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What are Research Expectations? A Comparative Study of Different Academic Disciplines

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ABSTRACT

This paper is intended to assist professors, administrators, librarians and other members of university level committees that must consider research expectations and research quality in academic fields that they lack. While this is not a problem for field experts, it is a difficulty when people are asked to make decisions in areas of study other than their own. This is commonly the case for senior university professors, librarians and administrators in regards to university wide decisions. The paper investigates this gap, through a study of 27 academic fields in 348 highly regarded universities. We find that there are almost always statistically significant differences in activity between academic fields, regardless of the metric one considers. However, it is possible to understand these differences by comparing the distribution of a known academic field to that of a field that one is not familiar with. Tables and information are provided to assist in the comparison of different fields of study on metrics such as: departmental publications and researcher level metrics of publications, citations, H-index, and total number of co-authors. The information can also be used to support decisions associated with promotion to senior posts such as endowed chairs and professorships. Information regarding specific universities and researchers are included in the data supplement.

1. Introduction

Assessing a field of study is considered difficult. However, understanding the boundaries of a field and the relative quality of different outlets in the field is critical to decisions regarding tenure and promotion. Consequently, many articles have been written in a wide range of fields to help researchers better understand and evaluate their own field (Bontis & Serenko, 2009; Dubois & Reeb, 2000; Fisher, Shanks, & Lamp, 2007; Guidry et al., 2004; Linton & Thongpapanl, 2004; Thongpapanl, 2012). It is even more difficult to evaluate the work of scholars in a different field (Henderson, Ganesh, & Chandy, 1990; D. A. Johnston, personal communication, August 15, 2012; K. Malloy, personal communication, August 14, 2012; G. T. Solomon, personal communication, August 14, 2012; D. W. Walsh, personal communication, August 14, 2012; F.S.Wu, personal communication, August 14, 2012). While citation and publication rate are frequently put forward as proxies of research quality and relevance (Anon, 1962; Clapham, 2005; de Meis, Velloso, Lannes, Carmo, & de Meis, 2003; De Rond & Miller, 2005; De Villiers & Malan, 1997; Good, 1964; Lofthouse, 1974; Mackay, 1974; Mitchell & Reichel, 1999; Nash & Walsh, 2000; Parchomovsky, 2000; Plümper & Radaelli, 2004; Qiu, 2010; Relman, 1977; Rhee, 2004; Smith, 2004; Yimin, 2001), differences between fields are not taken into account (Shin & Cummings, 2010). As this gap still exists, this paper takes a step towards forming a better understanding of the differences that exist in research expectations between fields within a university. This is critical as librarians are often asked to offer insights into the nature and quality of a professor's research portfolio. Although the library science community is aware of the inherent differences in publication, authorship, and citation patterns that exist from faculty-to-faculty and even between departments within the same faculty, this academic field knowledge may not be readily accepted by the researchers and administrators that populate the faculties of an academic or research institution. Consequently, a paper that moves us towards a better understanding of the inherent differences between fields by providing information on how research activity varies between fields is a valuable contribution and useful reference document. Such a contribution assists librarians when they are tasked with either offering insights into the relative quality of a candidate that is being considered by a university or providing guidance on advising what level of research activity is roughly equivalent to the activity in another field. It also offers librarians with some supporting information about the relevant importance of journals to different fields, and this information can help with decision-making regarding acquiring or discontinuing publications. Hence, this paper examines research and researcher activity in different fields for highly regarded universities (Linton, Tierney, & Walsh, 2011).

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There are a variety of reasons for members of a university community to understand differences in research expectations in different fields. Senior administrators, librarians, and professors need to understand the norms of the different academic fields within the universities' portfolio. Previous experience in a single academic department does not prepare academics for this role as they move to tasks that are more interdisciplinary in nature. While this knowledge will develop over time, the learning process can be accelerated through reading about differences in between-field norms, as is offered here and in the supplement.

Comparing between field norms is critical for hiring and promotion committees that involve university community members from a number of different fields. As this is commonplace in universities, it is an activity that needs to be understood as it is not possible to just assume that everyone will be able to identify good research and contributions in a field without understanding the difference in norms that separate an individual's field from that under consideration. Without appropriate baseline quantitative information for between-field calibration, the richness and value of qualitative assessment cannot be fully utilized. Particular attention to what constitutes substantive research activity is of particular value for decisions on promotion to full or chaired professor. Finally, an assessment of the differences in relative levels of activity of different parts of a university community can provide useful information to assist with decisions relating to acquisition of books, journals, and databases for the library science community.

