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Exploring Publication Productivity in the Philippines: A 10-year Gendered Analysis of Six Academic Disciplines

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This article presents a gendered analysis exploring publication productivity in the Philippines using bibliometric data from the Web of Science. It investigates the temporal pattern of journal article publications for six disciplines, its gendered distribution, differences between disciplines, patterns of authorship and collaboration, and how much women authors contribute and participate in research collaboration. Statistical analyses revealed that although overall publication productivity increased in number from 2003 to 2012, the percentage of female contribution and participation remained almost unchanged. Significant differences were also found among disciplines using logistic regression. Implications of the results in relation to the contemporary environment of higher education institutions and the socio-cultural context of the country are also discussed.

Keywords: Publication productivity, Collaboration patterns, Gender, Bibliometrics, Higher education

INTRODUCTION

The Global Gender Gap reports are published yearly by the World Economic Forum and ranks countries in terms of closing the gap of inequality between women and men. The reports examine four critical areas of inequality that includes: economic participation and opportunity; educational attainment; political empowerment; and health and survival. For the educational attainment sub-index, the "gap between women's and men's current access to education is measured through ratios of women to men in primary, secondary and tertiary level education" with the "longer-term view of the country's ability to educate women and men in equal numbers is measured through the ratio of the female literacy rate to the male literacy rate" (Hausmann, Tyson, Bekhouche, & Zahidi, 2014, pp. 4-6). For the past nine years, the Philippines has been ranked within the top 10 among 110 countries in the reports, sharing the best positions together with developed countries usually found in Nordic Europe. In addressing the inequality

in women's access to education at all levels and literacy rate, the Philippines can be considered as overall highest in the developing world for the recent decade based on these reports.

It then stands to reason that with such equal participation of women in education, a similar level of equality in terms of academic publication productivity could be expected. Publishing research is "integral to life in academia" (Schucan Bird, 2011, p. 921) and "serves a critical function in research communities including universities, laboratories, and research centers" (Vinluan, 2011, p. 277), the study of publication productivity is a "central process of science," and by "'understanding factors that are associated with productivity and variation by gender, assessment or correction can be made on inequities in rewards, including rank, promotion, and salary" (Fox, 2005, p. 131).

However, even well-known and cited international assessments such as the Global Gender Gap, Global Competitiveness reports (World Economic Forum), the Country Gender Assessment (Asian Development Bank), and Human Development Report (United Nations Development Programme) do not include a gendered analysis of research productivity as one of its indicators whether in education or innovation and thus may overlook the important role of women in creation and dissemination of scientific knowledge, and also gives an incomplete picture of gender equality for a country.

Thus, it is of paramount importance that productivity gaps between genders be identified in order to perceive a more meaningful educational environment that go beyond receiving and repeating scientific information. Understanding these may also prevent complacency among policy makers and stakeholders resting on their laurels in managing gender equality and feminization of the workplace. An assessment into gendered publication productivity would also allow a clearer view of possible holistic development for female academics and also serve as a reminder of how efforts should be continued in addressing gaps in gender equality that are seemingly unnoticed.

For analysts and policy makers in the developed world, there is relevance in examining the dynamics of knowledge production in a developing country such as the Philippines. Even among the richest of nations, development of education is uneven. Despite the "preponderance of prestigious scientific centers and research institutions, there are still network regions within the overall research system of a country—such as small regional universities and colleges, that closely resemble research institutions in developing countries" (Ynalvez & Shrum, 2011, p.205). These may share similarities in facing "limited financial resources, inadequate research equipment and facilities, and faculty given extreme teaching loads' tasked with publication requirements" (p.205) along with limited networks that may affect possibilities for collaboration.

CONTEXT

Women scientists have been found to publish fewer papers than men due to various factors such as not having "personal characteristics, structural positions, and facilitating resources that are conducive to publication" (Xie & Shauman, 1998, p. 863), emphasizing the importance of "structural sources of gender inequality in science where women and men are located in different academic structures with differential access to valuable resources" (p.864). There has also been a "wide recognition that women are underrepresented in academic science", with few choosing scientific careers and a tendency to underachieve for those who take such path (Webster, 2011, p. 185). A rich literature explores gender disparities in publication productivity (e.g. Cole &

Zuckerman, 1984; Duch et al., 2012; Fox, 2005; Van Arensbergen, Van der Weijden, & Van den Besselaar, 2012) and collaboration patterns (Abramo, D'Angelo, & Murgia, 2013; Rigg, McCarragher, & Krmenec, 2012; Ynalvez & Shrum, 2011). Seven antecedents to research productivity are identified by Blackburn and Lawrence (1995 as cited in Kaufman & Chevan, 2011, p. 123) covering both individual and environmental attributes. Individual antecedents include socio-demographic variables of gender and race, career variables (ex. academic discipline), and other related factors like work values and preferences. Variables such as institutional mission and resources, rewards of promotion and salary, and the issues connected to family responsibilities are part of the environmental antecedents. Specifically in the Philippines, Dela Torre (2009) analyzed bibliometric data from selected Philippine research journals in the social sciences and concluded that in relation to gender, "males make far greater contributions of articles than females, except in the disciplines whose professions are also dominated by women" (p. 51). This was argued as probably due to male and female status in Philippine society "where men have more time for study and research because they are not expected to do household chores after office hours" (p.51).

Interestingly, in the study made by Aguilar et al. (2013), gender was found to have no significant association with either publishing in high impact journals or total productivity despite the privilege given to and the greater number of male scientists in East Asian countries. Such results were "unexpected because males are more likely to be productive than females in a culture that harbors patriarchal orientation" (p. 53). At the same time, they argued that it was "not surprising due to recent studies in Western developed countries that had observed a decreasing trend in the productivity gap between male and female scientists" (p. 53). They further suggested that "such trend may have already gained momentum in the research systems of the developed non-West" (p.53).

