Insights on the Scientific Publications of the Faculty of the College of Science, UP Diliman: 1998-2017

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ABSTRACT

This paper compiles all the scientific publications from UP College of Science (UP Science) as indexed in both Thomson Reuters' Web of Science and Scopus from 1998 to 2017. This research follows a previous study that used journal publications as a measure to track the scientific productivity of UP Science. Likewise, this paper only considered publication output as the sole criterion used for academic productivity. A total of 2,295 unique journal publications or 54% of all indexed publications from the University of the Philippines Diliman come from UP Science. On average, UP Science increases its publication output by about eight articles each year with a total of 208 journal articles in 2017. Since 2013, UP Science has attained the benchmark of one publication per Ph.D. faculty per year. In addition to analyzing the document count per institute, efforts to distill the data and come up with additional insights on what drives productivity were done. From the dataset, more than half of the papers are a result of collaborations with foreign institutions. Opportunities for collaborations with other Higher Education Institutions and within UP Science remain low and should be capitalized on. Publications in prestigious journals are also slightly increasing and may be included as another metric to track. Aggregate and mean *h*-index for institutes also corroborates scientific productivity and impact of many institutes within UP Science. Lastly, insights on individual faculty productivity clearly shows the shift from primary researcher to mentor between their 6^{th} to 15^{th} year as faculty member. This highlights the potential role of graduate student publication as yet another strategy to increase UP Science's research output.

Keywords: UP Science, publication record, scientific productivity, institutional collaborations, mean *h*-index, research impact

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INTRODUCTION

A recognized metric for research and development (R&D) productivity of an individual or institution is its number of indexed, peer-reviewed journal articles that have been published (Vinkler 2011). In fact, individual publication output has been used for faculty promotions, commendations, and tenure applications in universities. Taken as an institutional output, publications are also used for university ranking, conferment of Centers of Excellence (CoE), and a track record or indirect measure of research capabilities of an organization for grants application purposes.

Aside from publications, academic research outputs also include intellectual property protection granted, number of students and personnel trained, prototype of products that may be commercialized, and policy recommendations. Beyond academic outputs are societal outcomes and impacts to which research may also contribute, including indicators of economic gains (startups founded, value of commercialized products, increased industry competitiveness, etc.), environmental protection (increase in biodiversity, reduction of pollution, etc.), and social equity (more effective and lower cost of public services, etc.). In fact, more and more institutions strive to attain outcomes and impacts (i.e., stakeholders' needs) and measure these accordingly as the ultimate contributions of R&D (Adam et al. 2018). Currently, these are not yet being tracked in the country, thus indexed and peer-reviewed publications remain as the only readily available metric for measuring research productivity.

This paper updates the landmark research done by Lim and Saloma (1998) that tracked the University of the Philippines Diliman's College of Science (UP Science) publication output. Worth noting are certain changes introduced in the databases used for this study. First, publications as indexed in both SCOPUS and Thomson Reuters' Web of Science are used (the previous study used UNCOVER and MEDLINE index, which had a narrower scope). Second, both indexing companies now include select Conference Proceedings. Lastly, regional journals under Thomson Reuters' Emerging Sources Citation Index since 2015 (e.g., Science Diliman is now indexed) are also included, which further expands the coverage of the database.

UP Science has a total of 166 Ph.D. faculty members distributed in nine degree granting institutes and programs – Marine Science Institute (MSI), National Institute of Physics (NIP), National Institute of Molecular Biology and Biotechnology (NIMBB), National Institute of Geological Sciences (NIGS), Institute of Biology (IB), Institute of Chemistry (IC), Institute of Mathematics (IM), Materials Science and Engineering Program (MSEP), and Institute of Environmental Science and Meteorology (IESM).

Lastly, also within UP Science is a research center known as the Natural Sciences Research Institute (NSRI), which is staffed by University Researchers and Adjunct Faculty from IB, IC and IM.