In summary, this paper offers:

(1) A quantitative basis for better understanding differences in research expectations between different fields within and across institutions;
(2) Consideration of the common metrics to describe research activity—number of publications, total number of citations, number of co-authors, and Hirsch index (the number that represents both frequency of publication and citation simultaneously—i.e., an index of 10 states that at least 10 papers are cited 10 or more times (Truex, Cuellar, & Takeda, 2009));
(3) Assistance to members of university committees in better understanding differences in norms—critical for providing baseline information across discipline decisions on tenure, promotion, and selection for honors such as chairs and special status such as distinguished professor;
(4) Provides equivalency in research metrics for consideration of personnel within a field or across fields;
(5) Offers a benchmark of what very prolific researchers' activity is in different fields of highly respected universities and how this varies;
(6) Provides useful insights for assessments on what constitutes a prolific researcher in different fields, which is important for recruiting and retention.

2. Method

In order to compare research output between fields, it is important to have a large group of universities that are active in most or all fields considered. The universities should be from a variety of different geographic locations to reflect possible differences in expectations and the nature of output in different countries. It was determined that these goals could be accomplished by selecting the top universities from an international ranking of universities. There are a number of different ranking systems of both a regional and international nature (Aguillo, Bar-Ilan, Levene, & Ortega, 2010; Aguillo, Granadino, Ortega, & Fernandez, 2008). To avoid over reliance on a single ranking system and the inherent biases of that particular system, we selected the top 250 universities from the two most divergent international ranking systems (Aguillo et al., 2008, 2010). More specifically, this study is based on the QS (QS, 2011) (Quacquarelli Symonds Limited) and WR (WR, 2011) (Webometrics) lists of top universities globally. Through the consideration of the top 250 universities for each of these rankings a list of 348 institutions were obtained. Repetition of data collection may result in slightly different numbers reflecting the separate counting of different parts of the same organization. For example, the University of London is made up of a number of semi-autonomous institutions. At the time of writing of this article, the University of Manchester and University of Manchester Institute of Science and Technology (UMIST) had merged into a single institution, and there are discussions of making a similar merger between the University of Leiden, Delft University and Erasmus University in the Netherlands. The data collection follows the same procedure as in Linton et al. (2011), and hence it is only reviewed briefly here.

For each university, data were collected manually from Scopus (www.scopus.com) in the following manner: (1) affiliation tab was chosen. (2) A search of the desired university is initiated. (3) Once the search is complete, all associated organizations, institutes or departments are checked to gain a complete record of university research activity. The show documents box was selected. (4) One now identifies and collects information on the most active researcher in a given field at a given university. (5) The list of articles for a given field is isolated—to do this one must eliminate the multidisciplinary category for each search. Having conducted this step, the most prolific author is the first name in the author list. The box associated with the first author is selected to gain access to all of the publications associated with that author. (6) On the next screen, the author's name on the most recent publication is located and selected. The name of the author, number of publications, number of citations, number of coauthors, and Hirsch index are all recorded and associated to the appropriate university and field of research in our database. If the selected author is found to be a faculty member at a different university, the next most prolific author is selected. In a few cases, no authors were found at the university under consideration. In these cases, zeroes were entered into the database describing the activity of the most prolific author. The process was conducted until information for all the universities was completed.

Information regarding the most prolific authors in each field at each university was placed into an Excel spreadsheet. This supplement—a set of 27 tables—provides the detailed data used in this study and can be found at (http://www.research.uottawa.ca/docs/researchexpectations.pdf). The data supplement includes numerical ranks for all institutions corresponding to each of the fields specified on Tables 1 to 5 of this paper. The statistical routines provided within Microsoft Excel were used to determine the percentile values associated with the different variables. Percentiles are a useful way to summarize the data as they give a quick simple way of depicting the underlying data. They represent the ordering of universities in a line from lowest to highest value and allow us to list the magnitude of each research related metric for the 1st (lowest value—min), 35th (10th percentile), 87th (25th percentile), 174th (50th percentile—median), 251st (75th percentile), 313th (90th percentile), and 348th (highest value—max). In addition, T-tests were used to compare the values of the same variable to determine if the values from the different fields are samples that come from the same population or if the samples are clearly from different underlying populations—that is the difference is statistically significant. The simplifying assumptions of paired T-tests and a single standard deviation describing both variables are avoided as this might bias the results. Summary statistics and results of the analysis are provided below in the next section.