For the Philippines, myriad studies had been conducted in assessing research productivity in state universities (e.g. Dumbrique & Alon, 2013; Quimbo & Sulabo, 2014), private educational institutions (Nuqui & Cruz, 2012), and even in the level of individual faculty members (Salazar-Clemeña & Almonte-Acosta, 2007; Vinluan, 2011). Such interest has been of recent significance as research is among the three primary functions of all Higher Education Institutions (HEIs) required by the Philippines Commission on Higher Education (CHED). As stipulated by CHED Memorandum Order No. 25, Series of 1998, under Priority Research Areas: "Research productivity is used as a basis for university status, institutional quality, establishment of center of excellence, obtaining autonomous/deregulated status, and opening of graduate programs" (Bay & Clerigo, 2013, p. 124). Publication productivity is also an established criterion for promotion and advancement as indicated in the Department of Budget and Management's (DBM, 2007) 'Manual on Position Classification and Compensation' for state universities and colleges. Correspondingly, private institutions such as De La Salle University (DLSU, 2012, pp. 5-17) also actively encourage and support faculty members to publish and present their research, and are integral their faculty development programs.

Aware of the lack in research productivity of Philippine HEIs, policies and mandates that are largely geared towards the improvement of research productivity have been formulated by CHED striving for a stronger research orientation among the HEIs. It's 'National Higher Education Research Agenda' (NHERA) for 1998-2007 "articulates goals of higher education research together with the mechanics and concrete

steps for achieving these goals" (Salazar-Clemeña & Almonte-Acosta, 2007). The recent NHERA-2 for 2009-2018 envisions the enabling of Philippine colleges and universities to produce high quality research to advance learning and national development, as well as international comparability of the Philippine higher education system. It encourages networking among HEIs, with each network focusing on areas wherein the members are or can excel in. It promotes partnerships/collaboration of HEIs with other research institutions, both local and foreign, as well as with industry and private laboratories, expecting appreciable impacts across all disciplines of higher education and other sectors as well. (CHED, 2009)

However, at present only a handful of papers, such as those made by Dela Torre (2009) and Ynalvez and Shrum (2011), particularly tackles gender in research productivity in the Philippines. And as such, this presents an opportunity to add to the sparse discussion on gendered research productivity in the country. Research quality can be assessed through study of bibliometric data, "allowing insights on research productivity of an author, an institution, or a country in a specific area of study" (Vinluan, 2011, p. 278). Bibliometric analysis "can track the growth of a research discipline and identify influential journals in that field" (p. 278). Various bibliometric techniques can be utilized in attempting to understand gender differences in science, with analysis that can be concentrated on small sample groups with short time-spans to larger samples that cover several countries and span many decades (Webster, 2001). This paper aims to contribute to the literature using bibliometric analysis in the hopes of exploring publication productivity in the recent decade focusing on the two universities of the country with the most prolific academic scholars in their respective fields.

RESEARCH AIM AND QUESTIONS

The main objective of this study is to examine female publication productivity in the Philippines and its implications. It aims to perform an objective assessment using bibliometric data in the fields of chemical engineering, education, literature, mathematics, political science, and psychology from 2003 to 2012. The analysis specifically addresses the following research questions:

1. What is the temporal pattern of journal article publication for the six areas of research indexed in the Web of Science?
2. What is the gendered distribution of these publications? Are there differences between the areas of research? How much do women authors contribute and how often do they participate?
3. What are the patterns of authorship and collaboration? How do these relate to participation of women in publication endeavors?

METHODS

Adopting similar approaches used by Vinluan (2011), Lewison and Markusova (2011), and Schucan Bird (2011), bibliometric data from the Social Sciences Citation Index (SSCI), Science Citation Index Expanded (SCI-E), Arts and Humanities Citation Index (A&HCI) were searched and processed in order to identify the number and proportion of women authors. The Web of Science (WoS) core collection is available by subscription to the WoS service provided by Thomson-Reuters, allowing access to over 55 million records from the top journals, conference proceedings, and books spanning more than 150 disciplines and archived records from 1900 to the present (Thomson Reuters, 2013).

Myriad studies on gender gap and difference in authorship, research collaboration, and publication productivity had extensively utilized the above mentioned indices (Aksnes, Rorstad, Piro, & Sivertsen, 2011; Lewison & Markusova, 2011; Rigg et al., 2012; Kadera, 2013; Østby, Strand, Nordås, & Gleditsch, 2013; Webster, 2001). It must still however be noted that journal coverage of the WoS is not absolutely complete, consistent in all disciplines, nor is it the only definitive source of bibliometric data that may be used for assessing publication productivity. For instance, "coverage of the SSCI can range from moderate (e.g. education, political science) to good (psychology)" (Vinluan, 2011, p. 280). Social scientists may also opt to write for other various types of literature, such as national journals, and non-scholarly works—particularly for the developing world not being represented well in international scientific databases—due to differences in priorities of local needs and global thematic interests (Ynalvez & Shrum, 2011; Vinluan, 2011). As such, some Philippine higher education institutions (i.e. University of Santo Tomas) that are regarded locally as having strong research capabilities and infrastructures in the fields of medicine or life sciences may not have as many actual publications listed in WoS areas such as Biology or Chemistry.

