 431 for full professors (h-index: 8). We acknowledge the disciplinary differences between landscape architecture and urban planning and therefore realize that such a comparison would benefit from an additional analysis that seeks to explain these differences. Most citation databases (e.g., Scopus, Web of Science Journal Citation Reports) stress that citation data are best examined within research categories. For example, Web of Science reports journal ranking within thematic research

Table 6. Top 20 Schools Ranked by Median Total Citations (Note: All Citation Values are Medians)

Rank	School	# Faculty Members	# Publications	Total Citations	h-index	hI,norm	hI,annual
1	Michigan State University	5	46	911	16	8	0.42
2	Texas A&M University	11	32	696	9	7	0.25
3	University of Maryland	5	30	503	7	6	0.27
4	University of Wisconsin–Madison	8	25	449	11	7	0.28
5	University of Washington	8	44.5	306	7.5	6	0.26
6	University of California, Berkeley	11	43	257	8	7	0.33
7	Rutgers, The State University of New Jersey	8	43.5	247.5	5.5	4	0.19
8	University of Arizona	7	22	237	7	6	0.42
9	University of Minnesota	7	22	217	4	4	0.20
10	University of Massachusetts, Amherst	9	39	182	6	5	0.19
11	University of Michigan	6	20	176.5	6	5.5	0.43
12	University of California, Davis	9	25	174	7	5	0.33
13	University of Southern California	4	22	165	6	5.5	0.23
14	Utah State University	10	19	145	5	3.5	0.19
15	Arizona State University	5	19	135	5	5	0.12
16	University of Pennsylvania	8	14	114	5	4	0.20
17	University of Guelph	7	7	113	4	3	0.20
17	University of Kentucky	5	13	113	4	4	0.18
19	University of British Columbia	11	12	95	4	4	0.22
20	Temple University	7	13	92	5	4	0.16

areas such as environmental studies (156 journals as of November 2021), urban studies (72 journals), and regional and urban planning (51 journals). Thus, future research needs to consider factors and metrics that explain salient themes within the broader landscape architecture discipline.

Our analysis also found significantly skewed distributions of citation counts. A total of 76 faculty members (15.1%) had no citations. The top 20 scholars accounted for the majority (50.1%) of total citations, and the top 20% ($n = 100$) of landscape architecture faculty produced most of the citations (86.8%). A similarly (albeit less extreme) distribution was found in urban planning citation counts. Sanchez (2017) found that 20% of faculty produced nearly 80% of all citations. In terms of the number of publications, 20% of faculty produced 55.2% of publications, which was around 50% in previous studies on refereed journal articles (Christensen et al., 2019; Milburn & Brown, 2016).

In addition to traditional measures such as total citation counts and h-index, this study adds alternative measures such as hI,norm (individual h-index, accounting for co-authorship effects) and hI,annual (average annual increase in individual h-index, accounting for co-authorship and career length effects)

to better understand faculty scholarship impacts. In particular, hI,annual did not correlate with either seniority or rank. Additional research and analysis can be used to explain these types of occurrences and the patterns of citation activity.

In terms of a scholar's individual characteristics, we found associations between the levels of citation measures and career length (higher for senior scholars), rank (higher for higher ranks), and degree type (higher for those holding a doctoral degree). But a further examination showed that the mean differences in citation counts were only statistically significant between full professors and the other groups, not between assistant and associate professors. In terms of gender (inferred based on given names and photos), the levels of citations between male and female scholars were comparable, with no statistically significant differences. A similar result was found in previous studies about the number of scholarly publications by male and female faculty members (Milburn & Brown, 2003b, 2016).

Further steps that can be taken for future research include a qualitative and in-depth analysis of faculty research productivity and impacts. Mining publication data (e.g., for information on research areas, individual papers, publication types and venues, co-authorship, and author order) can provide a more in-depth view of scholarly research in the field. The results of this study can be further supplemented by looking into the degree majors and study areas of landscape architecture faculty. As landscape architecture faculty come from a variety of backgrounds, it is important to know their backgrounds and the research areas they are advancing (Ozdil, 2021).

Citation analysis has been criticized for being discipline-dependent and skewed toward science and technology, and the design fields are among those disciplines underrepresented in the area of scholarship (Gervits & Orcutt, 2016). No single metric can quantify scholarly impact; however, a model that takes into consideration multiple research outlets and discipline-specific comparisons is needed (Gervits & Orcutt, 2016). Aside from journal articles and conference proceedings, in landscape architecture scholarly output can include textbooks, creative work, design and planning projects, built work, exhibits, design competitions, and other things with direct relevance to the teaching and practice of landscape architecture. Productivity solely measured through peer-reviewed publications and citation indicators can be limited by the relatively high instructional responsibilities in the field and student contact time associated with disciplines involving time-intensive, studio-style or project-based pedagogies (Chen, 2013; Milburn et al., 2001). Thus, citation analysis must be supplemented with tools and metrics to show a more complete picture of scholarly productivity and impact in landscape architecture (Christensen & Michael, 2014).

We acknowledge that bibliometric analysis and evaluation can be complicated, particularly around discipline-specific comparisons. In our case, we focus on individual faculty and academic units (departments and programs) in landscape architecture. Other levels of analysis could involve further data collection for individual faculty, including all degrees obtained, all schools attended, professional work experience, teaching loads, incentives such as start-up packages, salary level, administrative positions held, and so forth. Myriad factors beyond the scope of this paper could potentially influence the time and effort that goes into scholarly production. This is also true of analyses at the academic unit level, where the mix and diversity of individual characteristics just mentioned can be represented at the department or program level. Do "pure" landscape architecture units (i.e., with no mixing of disciplines like urban planning) exhibit different levels of scholarly productivity and visibility compared to units with a mix of faculty? Do particular schools where landscape architecture faculty obtain their degrees produce more research and scholarship-oriented faculty compared to other schools? These are topics that will be pursued in future research efforts to understand the intricacies of both individual and academic unit scholarly activities.

We hope that the analyses presented in this study will provoke further discussion about the need to develop valid measures for quantifying scholarly productivity and impact within landscape architecture. To our knowledge, the results presented here are among the few to illustrate citation dynamics for landscape architecture faculty in the United States and Canada; they therefore provide interesting insights into the discipline. Citation analysis can help

students, peer scholars, practitioners, and universities evaluate the landscape architecture discipline both at the program and individual faculty level. Understanding which factors influence scholarly output, such as discipline, career length, rank, gender, and structures of collaborations, can further provide the context of an individual scholar's impacts. Also, citation analysis can promote efforts by faculty members to document and disseminate their scholarly inquiries and outcomes (LAAB, 2021).

Our findings suggest that landscape architecture is trending toward more emphasis on research and scholarly output. There could be a variety of explanations for this, but we expect that the impact of the trend toward quantifying productivity and quality/impact is being felt throughout universities, particularly in the case of public universities, which must compete for limited resources and justify the use of taxpayer dollars. These kinds of pressures are being faced and debated by disciplines across higher education, and landscape architecture as a discipline ultimately needs to decide which ways of measuring research output are most appropriate for the field. Finally, it is important to keep in mind that research and scholarship constitute just one of the three basic areas of faculty responsibility and that the metrics described in this article should be considered along with assessments of teaching and service. Faculty roles in higher education continue to evolve, along with the possible ways of measuring performance.

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