3. Results and Discussion

3.1. Consideration of Overall Data

The distribution of the total number of publications in each field is summarized in Table 1. From this information, it is possible to see that there is a tremendous variation between fields of study. Furthermore, by examining the supplement (see Section 3.2), one can see there are

Table 1
Total publications for each area of study for 348 top universities: minimum, various percentile levels, and maximum value.

Category	Min	10th	25th	50th	75th	90th	Max
Medicine	2	578	1,762	8,438	16,824	26,447	127,212
Astronomy and Physics	0	1,008	2,495	4,961	8,194	1,348	42,552
Biochemistry, Genetics, and Molecular Biology	0	854	2,185	5,729	9,881	15,039	53,935
Engineering	0	587	1,490	3,708	6,996	12,218	34,750
Chemistry	0	876	1,845	3,069	4,853	8,117	21,812
Materials	0	370	737	1,735	2,997	5,526	17,515
Immunology and Microbiology	0	93	287	949	2,141	3,510	18,363
Earth and Planetary Science	0	85	283	919	2,300	3,564	18,103
Environmental Science	0	319	566	1,048	1,991	3,125	8,127
Agricultural/Biological Sciences	0	97	261	1,239	2,783	5,329	18,452
Mathematics	0	413	735	1,315	2,273	3,667	8,610
Computer Science	0	438	724	1,313	2,350	4,089	11,261
Chemical Engineering	0	168	388	747	1,427	2,525	7,860
Multidisciplinary	0	59	105	256	504	1,116	8,485
Pharmacology, Toxicology, Pharmaceuticals	0	115	325	989	1,920	3,070	15,915
Neuroscience	0	104	298	909	2,152	3,396	25,837
Social Sciences	0	259	495	1061	2,014	3,343	19,732
Psychology	0	78	321	776	1,579	2,675	6,940
Health Professions	0	13	49	202	623	1,226	4,932
Economics, Econometrics, Finance	0	71	171	339	621	1,225	5,889
Decision Sciences	0	95	167	294	505	807	1,926
Business Management	0	90	146	341	571	981	3,330
Nursing	0	12	65	177	426	944	3,364
Veterinary	0	5	23	73	224	1,240	5,106
Arts and Humanities	0	2	9	130	388	800	5,108
Dentistry	0	3	8	44	346	889	3,508
Undefined	0	7	24	104	333	658	2,768

substantial variations in research performance within a university. In some cases this is a result of a university having no activity in an area, as we see from zero or near zero minimum values for the 27 fields listed in Table 1. Maximum values are often non-representative due to an unusual situation such as interdisciplinary researchers having all their publications from a number of different fields counted.

Table 2
Total publications for most prolific author for 348 top universities: minimum, various percentile levels, and maximum value.

Category	Min	10th	25th	50th	75th	90th	Max
Medicine	10	99	183	321	506	702	1,693
Astronomy and Physics	0	138	240	355	476	614	1,930
Biochemistry, Genetics, and Molecular Biology	0	134	197	284	404	644	1,693
Engineering	0	116	170	254	365	495	1,930
Chemistry	0	156	224	349	517	727	1,641
Materials	0	121	189	280	411	597	1,930
Immunology and Microbiology	0	74	129	205	317	468	1,641
Earth and Planetary Science	0	47	77	122	191	286	741
Environmental Science	0	64	110	166	253	357	1,175
Agricultural/Biological Sciences	0	56	91	143	233	353	841
Mathematics	0	53	83	139	228	373	681
Computer Science	0	69	116	196	308	420	1,201
Chemical Engineering	0	87	144	208	324	455	1,245
Multidisciplinary	0	33	63	136	249	372	1,019
Pharmacology, Toxicology, Pharmaceuticals	0	80	138	238	354	525	1,641
Neuroscience	0	72	121	196	309	471	1,019
Social Sciences	0	35	65	131	223	348	701
Psychology	0	44	84	149	241	358	792
Health Professions	0	23	57	113	219	331	1,100
Economics, Econometrics, Finance	0	19	33	58	105	170	681
Decision Sciences	0	25	45	76	148	265	1,020
Business Management	0	14	32	57	113	200	574
Nursing	0	0	45	96	193	339	1,206
Veterinary	0	0	52	124	198	318	1,995
Arts and Humanities	0	1	9	26	74	206	488
Dentistry	0	0	13	82	157	265	1,141
Undefined	0	0	25	73	162	280	1,035

Table 3
Total citations for most prolific author for 348 top universities: minimum, various percentile levels, and maximum value.