The following search parameters were used in the Web of Science online interface in order to extract the data used in this study:

Address = Philippines (n = 18,698)
Timespan= 2003 to 2012 (n = 8,921)
Document Type = Article (n = 6,678)
WoS Category = Engineering Chemical; Political Science; Research Area = Education Educational Research; Literature; Mathematics; Research Area = Psychology (n = 492)
Organizations-Enhanced = University of the Philippines; Univ Philippines; De La Salle University (n = 265)

From the 265 listed articles, thorough manual pre-processing was conducted for each entry to identify the sex of every listed author. Utilizing procedural approaches similar to Webster (2001), Lewison and Markusova (2011) and Schucan Bird (2011), the first and second names of the authors allowed the deduction of their sexes. Most names encountered were English, Spanish, or Filipino names clearly indicated genders. For articles that only listed initials, notes or biographical details within the articles were used, and extensive internet searches were conducted to find online profiles and pictures in University home pages, Conference websites, Google Scholar, Academia.edu, LinkedIn, and so forth. Additionally, those that had very little, ambiguous, or restricted information about their sex, was inferred using online testimonials from their students using forum websites such as their courses' Google/Yahoo Groups, or in PinoyExchange.com, and so forth in threads that specifically discusses professors of DLSU and UP. Posts usually describe the experiences of the students taking the course and also indicate the teacher's sex as either "Sir"/"Ma'am", as Filipino students usually address their professors and lecturers in such manner. Only four psychology articles (1.5% of sample) had unavailable or incomplete information about their authors and were excluded from the analysis. Hence, this resulted in 261 journal articles utilized as the sample that represents 53.05% of the 492 available articles in the six areas of research listed in WoS for the years 2003-2012 from the Philippines.

The six areas of research/WoS categories were selected as these disciplines have been frequently utilized in studies on gender differences in publication productivity conducted in various countries such as Poland, Russia, The Netherlands, United Kingdom, and United States (See Duch et al., 2012; Van Arensbergen et al., 2012; Webster, 2001; Lewison & Markusova, 2011; and Schucan Bird, 2011). These also

allowed adequate representation of Hard/Soft & Pure/Applied disciplinary areas based on the Biglan (1973) categorization affording a diverse range of curriculum styles, modes of teaching, and methods of assessment for the sample. De La Salle University and the University of the Philippines (Diliman) was selected as the two institutions consistently having contributing authors in majority of SSCI areas, and the highest number of journal article publications for the six disciplines. Furthermore, they are considered as among the top universities in the country, even classified in a study conducted by Bernardo (2003) as the only two out of the 223 higher education institutions in the Philippines meeting the criteria for doctoral/research university category (pp.95-127). Other logistical considerations included the inapplicability of random sampling of universities as many had very few (less than five) or no publications in WoS categories. The availability of faculty and researcher information was also taken into account as both universities allowed relative ease of access compared to other universities studied by the authors, that would also eventually allow intended further studies that can expand to other fields and extended scope.

Data was extracted using the WoS interface and saved in spreadsheet format where each article entry was processed and encoded in order to create the necessary variables used in the analysis. Relevant information used from the extracted data was: Number of authors, number of institutions, addresses of institutions, publication year, and research area. These were then combined with the gender information of the authors in order to define the following: (1) similar to Schucan Bird (2011), the proportion of women contributors in each article (*FemaleRatio*) was obtained by dividing the number of female authors with the total number of authors; (2) following Abramo et al. (2013) and Østby et al. (2013), a Boolean indicator of female participation (*HasFemale*) in an article was created, coded as '0' if women did not take part and '1' if women participated; (3) also derived were Boolean indicators of single-authorship or co-authored publication (*Co-Authored*); (4) having intramural collaboration (*Intramural*); having local extramural collaboration (*ExtramDom*); (5) having international extramural collaboration (*ExtramIntl*); and (6) whether an article only had single-sex or had both male and female authors (*MixedSet*). Data screening prior to analysis was carried out using procedures suggested by Tabachnick and Fidell (2006, pp. 60-114). Statistical analysis was then conducted by using functions available in spreadsheet and statistical software packages (Field, 2009).

For the dependent variable of female participation (*HasFemale*), logistic regression was conducted—essentially this technique is multiple regression with an outcome variable that is a categorical variable, and predictor variables that are continuous or categorical. In its simplest form, the model can predict which of two categories someone or something is likely to belong to, given other information (Field, 2009, p.265). Logistic regression predicts the probability of Y occurring given known values of X_1 (or X_s). When there are several predictors, the logistic regression equation from which the probability of Y is predicted is defined as:

$$P(Y) = \frac{1}{1 + e^{-(b_0 + b_1 X_{1i} + b_2 X_{2i} + \ldots + b_n X_{ni})}} \quad (1)$$

in which b_0 is the constant, predictor variables $X_1 \ldots X_n$, with *b1 ... bn* coefficients (or weights) attached to them, and ***e*** is the base of the natural logarithms (Field, 2009, p. 266).

For this analysis, the sample size used was 176 and the number of independent variables was seven. According to most rule-of-thumb regression criteria in the literature, a 10-to-1 IV to DV ratio is adequate. Specifically for binary