METHODOLOGY

A search for all articles with UP or UP Diliman in the affiliations field of the two indexing databases was done. These were then distilled to determine the publication count per institute within UP Science. Paper presentations that are indexed as either oral or poster presentations were removed, but full papers in conference proceedings were included. The two databases were then cross-referenced to remove journal articles that are indexed in both to arrive at the master list of journal publications. When counting output per institute, papers with authors coming from different institutions were counted multiple times. However, for all other metrics presented below, each paper is only tagged once and attributed to the affiliation of the first/lead author to eliminate double counting of papers. Collaborating institutions were classified into (1) UP Science institutes, (2) UP Diliman units, (3) local Higher Education Institutions (including other UP System units), (4) local non-academic research centers and industries (including government agencies and secondary education institutions), and (5) foreign institutions.

Data on individual faculty count and characteristics came from each institute's webpage. First/lead authors not listed as faculty members but indicated an affiliation with one of UP Science's degree granting institutes and programs were assumed to be graduate students and researchers of the indicated institute. For the study on journal ranking, the researchers used Scopus's SCImago Journal Rank (SJR). The SJR ranks each journal according to the ratio of the number of citations each paper in the journal receives with the number of scholarly papers the journal publishes. Journals under similar subject areas (e.g., Geophysics, Cell Biology) are then ranked based on the SJR ratio for the last three years (2015–2017).

Aside from assessing the scientific productivity of UP Science through standard publication counts and metrics, the researchers used the Hirsch index (*h*-index) for comparing the impact of published works. Only journal articles published by faculty members and researchers affiliated with UP Science from 1998 to 2017 were included. Citation counts for each paper, essential in determining *h*-index (Hirsch 2005), were retrieved from the Scopus and Web of Science databases. The researchers did not use Google Scholar as it overestimates citation counts and it includes and over-represents citations from gray literature, e.g., popular scientific literature, unpublished reports, magazines, and questionable journal titles (Aguillo

2012) as well as duplicate citations and stray publications (Harzing and Alakangas 2016). Each institute's mean and aggregate *h*-indices were computed from faculty members' individual *h*-indices to partially correct the bias of *h*-index in rewarding faculty seniority and account for each institute's unique citation patterns (Lazaridis 2010).

RESULTS AND DISCUSSION

Publication Totals

Over the 20-year period, a total of 2,295 unique journal articles came out of UP Science (Figure 1). Counting each paper as a contribution of the individual institutes, however, the sum of publications from each institute will be 2,634 papers (315 papers resulted in two or several institutes collaborating). On average, the output of UP Science increased by eight papers per year, culminating in 2017 with 208 papers published. From the total papers (2,634), MSI contributed the most number of papers (619). This is followed by NIP (580), IB (337), NIGS (244), IM (235), NSRI (208), IC (205), IESM (98), NIMBB (81), and MSEP (27). It is noteworthy that, while MSI and NIP retained their high average output throughout the 20-year period, IB, IM and NSRI steadily increased their yearly output, culminating in 2017 with 45, 27 and 22 papers, respectively. IESM and NIMBB also significantly increased their output in recent years. IESM was averaging 2.9 papers per year until 2014 but jumped to 19.0 papers per year in the last three years. Similarly, NIMBB was averaging 3.2 papers and increased to 11.0 in the last three years. IC and NIGS fluctuate in publication output but still ended up with a high average output in the last three years of 15.7 and 19.6, respectively.