Category	Min	10th	25th	50th	75th	90th	Max
Medicine	2	569	1,762	4,114	9,282	18,285	57,461
Astronomy and Physics	0	743	1,625	2,837	4,875	10,127	39,219
Biochemistry, Genetics, and Molecular Biology	0	858	1,894	3,590	7,734	13,185	48,832
Engineering	0	347	685	1,376	2,810	5,900	75,622
Chemistry	0	740	1,639	3,247	7,619	14,380	49,335
Materials	0	588	1,157	2,454	4,634	9,593	75,622
Immunology and Microbiology	0	591	1,261	2,668	5,919	11,069	68,805
Earth and Planetary Science	0	246	595	1,224	2,125	3,978	23,768
Environmental Science	0	387	909	2,052	3,576	5,654	43,621
Agricultural/Biological Sciences	0	278	722	1,332	2,577	4,572	43,621
Mathematics	0	123	299	714	1,707	3,403	14,794
Computer Science	0	165	378	1,131	2,513	4,693	28,740
Chemical Engineering	0	388	847	1,663	3,192	5,702	75,622
Multidisciplinary	0	97	359	1,571	4,284	11,805	47,418
Pharmacology, Toxicology, Pharmaceuticals	0	322	979	2,139	4,212	7,552	49,335
Neuroscience	0	501	1,237	2,623	5,772	8,775	43,932
Social Sciences	0	85	302	1,005	2,927	7,460	47,418
Psychology	0	233	662	1,781	3,575	6,873	39,863
Health Professions	0	52	288	968	2,591	5,037	32,401
Economics, Econometrics, Finance	0	48	135	322	792	2,093	14,794
Decision Sciences	0	74	183	491	1,130	2,075	75,622
Business Management	0	27	140	406	997	2,026	10,348
Nursing	0	0	142	761	2,806	6,440	47,418
Veterinary	0	0	281	1,089	2,459	5,051	23,842
Arts and Humanities	0	0	4	66	483	3,043	24,291
Dentistry	0	0	43	533	1,352	2,635	13,096
Undefined	0	0	74	464	1,511	4,451	37,338

Table 4
H-index for most prolific author for 348 top universities: minimum, various percentile levels, and maximum value.

Category	Min	10th	25th	50th	75th	90th	Max
Medicine	0	10	21	35	47	62	113
Astronomy and Physics	0	14	20	28	36	43	82
Biochemistry, Genetics, and Molecular Biology	0	16	22	33	43	56	110
Engineering	0	9	13	19	27	37	105
Chemistry	0	12	20	29	39	52	150
Materials	0	11	17	26	34	43	105
Immunology and Microbiology	0	12	18	27	41	54	124
Earth and Planetary Science	0	8	13	20	27	37	86
Environmental Science	0	11	17	24	33	41	93
Agricultural/Biological Sciences	0	8	15	20	28	36	93
Mathematics	0	6	9	14	22	29	61
Computer Science	0	7	10	16	27	36	75
Chemical Engineering	0	9	15	22	30	41	105
Multidisciplinary	0	3	11	19	35	53	99
Pharmacology, Toxicology, Pharmaceuticals	0	7	14	22	34	43	112
Neuroscience	0	11	19	28	40	51	100
Social Sciences	0	4	9	17	27	43	99
Psychology	0	7	14	23	32	44	91
Health Professions	0	3	9	15	26	39	77
Economics, Econometrics, Finance	0	3	6	9	14	23	75
Decision Sciences	0	2	7	11	17	23	115
Business Management	0	3	6	11	17	22	64
Nursing	0	0	6	13	25	39	107
Veterinary	0	0	9	17	28	39	87
Arts and Humanities	0	0	1	4	12	28	78
Dentistry	0	0	3	11	19	31	67
Undefined	0	0	0	8	18	32	63

Table 5
Number of coauthors for most prolific author for 348 top universities: minimum, various percentile levels, and maximum value.