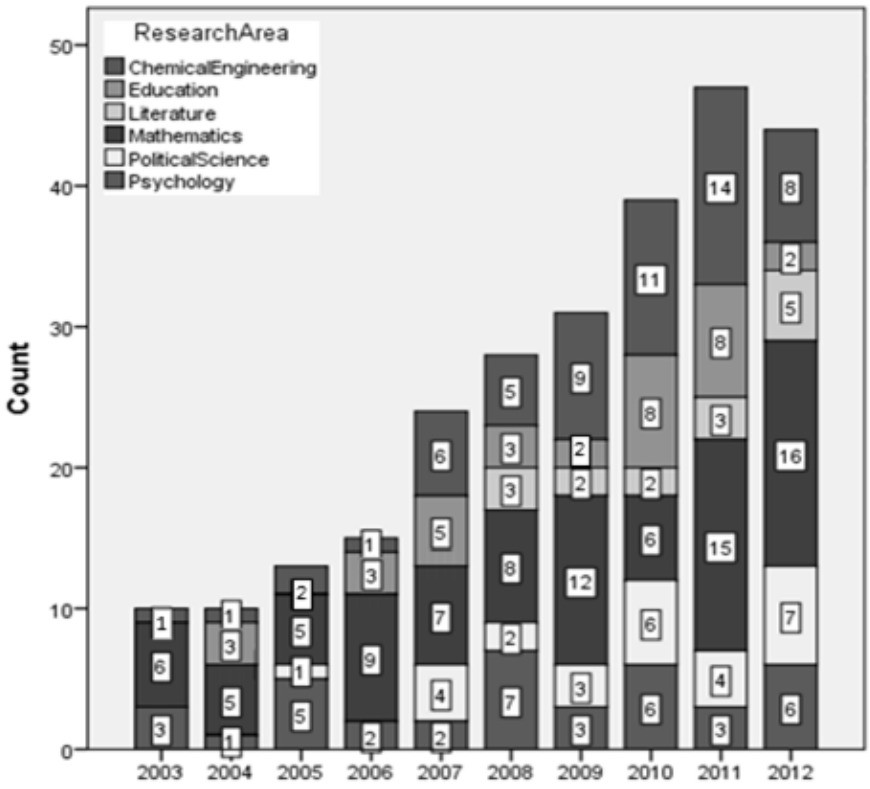

Figure 1. *Number of publications in SSCI, SCI-E, and A&HCI with at least one author from DLSU or UP for 2003-2012 categorized by Research Area/WoS categories.*

logistic regression, Peduzzi, Concato, Kemper, Holford, and Feinstein (1996) and Long (1997) have the following guideline for a minimum number of cases to be included in the study: Let *p* be the smallest of the proportions of negative or positive cases in the population and *n* the number of covariates (the number of independent variables), then the minimum number of cases to include is:

$$N = 10\ n / p$$

In this case, there are seven covariates to include in the model and the proportion of positive cases in the population is 0.705 (70.5%). The minimum number of cases required is:

$$N = 10 \times 7 / 0.705 = 99.29$$

Thus, for the logistic regression model in this study, a 176 sample size is quite adequate. As for the statistical power, indicated in Table 5 is the Cox and Snell's measure and Nagelkerke's adjusted value, which can be used as effect size measures for the model (Field, 2009, p.287). Using the model chi-square statistic addresses the question of how much better the model predicts the outcome variable can be assessed as it measures the difference between the model and the model when only the constant was included (Field, 2009, p. 285).

For the second set of data used for this study, the names of faculty and research staff members from De La Salle and University of the Philippines were gathered from the universities' respective faculty rosters online. Information on 681 (DLSU: 315, UPD: 366) faculty members

Table 1. *Descriptive Statistics and Simple Linear Regression for Female Ratio and Simple Binary Logistic Regression Results for Has Female*

Area of Research / WoS Category	N	*FemaleRatio*				*HasFemale*			
		10-year average contribution	B (Slope)	T	p-value	10-year average participation	B (Slope)	Wald	p-value
Chemical Engineering	58	20.64%	.016	1.128	0.264	58.62%	0.094	0.551	0.458
Education	34	46.08%	-.025	-0.717	0.478	55.88%	-0.047	0.097	0.755
Literature	15	36.67%	.019	0.225	0.825	60.00%	0.000	0.000	1.000
Mathematics	89	34.91%	-.002	-0.161	0.872	67.42%	0.025	0.101	0.751
Political Science	27	27.78%	.045	1.035	0.311	70.37%	0.308	1.469	0.226
Psychology	38	40.07%	-.014	-0.749	0.459	71.05%	-0.079	0.359	0.549
All	261	33.31%	-.005	0.549	0.583	59.00%	-0.020	0.171	0.679

Note: Regression results in each row are those from the simple linear regression analysis of Female Ratio and the simple binary logistic regression analysis of Has Female on the independent variable, publication year.

and research staff from the corresponding six fields were obtained and then processed in a similar fashion to the bibliometric data obtained from the WoS. However, it must be noted that this demographic data is only suitable for preliminary analysis as only information for school year 2013 was available at the time of this writing and detailed listing of faculty member information such as rank, part-time or full-time employment, and educational attainment is restricted for some departments. As such, we had sent follow-up postal and e-mail correspondences to the colleges and departments to be allowed access to archived personnel information.

At the time of this writing, permission has yet to be obtained from the respective institutions. It is hoped that once the faculty demographic data becomes available it may be used in future studies that can also be extended to longitudinal analysis and afford additional analysis of female academics and research productivity. Future research would also benefit from additional data sources that contain other demographic variables and customized surveys for faculty members that specifically investigate gendered difference. It may further explain the results of this paper's bibliometric analysis and open possibilities for predictive analysis and empirical establishment of causality.

RESULTS

Temporal Pattern in the Number of Publications

During the 10-year period, from 2003 to 2012, a total of 261 journal articles were published by authors from De La Salle University and University of the Philippines. These consisted

of 58 articles in Chemical Engineering, 34 in Education, 15 in Literature, 89 in Mathematics, 27 in Political Science, and 38 in Psychology.

Overall, the number of articles steadily increased from 10 in 2003 to 44 in the 2012, the highest number was in 2011 at 47, with Mathematics (15) and Chemical Engineering (14) having the highest numbers of articles published for that year (Figure 1).

Gendered Distribution

Analyzed by sex of the authors, the sample's female author contribution (*FemaleRatio*) was 33.31% (equivalent to 87 articles) and 66.69% contributed by men (equivalent to 174 articles). However, looking at participation of women from another perspective, 59% (154) of the articles included women as authors or co-authors (*HasFemale*). Among the disciplines, Education and Psychology have the highest female contribution (46.08% and 40.07% respectively), while the lowest contribution at 20.64% was found in Chemical Engineering. Female participation was also highest in Psychology at 71.05% (Table 1).