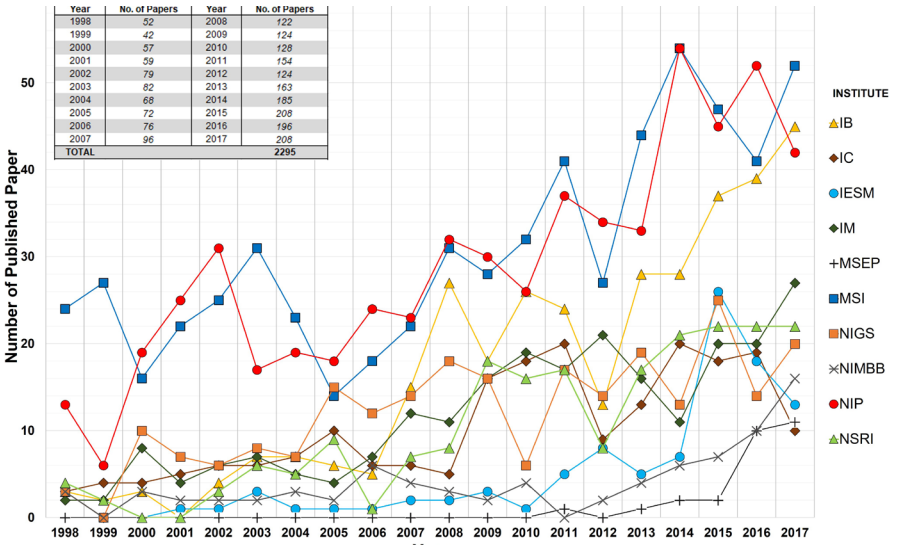

Figure 1. Year-over-year publication record totals of UP Science.

Since the size of the faculty pool of each institute varies, the publication output is normalized based on the number of Ph.D. faculty plantilla positions. Assuming that the current number of faculty Ph.D.'s is the same since 2012, the highest number of publications per capita per year was found in NIP (2.1), MSI (1.9), and IESM (1.6). This is completely the opposite of the findings in 1998 where all institutes failed to produce the benchmark value of one publication per faculty member per year (Lim and Saloma 1998).

Insights on Institutional Collaboration

Based on the co-authorship of published papers, we investigated the trends in UP Science collaborations with other institutions. A total of 52% of all published papers are with foreign collaborations and have consistently remained within the 45-60% range throughout the 20-year record (Figure 2). The majority of the collaborations from 1998-2004 was with American or European institutions (43% and 40% of total papers co-authored with foreign institutions, respectively). European collaborations, however, have declined to just 28% in the last seven years. At the same time, a shift in collaborations with East Asian countries was observed starting 2004, posting a 44% average since that year. Joint research with ASEAN countries and Australia both fluctuates around 12% on average. Collaboration with African, South Asian, and Middle Eastern regions remain low at 7%.

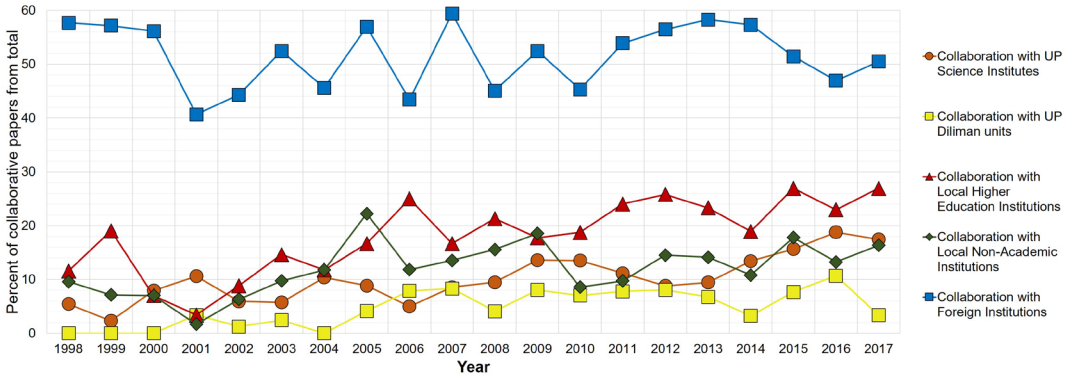

Figure 2. Year-over-year publication record of UP Science with foreign collaboration grouped by region.

Local research collaborations are slightly increasing, albeit still significantly lower than foreign collaborations. Partnerships with other local Higher Educational Institutions (HEIs) (20% of total papers) also posted a slightly increasing trend with 26% of papers in the last three years (Figure 3). The largest chunk of these papers (41%) was written in partnership with other UP System units while private HEIs and other State Universities and Colleges (SUC) have 31% and 20% shares, respectively. Since 2010, these proportions have steadily remained within the above-mentioned averages. Among UP Science institutes, NIMBB has collaborated most with other UP System units at 25% of all their published papers. On the other hand, IESM has the highest proportion of papers written with private HEIs at 16% and MSEP has 15% of its papers written with SUCs. NIGS has the highest proportion of papers done with industry collaboration, accounting for 46% of all its published papers (113 papers).