Category	Min	10th	25th	50th	75th	90th	Max
Medicine	2	108	150	150	150	150	150
Astronomy and Physics	0	125	150	150	150	150	150
Biochemistry, Genetics, and Molecular Biology	0	150	150	150	150	150	150
Engineering	0	73	127	150	150	150	150
Chemistry	0	12	20	29	39	52	150
Materials	0	111	150	150	150	150	150
Immunology and Microbiology	0	110	150	150	150	150	150
Earth and Planetary Science	0	57	104	150	150	150	150
Environmental Science	0	69	128	150	150	150	150
Agricultural/Biological Sciences	0	53	112	150	150	150	150
Mathematics	0	25	46	89	150	150	150
Computer Science	0	54	98	150	150	150	150
Chemical Engineering	0	79	125	150	150	150	150
Multidisciplinary	0	31	73	150	150	150	150
Pharmacology, Toxicology, Pharmaceuticals	0	80	150	150	150	150	150
Neuroscience	0	80	137	150	150	150	150
Social Sciences	0	16	48	129	150	150	150
Psychology	0	36	85	150	150	150	150
Health Professions	0	22	70	150	150	150	150
Economics, Econometrics, Finance	0	7	17	36	81	150	150
Decision Sciences	0	15	32	59	127	150	150
Business Management	0	8	21	49	109	150	150
Nursing	0	0	6	13	25	39	107
Veterinary	0	0	86	150	150	150	150
Arts and Humanities	0	0	1	13	96	150	150
Dentistry	0	0	17	98	150	150	150
Undefined	0	0	23	92	150	150	150

Consequently, it is suggested for the purpose of comparison that minima and maxima are ignored. To illustrate the extent of the difference, *Medicine* is compared to *Arts and Humanities*. With a 90th percentile value of 800 a high publishing *Arts and Humanities* faculty compares well against a 10th percentile Medicine university (578), but poorly against a university at above the 25th percentile (1,762). The 25th, 50th, and 75th percentiles are 1,762; 8,438; and 16,824 for *Medicine* and 9, 130, and 388 for *Arts and Humanities*. This constitutes a difference of a factor of 42 and 196, for the 75th and 25th percentile respectively. Clearly corrections are needed not only in terms of differences between areas of study, but consideration must be given in relation to actual placement on a distribution as a percentile, since multipliers to correct for research activity vary with movement along the respective distributions. Having considered total publications for an area of study, the performance of the top performer in terms of publications is now considered.

Much of what can be said about patterns and interpretation of the most prolific author in an area of study (Table 2) is similar to what can be said about the area of study (Table 1). There is, however, one additional insight worth mentioning. Universities with a higher activity level (and rank) tend to be the beneficiaries of multiple strong researchers—not a single star research performer. The lower performing universities are often to a large extent reliant on the productivity of a single researcher (or research group). The number of citations associated with the most prolific author (Table 3) is exceedingly low (in some fields at the level of zero up till and possibly beyond the 10th percentile). As the percentile level increases the relative difference between the least cited area of study and most cited area of study declines significantly. For example, at 25 percent the minimum value is 4 (*Arts and Humanities*) and the maximum value is 1,762 (*Medicine*)—a difference of almost 450 times. While at the 90th percentile the minima (2,026—*Business*) and maxima (18,285—*Medicine*) are separated by a factor of about 9 times. The H-index (Table 4), unsurprisingly, offers much greater consistency between different fields of study. If one discounts *Arts and Humanities* and *Undefined*, the range between minima (9) and maxima (35) at the 50 percent level is four. This declines to a factor of two as one reaches the top ranked author (maxima—124 and minima—61). Finally, the coauthors are considered in Table 5. Little can be said as the *Scopus* imposed maximum of 150 coauthors results in fields such as *Biochemistry* having over 90 percent of the 348 universities with a most prolific author with at least 150 coauthors. Only in the case of *Nursing* is the limit of 150 never reached. Having considered the nature of the data presented in the five tables, statements of a more general nature are offered.