For *FemaleRatio*, a Kruskal-Wallis test was performed to find differences between the groups (Field, 2009, pp. 542-557) and the results indicate that there was a statistically significant difference among the areas of research ($H(5)=13.259$, $P=0.021$) with a mean rank of 109.54 for chemical engineering, 146.63 for education, 125.57 for literature, 138.59 for mathematics, 107.76 for political science, and 150.64 for psychology. Pearson's chi-square test ($\chi(5) = 16.895$, $p = 0.005$) indicate that there is a statistically significant association between female participation (*HasFemale*) and the area of research. Also, Cramer's V measure of association (Field, 2009, pp. 689, 693) shows that the strength of association between the variables to be moderately strong and significant (.254, P= 0.005). As such, both female contribution and participation were found to significantly differ between research areas.

Temporal Pattern of Gendered Distribution by Research Area

Table 1 shows the slopes obtained from bivariate regression using the year of publication

Table 2. *Z-test Results for Each Area of Research that had at Least 30 Publications: Chemical Engineering, Education, Math, and Psychology, Along with the Overall Sample (n=261)*

Area of Research/ WoS Category	Faculty Female Proportion (SY 2012-2013)	Female Author Contribution in Articles (2003-2012)	z	z Critical two-tail	P(Z<=z) two-tail
Chemical Engineering	40.00%	20.64%	2.847	1.960	0.004
Education	66.97%	46.08%	2.433	1.960	0.015
Mathematics	42.22%	34.91%	1.349	1.960	0.177
Psychology	69.01%	40.07%	3.841	1.960	<0.001
All 6 Areas of Research	55.51%	33.31%	7.639	1.960	<0.001

Table 3. *Descriptives for Authorship Patterns*

Area of Research / WoS Category	Single Authorship			Co-Authorship			
	Female	Male	Total	Single Sex Groups		Mixed Group	Total
				Female	Male		
Chemical Engineering	0	5	5	0	19	34	53
	0.00%	100.00%	100.00%	0.00%	35.85%	64.15%	100.0%
Education	11	11	22	2	4	6	12
	50.00%	50.00%	100.00%	16.67%	33.33%	50.00%	100.0%
Literature	5	8	13	0	1	1	2
	38.46%	61.54%	100.00%	0.00%	50.00%	50.00%	100.0%
Mathematics	6	4	10	3	25	51	79
	60.00%	40.00%	100.00%	3.80%	31.65%	64.55%	100.0%
Political Science	7	18	25	0	1	1	2
	28.00%	72.00%	100.00%	0.00%	50.00%	50.00%	100.0%
Psychology	1	9	10	2	2	24	28
	10.00%	90.00%	100.00%	7.14%	7.14%	85.72%	100.0%
All	30	55	85	7	52	117	176
	35.29%	64.71%	100.0%	3.98%	29.55%	66.47%	100.0%

as a predictor for the sample and for each research area (Tabachnick & Fidell, 2006, pp. 437-449). It must be noted that due to the small sample of articles within some of the subject areas, it is only possible to report tentative findings from individual disciplines (Field, 2009). Though there was about a four-fold increase in the number of papers published in 2012 as compared to 2003, the overall percent contribution of women authors remained essentially the same (B:-0.005, p=0.549). In each of the six disciplines there was very little increase or decrease in female author contribution over the decade.

Similar results have also been obtained for female participation, where binary logistic regression found very little change (B:-0.020, p= 0.679) for the overall sample and each area except for Political Science that had a modest increase in participation over time (B:+0.308, p= 0.226).

Representation of Women in Publications

A demographic review of the faculty rosters from De La Salle University and the University of the Philippines-Diliman provided data for the proportion of men and women in each department/college corresponding to the sample articles' six areas of research. As the contribution (*FemaleRatio*) of women in academic publications had remained almost unchanged over time and tentatively assuming that it would be relatively the same in the succeeding year of 2013, the overall proportion of women in the sample articles may be compared with the most recent population (SY 2012-2013) of female academics in the two universities' relevant faculties. Following Schucan Bird (2011), comparisons were tested for statistical significance using a Z test, chosen as it was appropriate for comparing a sample proportion to

Table 4. *Descriptives for Collaboration by Areas of Research*

Area of Research / WoS Category	N	Collaboration Patterns		
		Intramural	Extramural Domestic	Extramural International
Chemical Engineering	53	29	4	44
		54.72%	7.55%	83.02%
Education	12	5	1	6
		41.67%	8.33%	50.00%
Literature	2	0	0	2
		0.00%	0.00%	100.00%
Mathematics	79	29	12	53
		36.71%	15.19%	67.09%
Political Science	2	1	0	1
		50.00%	0.00%	50.00%
Psychology	28	9	7	22
		32.14%	25.00%	78.57%
All	176	73	24	128
		41.48%	13.64%	72.73%
		No. of articles and		
		% among Co-authored papers for each area		

a population proportion (where the sample size is greater than 30), with a 5% level of significance.

The entire sample's female author contribution (*FemaleRatio*) of 33.31% (equivalent to 87 articles), is compared with the proportion of women in the departments/colleges of the corresponding areas of research which had 55.51% women faculty members overall. The proportion of female-authored articles in the sample is therefore lower than the proportion of women faculty with the result being statistically significant ($z= -7.639$, $p< .001$, two-tailed).

Table 2 shows the results for each area of research, with significant findings in chemical engineering, education, and psychology indicating that the proportion of female authored articles are lower than the proportion of women faculty. It must however be pointed out that this may serve only as a preliminary assessment, until corresponding faculty information is obtained for the years 2003 to 2012 for a comprehensive analysis with female faculty proportion over time.