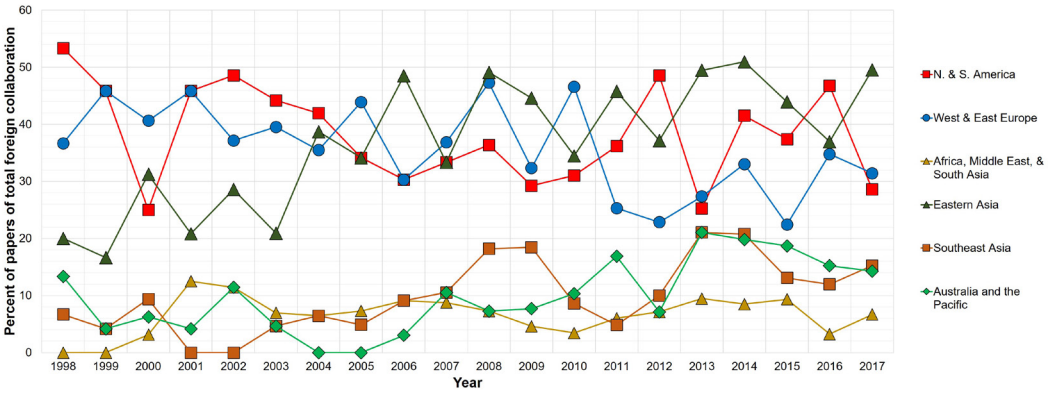

Figure 3. Year-over-year publication record of UP Science in collaboration with other institutions.

Collaborations within UP Science are still limited to around 15% of total papers. As can be expected, most of the collaborations occurred through NSRI having adjunct researchers from other institutes–with IB (98 papers) and with IC (35 papers). MSI has collaborated most with other institutes, having at least 15 papers each with NIMBB, IESM, NIP, and IB.

Insights on Faculty Productivity

Out of 166 full-time faculty members ranked as Assistant Professor, Associate Professor or Full Professor as of December 2017, we selected a representative sample of 126 professors (75.9%) for comparison and assessment of their authorship attribution on their published papers. These faculty members were included based on data availability, particularly on when they started as tenure-track faculty after receiving their Ph.D. degree. The average number of years these faculty members have served in the university was 14.6 (σ: 8.3) years. As of 2017, 70 of these faculty members were already granted tenure by the university, with 7.3 years as the average duration between the time they obtained their Ph.D. and being granted tenure (University of the Philippines 1987-2017).

A summary of the faculty data per institute cross-referenced with their respective length of service in the university is found in Table 1. In many of the institutes, most faculty members have already served in the university for 10 years. The majority of the faculty has been in service for 6–15 years. Table 2 shows the aggregated data of all the 126 faculty members in the population. Obviously, the dataset may be biased simply because there will be fewer and fewer faculty members included as years of active service increase. However, when individually investigated, majority of institutes follow the group trends presented.

Table 1. Summary of the number of faculty members per institute (with available data) and their length of service as of December 2017

	YEARS IN ACTIVE SERVICE							
Institute	**1–5**	**6–10**	**11–15**	**16–20**	**21–25**	**26–30**	**31–35**	**Total**
IB	5	8	3	3	2	1	0	22
IC	2	8	4	2	4	3	1	24
IESM	0	3	3	2	0	1	0	9
IM	4	5	4	2	2	3	0	20
MSI	0	2	2	1	3	2	2	12
NIGS	1	3	2	4	2	1	0	13
NIMBB	0	1	1	1	2	1	0	6
NIP	2	3	6	4	4	1	0	20

Table 2. Number of papers by authorship attribution grouped by faculty member's number of years in active service

	YEARS IN ACTIVE SERVICE						
Authorship Attribution	**1–5**	**6–10**	**11–15**	**16–20**	**21–25**	**26–30 3**	**1–35**
Primary Author	107	87	69	42	19	4	0
Co-author	112	299	376	339	192	50	2
Total	219	386	445	381	211	54	2

The growth rate of publications written by UP Science faculty sharply differs between primary authorship and co-authorship throughout their careers in the university. Faculty members are most productive during their 1st to 5th year in terms of papers written as lead authors. On average, UP Science published 21.4 papers per year during the faculty member's first five years. Newly hired faculty members likely publish chapters of their Ph.D. dissertation during these first few years, boosting the number of publications written as primary authors. During a Ph.D. faculty's early career in the university, they also begin to establish laboratories that give faculty members resources (e.g., grants, graduate students) to write papers as primary authors, which is also a requirement for tenure. In succeeding years, the number of publications written as primary author decreases. During their 6th to 10th year, it decreased to 17 papers a year. On their 16th to 20th year, this fell further to 5.4 papers contributed annually.

At the same time, co-authorship in publications increases until it peaks during the 11th to 15th year of a UP Science faculty's service. Upon entering their mid-careers, the number of papers UP Science faculty co-author explodes in numbers. During their 6th to 10th year on average, 37.4 papers annually are written as co-authors. This increasing trend continues until their 11th to 15th year at 15.4 papers per year. During this decade (6th to 15th year), majority of faculty members have been granted tenure by the university and most would probably have a pool of junior faculty members and researchers by this time in their career. Lastly, it is important to point out that many papers written during these years are co-authored with graduate student advisees doing their M.S. and Ph.D. degrees or in collaboration with other researchers in their field.

Upon examining the proportion of papers written as primary authors to the total publication record of UP Science, an interesting insight was observed. During the first five years of a faculty member, UP Science published 48.9% of papers as primary authors. This proportion decreases at a ratio closely following a power law relationship (Figure 4). This power law relationship has been used extensively in scientometrics (Ronda-Pupo and Katz 2017), in citation networks (Mayernik 2010; Milojevic 2010), research output (Sutter and Kocher, 2001), citation distribution probabilities (Brzezinski 2015), and the most well-known being Lotka's Law (Lotka 1926).

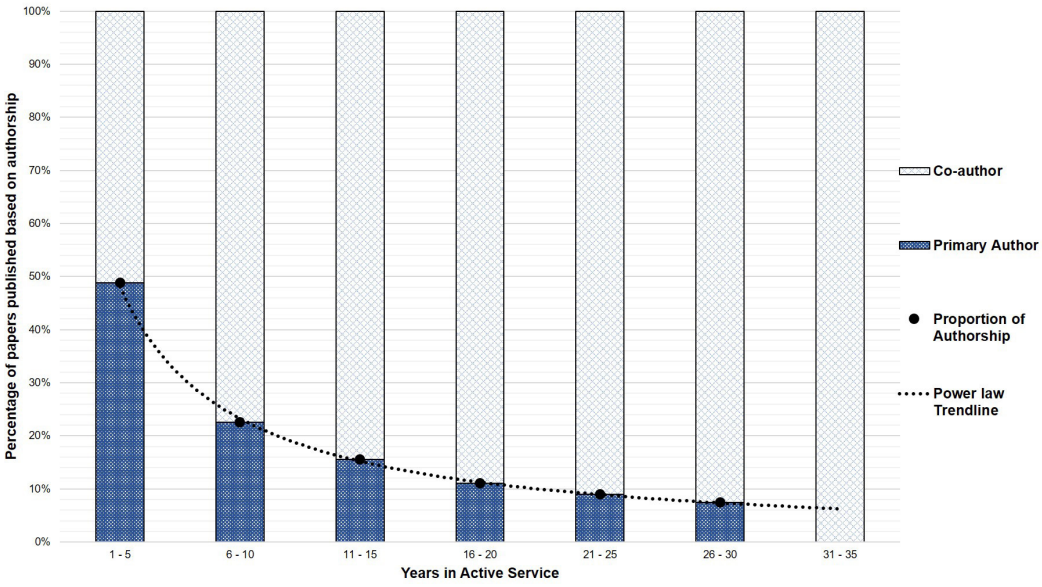

Figure 4. Authorship classification of papers by selected UP Science faculty members (n = 126) as a proportion of their total publication record every five years in active service since earning their Ph.D. degrees.

In five-year intervals following a Ph.D. faculty's research career, this ratio progresses from 1/2 (1^{st}–5^{th} year), 1/4(6^{th}–10^{th} year), 1/6(11^{th}–15^{th} year), 1/8(16^{th}–20^{th} year), 1/10(21^{st}–25^{th} year), and to1/12(26^{th}–30^{th} year). Fitting a power law regression line, Equation 1 almost exactly approximates (R^2 = 0.9975) the actual proportion of papers published as primary authors by UP Science.

$$y = 1.2702x^{-0.842}$$

where, y is the proportion of papers written as the primary author, and x is the midpoint of the five-year interval of a faculty member's years in active service.