Patterns of Authorship and Collaboration

Single authorship. Of the 261 sampled articles, 85 (32.57%) were single-authored articles. Among these single-authored articles, 30 (35.29%) were written by women and 55 (64.71%) written by men (see Table 3). For literature, psychology, and political science, majority of single-authored articles were written by men. There was no single-authored article

Table 5. *Binary Logistic Regression Coefficients Estimating Odds of Having Female Collaboration Among Co-authored Articles*

	B	S.E.	Wald	p-value	Exp(*B*)
Number of Authors	.594	.255	5.429	.020	1.811
Number of Institutions	-.385	.383	1.009	.315	.680
Intramural	1.402	.572	6.001	.014	4.065
Extramural Domestic	1.188	.783	2.304	.129	3.281
Extramural International	1.588	.737	4.636	.031	4.893
Publication Year	-.080	.077	1.086	.297	.923
Research Area (Comparison Group: Chemical Engineering)					
Education	1.043	.773	1.820	.177	2.839
Literature	.865	1.503	.332	.565	2.376
Mathematics	1.139	.483	5.560	.018	3.125
Political Science	.966	1.502	.414	.520	2.627
Psychology	2.287	.859	7.082	.008	9.842
Constant	158.082				
Nagelkerke*R*-Squared	0.245				
-2 Log likelihood	180.335				
Chi-Squared	33.316				

by a woman in chemical engineering. It is only in mathematics where women wrote more than men (six articles by women, four articles by men), while there was an equal number (11) of single-authored articles in education for men and women. Single authorship was more frequent in education, literature, and political science (Table 3).

Co-authorship. Of the whole sample (n=261), 67.43% (176) were written by two or more authors. Co-authorship was more frequent in chemical engineering, mathematics, and psychology. Co-authored articles included single-sex (female only or male only) and mixed-sex (male and female) collaborations.

Mixed-sex collaboration was more common than single-sex collaboration: 66.48% (117) of the co-authored articles were written by mixed-sex teams as compared with 33.52% (59) written by single-sex teams. For single-sex collaborations, the vast majority were authored by men: 88.14% (52) articles authored by single-sex teams that were male-only compared with 11.86% (7) female only collaborations.

Table 3 shows that among the sample of co-authored papers (176), seven female-only

collaborations only make up 3.98%, while the 52 male-only collaborations represented 29.55%. Female-only collaborations was very uncommon, with only a handful found in education, mathematics, and psychology, and none in chemical engineering, literature, and political science. The majority of male-only collaborations were found in mathematics (25) and chemical engineering (19).

The majority of co-authored papers written by mixed-sex groups were found mostly in mathematics (51), chemical engineering (34), and psychology (24). The mixed-sex collaborations in these three areas of research represented 41.76% of the total number of all articles sampled (n=261). As for the composition of the mixed-sex teams, the most number of mixed-sex collaborations were made by teams with more men than women writing 57 articles (48.72%). This is followed by 36 (30.77%) collaborations by teams with equal number of men and women, and finally teams with more women than men had 24 collaborations (20.51%). This is reflected in chemical engineering and mathematics, wherein majority of mixed-sex collaborations have more men co-authors, followed by equal proportioned teams. Psychology is the only area of research where teams with more women than men had more collaborations compared to the more-male and equal proportioned teams.

Collaboration Patterns

As Table 4 shows, for co-authored papers (n=176) written in the recent decade, 72.73% (128) had extramural international collaborations and 41.48% (73) had intramural collaborations (two or more authors from the same university, either DLSU or UPD). Only 13.64% (24) had extramural domestic collaborations, and moreover only one article out of the entire sample had collaboration between DLSU and UPD authors.

Intramural and extramural domestic collaborations. The most number of intramural collaborations were found in chemical engineering (29), mathematics (29), and psychology (9). There were only five intramural collaborations in education, one in political science, and none in literature.

Domestic extramural collaborations were also found highest in chemical engineering (4), mathematics (12), and psychology (7). There was only one collaboration in education and none found in both literature and political science. Local institutions that collaborated with UPD in chemical engineering included mostly non-university institutions. In psychology, UPD authors collaborated with Ateneo De Manila University in two publications, while authors from University of Santo Tomas collaborated with both DLSU and UP once. The most number of domestic extramural collaborations for both DLSU and UP were made with Mindanao State University and MSU Iligan Institute of Technology, and are in the area of mathematics. In education, the sole article that had extramural domestic collaboration was between authors from UPD and University of Santo Tomas.

Extramural international collaboration. Almost half of the whole sample (n=261), 49.04% (128) were written by authors from different countries collaborating together. This was most frequent in mathematics (53), chemical engineering (44), and psychology (22). Among the samples, international collaboration was done with authors from other Asian countries such as, Malaysia, Japan, and Singapore. Collaboration with other regions included institutions based in Australia, Germany, Italy, France, UK, USA, and Russia. Most international collaborations in psychology were with universities in Japan and USA. Majority of chemical engineering collaborations were with Malaysian universities, while mathematics had most of its collaborations

distributed between European and Asian institutions.

A binary logistic regression model estimating the odds of having female collaboration for co-authored articles is presented in Table 5. The model explains 24.5% of variation in female participation in co-authored articles (Field, 2009). Herein, significant variables were the *Number of authors*, *Intramural collaboration, and Extramural international collaboration*. However, *Number of institutions* does not contribute to the model, as its negative *B* indicates less participation of women with more institutions involved but not significantly, after controlling for the other predictors. *Extramural domestic collaboration* does not contribute to the model; its *B* indicated a positive association with participation of women and coauthoring with local institutions, but not significantly. The odds ratio also indicates, for instance that, articles that had intramural collaboration were 4.1 times more times likely to have female authors, while those that had external international collaborations were 4.9 times more likely to have female authors.

Research Area contributes to the model showing significant overall contribution as a multi-category variable. Using Chemical Engineering as the comparison group, *Research Area* yielded all positive coefficients, but not all had significant results. Testing for the contribution of each parameter shows that for mathematics and psychology there are more women participating as compared to those in chemical engineering, after controlling for the other predictors. Education, literature, and political science also had positive association with participation of women, but not significantly.

DISCUSSION

This paper has examined publication productivity and gender differences in chemical engineering, education, literature, mathematics, political science, and psychology in the Philippines. An overall increase in publication productivity has been observed in the recent decade, similar to findings made by Vinluan (2011, pp. 281-282). However, as the results had shown, only about one-third of the publications were contributed by women, and that the overall percent contribution of women authors and their participation in publication endeavors had remained essentially the same throughout. In each of the six disciplines there were very little increase or decrease found.