This regression equation may be further validated and tested if it holds accurate for publication records of other colleges and institutions. In the meantime, the relationship between the years in active service and the proportion of papers published as the primary author may provisionally serve as a rough guideline for assessing the current and future scientific productivity of an individual faculty member or institute.

Insights on Journal Breadth

From 1998 to 2017, the UP Science institutes and programs published 2,295 papers in 934 unique academic journals and conference proceedings (Figure 5). UP Science increased where it published papers by 6.3 journal titles annually on average, ending 2017 with 165 unique academic journals. During the 20-year period, MSI published papers in 254 journals, followed by NIP (229), and IB (186). During the last five years (2013–2017), these three institutes maintained their lead on the breadth of their research with averages of 38.8, 35.8, and 30.6 journal titles per year, respectively.

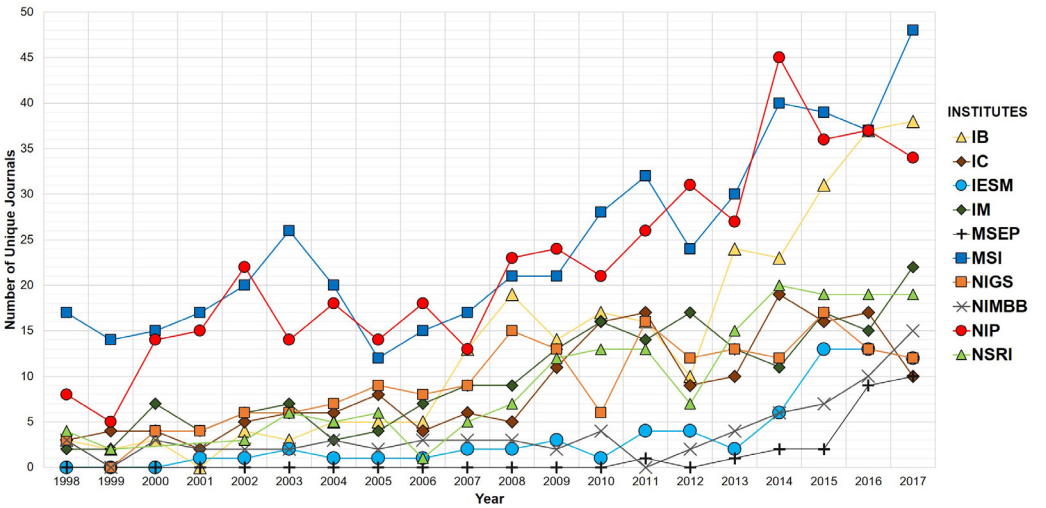

Figure 5. Year-over-year record of the total number of unique journal titles in which UP Science published papers.

Among the 934 journals included in this study, the most popular journal that institutes publish in is the Department of Science and Technology's Philippine Journal of Science (PJS). All ten UP Science institutes have published at least one paper with PJS. PLoS ONE, published by the Public Library of Science, follows PJS with all institutes having published papers with them except IC and MSEP. Meanwhile, seven institutes, all except IC, MSEP, and IESM, have published at least one paper in Nature Scientific Reports. Quantity-wise, UP Los Baños' Philippine Agricultural Scientist leads with 78 journal articles from UP Science. It is followed by PJS with 58 papers and Marine Pollution Bulletin with 46 papers.

Although UP Science has published in almost a thousand journals titles since 1998, the 10 UP Science institutes have published only two papers in 200 (21.4%) of these journals, three articles in 74 journal titles (7.9%), four or more papers in 163 journals (17.5%), and the rest in 497 journals (53.2%), having only a single paper published in each of these journals. Overall, most institutes in UP Science still favor publishing papers in highly specialized journals and less on topics that are interdisciplinary in nature. Nevertheless, during the last six years, UP Science institutes published in a steadily increasing number of journals.