But looking at it in another light, it may also be said that female publication productivity remained steady though the years considering the four-fold increase in the total number of papers published in 2012 as compared to 2003, having at least an absolute increase in the number of publications that women contributed. It is also encouraging that there is at least one female author in more than half of all publications for all of the six areas of study. Preliminary figures also indicated that there is an overall high number of female faculty employed by the two institutions. Nevertheless, with the low author proportion and the relatively high number of female faculty members currently in universities, there is still need for improvement. Overall, whether looking at female single authored, single-sex co-authored, or total contributions of women, these results bear similarities in observations made by Cole and Zuckerman when they referred to the productivity puzzle back in 1984, wherein they found gender difference in various fields amounted to having men published almost twice the number as women. At the same time, these results disagree with findings made by Ynalvez and Shrum (2011) that found no gender difference in publication productivity in the Philippines.

In terms of collaboration patterns in co-authored articles, even when intramural and extramural domestic collaborations are combined, there were still more extramural international

collaborations in comparison. This may perhaps be attributed to the lack of resources in local institutions or expertise in the research staff. As Vinluan (2011, pp. 284-285) similarly observed in education and psychology, there were more international collaborations with partners predominantly from developed countries such as Australia, Canada, Japan, and the United States. Another possibility is the way extramural (local/international) collaborators assess the type of research engagement they have with a particular institution in terms of benefits (Kruss, 2012) and long term continuity of the project.

Moreover, the fact that only one article (0.56% of all co-authored papers in the sample) were collaborated by members of the top two universities in the Philippines may also warrant further investigation into possible competition amongst local faculty members and universities. This particularly becomes more interesting for both De La Salle University and the University of the Philippines, as many of the former's faculty had graduated or taught prior in the latter institution. In a gendered perspective, it was found that intramural or international extramural collaboration had a significant positive association with the participation of women authors.

It must however be considered that analyses conducted in this research does not claim to be all-encompassing in bibliometric analysis, that due to methodological limitations certain aspects can still be further explored and investigated in future studies. For instance, we had attempted to conduct analysis on first author billing. However, due to the different practices of author listing in different fields of engineering and sciences as well as journal publication requirements that are covered in our sample, it was not possible to surmise contribution solely on the author order unless explicitly specified in the article (see also Prozesky, 2006, p.159). Nevertheless, it is still possible to conduct gendered research that explores author order—as various literatures demonstrated by focusing on specific journals, departments, professions, or fields of study (Jagsi et al., 2006; Schrager, Bouwkamp, & Mundt, 2011). This can be an interesting topic to explore for later research and significant results may be obtained by increasing samples for a specific field in engineering or science by incorporating additional bibliometric data from other sources such as EBSCO and SCOPUS.

Comparing relevant studies, the findings of this paper bear similarities in the results obtained for Philippine scholars by Vinluan (2011, pp. 285-288) concerning the higher propensities towards intramural and extramural international collaboration. The positive associations with international collaboration also seem to agree with some of the findings of Ynalvez and Shrum (2011) in their survey on Philippine agricultural scientists, that women may be "assertive and forthcoming as men when it comes to prospects for international collaborations, attaining parity in terms of their propensity to collaborate, closing the gender gap in having international collaborators" (p.214). However, the high number of mixed set collaborations and the majority of single sex collaboration having all male authors did not seem to agree with observations made by Ynalvez and Shrum on homophilous tendencies of Philippine scientists or the preference of women joining single sex collaborations. These contradicting results may perhaps also be attributed to the difference in methodologies and specific contexts (geographic location and institutional resources) of their sample populations and that of this article, thus requiring further considerations for future research in the Philippines.

In terms of discipline, there were a noticeably larger number of articles in the hard sciences such as mathematics and chemical engineering, as compared to the soft sciences such as education, literature, political science, and psychology. This seems to agree with Vinluan's (2011, p. 290) opinion that the Philippine scientific community

being more productive than its social science counterpart, which may be due to research grants not being easily and readily obtained in fields such as education and psychology, as compared to engineering and natural sciences.

The low number of articles listed in the WoS even when taking both women and men's contributions, can also be related to similar findings of other studies that attribute low research productivity partly due to the teaching-focused orientation of higher education institutions of the country and research environment of the country (Nuqui & Cruz, 2012; Quimbo & Sulabo, 2014; Salazar-Clemeña & Almonte-Acosta, 2007) and that publication in SSCI-indexed journals may be considered as peripheral activities in the Philippines rather than core activities (Vinluan, 2011). The acceptance of other forms of evaluation aside from academic publication (DBM, 2007) for recruiting, classifying, and promoting faculty designed to take into consideration the teaching-focused nature of Philippine HEIs, may actually have a discouraging or complacency effect.

Common recommendations for improving research productivity include developing the research culture of the institutions, considering faculty incentives, improving infrastructures, and university capabilities. Specific needs such as research facilities, access to email, and the Internet have also been emphasized (Dumbrique & Alon, 2013; Ynalvez & Shrum, 2011). It was however noticeable that very few papers even discussed gender difference or the contextual factors that can contribute to it, families and personal responsibilities were rarely mentioned as significant determinants in a researcher's productivity in the Philippines. This is perplexing, as myriad studies for the last three decades (such as Cole & Zuckerman, 1984; Duch et al. 2012; Xie & Shauman, 1998) extensively discussed the gendered nature of higher education and the interaction of wider gender roles, family relationships, household characteristics, and personal responsibilities affect women's ability to write and publish research (Fox, 2005; Schucan Bird, 2011).

As such, in addition to the initiatives proposed in previous literature on the Philippines that could increase overall productivity, we also believe that in addressing the gender disparity in scientific publications, a closer examination of the cultural and socio-economic context may be beneficial.

Yamauchi and Tiongco (2012) argued that the progressiveness of Filipino women in education, in terms of receiving more schooling than men, is actually related to the penalty (discrimination) that exists in its labor market. As education is an important determinant of earnings, parental investments in education have a larger impact for their daughters' income and ability to find work in the competitive job market. Parents expect a larger income shared from better-educated adult daughters. As a form of quid pro quo, childcare support from parents is a function of income-sharing that can benefit the working women. Domingo and Asis (1995) asserted that for "domestic work traditionally performed by wives, elderly parents take care of these responsibilities and may encourage co-residence" (p.46). This becomes critical particularly for female scientists who in addition to professional responsibilities, are "also expected in Filipino society to take a prominent role in care-giving and household responsibilities" (Ynalvez & Shrum, 2011, p.214).

Similarities can be drawn in the experiences of Poland, where participation of women in science was encouraged early on, and women enjoyed social and economic privileges uncommon in the West—such as affordable childcare and full employment (Webster, 2001). In the Philippines, such privileges can be available due to the prevalent extended family structure—and at the same time becomes a necessity in order for women to contribute to the income of the household. However, for both countries it becomes apparent that equality of participation and contribution across disciplines may not

necessarily be achieved. Webster (2001) also observed that science produced by Polish women seemed more parochial with levels of output lower than expected when compared with employment levels. Similarly, as Aguilar et al. (2013) observed in their study of research productivity of scientists in East Asia,

> an attribute of Japanese research system is the priority accorded to male scientists and conversely hinders married female scientists who want to do scientific work. Such predicament for these female scientists in Japan is very exacting, given that domestic expectations are added to the demands of the scientific profession. (p.46)

Moreover, equilibrium may be reached by some female academics in balancing their demanding professional and personal/family responsibilities, in such cases—attaining a college degree and participating in other non-publishing activities would be sufficient enough, no longer needing to publish in order to secure their positions or promote themselves to have additional income. Thus paradoxically, two objectives of faculty development (DBM, 2007): increasing research productivity and motivating faculty to upgrade their ranks can become contradicting. The current mechanisms of ranking and rating, and logics of individualization and metricization (Ch.7, pp. 2-26) can seemingly lead to a plateau in academic careers when employed in teaching focused HEIs. A veritable limbo for overtasked female academics who may be relegated to primarily teaching and administrative assignments—with very little time or motivation left for research and publication.

Some may argue that it would still ultimately depend upon the individual female scholar whether or not to go further the academic career path, and to face the inevitability of publication requirements in order to be promoted to the higher professorial ranks. Though this may case for some, it must be considered that although the unequal position of women in science can be based on quality differences between male and female researchers that "may partly be attributed on their free choices"; there are discriminatory arrangements in society at large, such as inequalities in division of domestic work and child care, that women also have to struggle with (Van Arensbergen et al., 2012, p. 860). Though small consolation, it may be encouraging to know that studies in life and material sciences that acknowledge complex relationship between gender, family characteristics, and publication productivity, found evidence that women with caring responsibilities can be more productive than those without, as these were "women who survived the rigorous and demanding process of scrutiny, selection, and evaluation in science"(Fox, 2005, pp.145-146). Prozesky (2008, p. 61) suggested that the productivity puzzle would be best solved by examining carefully how highly productive women succeeded in dealing with the effects of family-related factors on their career publication productivity. Related findings may have crucial implications as well since women may decide to postpone their PhD to take care of small children, which affects their research progress.

Despite the top ranking that the Philippines had consistently received in the Global Gender Gap reports that subsumes education as an indicator, an important aspect of higher education and the production of knowledge remain relatively low for the Philippines. It is somewhat unfortunate that this disparity is unnoticed and unaddressed in the country's own "National Higher Education Research Agenda for 2009-2018", and the :Philippine Development Plan for 2011-2016"—failing one of the President Aquino's 16-point agenda that deals with gender equality: "From a lack of concern for gender disparities and shortfalls, to the promotion of equal gender opportunity in all spheres of public policies and programs" (Official Gazette, 2012). Even more concerning is how in academia itself,

there seems to be very little scholarly attention given to the gendered differences.

The increased emphasis on publication productivity, impact, and income-generation as criteria for the academic evaluation of scholars and institutions presents a dilemma. For countries like the Philippines that have teaching-focused HEIs, income primarily comes from student enrolment and tuition, which would necessitate more teaching loads for the faculty—cutting into time that may be allotted for research and publication. If university policies are not properly adjusted, this may also eventually be the case even for developed countries, should the rush for internationalization, competition, and entrepreneurialization increase eagerness of HEIs to accommodate the rising number of foreign students from emerging economies such as China to the point of detrimentally decreasing available time for research and shift individual faculty motivations in order to conform to institutional priorities.

It is observed that the entrepreneurial university model is being adopted by academics in developing countries wherein engagement in third stream activities are being promoted in HEIs (Kruss, 2008, 2012), though it is yet unknown at the moment if women could exemplify a high level of productivity in commercializing their research outputs. Thus, there is a need in the future to focus on what terms the government and even funding bodies could help boost research capacity among women (Prozesky, 2006, p.106), especially in the Philippines' case.

This paper has shown that the proportion of women contributors had remained unchanged for the most part of the recent decade, and though the findings obtained by this study have documented gender disparity in productivity, accounting for it is still another matter (Fox, 2005). This thus serves as an invitation for future studies to further understand and address the reasons for persistent gender differences in publication productivity in developing nations such as the Philippines and particularly more so for countries regarded as paragons highly ranked in international assessments. This presents an opportunity to examine deeper and more meaningfully "excellence" and "progressiveness" in education, and to continue encouraging countries that aspire to improve the environment for women in general, and particularly for female scholars—to be able to contribute more in the creation and dissemination of scientific knowledge and the betterment of their academic careers.

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