Insights on Journal Prestige and Citation Impact

The SCImago journal and country rank (scimagojr.com) compiles data from Scopus to come up with a ranking of journals in the 313 major subject areas. The ranking is based on the number of citations that journals receive as an indirect measure of the prestige/ranking of the journal. From this, the top 10% of journals in each of the subject areas were identified.

Throughout the six-year period of 2011 to 2016, UP Science published a total of 261 papers in SCImago's Top 10% Journal Ranking, with an average of 4.4 papers per institute annually. Individually, most institutes posted a modest increase in total papers published in such journals during the time period (Figure 6). Although the year-on-year trend of the six-year average of the proportion of publications published in high-ranking journals was steadily increasing, it remained at a low 21.7% of all journal articles written by UP Science from 2011-2016. Institutes that published at least one-third of their papers in highly ranked journals (which helped bring up the UP Science average) were NIGS, MSI, and NIMBB, averaging 41.4%, 36.2%, and 34.6%, respectively.

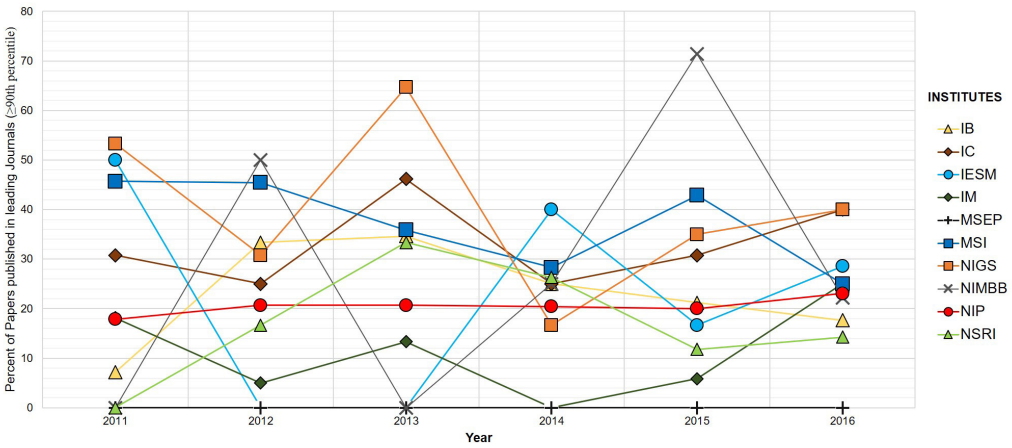

Figure 6. Year-over-year (2011–2016) record of UP Science papers published in leading journals.

The mean and aggregate *h*-indices for UP Science institutes generally corroborate what were observed and discussed in this paper on each institute's scientific productivity and research impact. MSI still tops the rest of the institutes with a mean *h*-index of 10.0 and an aggregate *h*-index of 51. NIP and NIGS follow with mean *h*-indices of 5.9 and 5.7 and aggregate *h*-indices of 28 and 30, respectively. Impact-wise, these three institutes house productive faculty members that published highly cited papers throughout the 20-year period.

CONCLUSIONS

The UP College of Science continues to improve its R&D productivity as measured through journal publications. Since 2013, UP Science has consistently exceeded the one publication per Ph.D. faculty per year benchmark. Insights on how to further increase this R&D output can be deduced from the data. For one, collaborations particularly with other HEIs and with other UP Science institutes may help bring publication numbers up both for UP Science and the rest of the country. Second, based on the faculty productivity data, increasing the number of graduate students will also increase the publication output. Mentoring (particularly during the faculty's 6^{th} to 15^{th} year of service) serves as a multiplier effect, suggesting that if we can encourage (or even require) Masters students to also publish their work, then UP Science publication totals can easily increase by 50% each year.

The quality of papers being published as measured through the journal ranking may also be a good metric that UP Science can track year over year. Efforts to publish in prestigious journals may be included as an additional target other than just publication count. Tracking the aggregate and mean *h*-index for faculty members and institutes may also be done to assess the productivity of the UP Science research community. Lastly, as mentioned above, journal publication is just one metric for scientific productivity. Eventually, UP Science could put in place societal impact metrics such as technology commercialization, environmental protection and better public service through science and technology research.

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