A casual examination of the five tables clearly shows tremendous differences between fields in terms of the distribution of publishing volume for both departments and most prolific author metrics—publications, citations, H-index, and number of different co-authors. In fact, if a T-test is used to consider whether the different fields of study are different, we find that only 11 of the 1,755 possible combinations appear to be from the same population (5 percent likelihood). The number of occurrences at the 5 percent level is only 0.6 percent (11/1,755). Hence, direct comparability between fields of study is a rare occurrence. More specifically, the following distributions were found to be directly comparable:

(1) Publication volume (Table 1): *Immunology* and *Social Sciences*, *Chemical Engineering* and *Psychology*.
(2) Publications of most prolific author (Table 2): *Decision Science* and *Undefined*.
(3) Citations of most prolific author (Table 3): *Engineering* and *Social Sciences*, *Computer Science* and *Health Professions*, *Chemical Engineering* and *Psychology*.
(4) H-index of most prolific author (Table 4): *Computer Science* and *Veterinary*.
(5) Number of coauthors for most prolific author (Table 5): *Engineering* and *Neurosciences*, *Multidisciplinary* and *Veterinary*, *Management* and *Undefined*, *Management* and *Dentistry*.

This lack of direct comparability is a critical finding as it suggests that it is inappropriate and incorrect to base one's knowledge on the norms of one area of research on the quality of a candidate or department in another area of research. However, Tables 1–5 are very helpful in that they allow for determination of equivalencies between percentiles in one field with an equivalent level in another field. In other words, if a researcher's performance is at the 50th percentile level in their field of study one can equate this to a different field of study and in this way obtain a better understanding of whether the researcher's performance is superior or inferior to what it may seem otherwise. For example, in *Arts and Humanities* an H-index score of 4 (50th percentile) is equivalent to an H-index of 35 (50th percentile) in the field of *Medicine*.

While such information is not a replacement for expertise in a specific academic field, people making decisions at a university level can use this information to better relate between a field where they have academic field expertise and the field under consideration for which they lack academic field knowledge. The information in Tables 1–5 alerts one to the tremendous differences between academic fields and offers some insights into these differences. Such information does of course have its limitations. For example, in specialty areas such as *Dentistry* and *Veterinary Science*, there are zero values and very low values at the lower percentile rankings. This absence of activity typically indicates an absence of the specialty from the university under consideration. In fact, absence of an activity accounts for values of zero not only for the minimum in many tables, but also at the 10th percentile level in some cases. As there are tremendous differences in the specialization of universities around the world, it is unsurprising that the minimum value of most fields of study is zero—an absence of any specialist activity in these areas. Having considered the reason for extreme values (an absence) at the low end of the rankings, surprisingly high values at the high end of the spectrum are considered. Authors who are very prolific often have interdisciplinary activity. This activity opens up the possibility of greater access to funding, increased research quality through practice, and a superior network of co-authors. As there are significant differences in publishing norms from one field to another, multidisciplinary activity increases the likelihood of domination of two or more fields. If one is very prolific in a field that has higher publication or citation rates, it is likely that one's activity will be the most prolific in other fields that one's work also touches on. For example, if one considers total publications (Table 2) for the most prolific author, the maximum value is held by the same multidisciplinary researcher/author in the following cases: *Medicine* and *Biochemistry*, *Astronomy* and *Engineering* and *Materials*, and *Chemistry* and *Immunology* and *Pharmaceuticals*. While in the example of total citations for the most prolific author (Table 3), the maximum value of total citations is received by the same multidisciplinary researcher in the following cases: *Engineering* and *Materials*, *Chemistry* and *Pharmacology*, *Environmental Science* and *Agriculture*, *Nursing* and *Social Science* and *Multidisciplinary*. Hence, we can see that the presence of interdisciplinary researchers at the top of the rankings and the absence of a field of study from a number of universities has a significant influence at the bottom of the rankings. Consequently, to really understand the difference from one field to another, it is best to avoid the tails of the ranking (maximum, minimum and perhaps even 10th and 90th percentiles) and focus more on the values between the inter-quartiles (25th to 75th percentile). This also contributes to the very low direct comparability between differences in fields of study.

It is important to note that there are many important aspects of research that are not captured in this study. In fields such as *Arts and Humanities*, the roles of books are critical but overlooked here. In an effort to capture a wide range of journals, data from *Scopus* were utilized. While *Scopus* is more inclusive than the *ISI Web of Science*, it has limitations. This study in part reflects and reports the limitations associated not only with the sources selected by *Scopus* but also with the quality of the database. The most notable example of this is that *Scopus* will not show more than 150 coauthors. Hence, in Table 5, there is an abnormally large number of 150s reported, as 150 refers to all numbers with a magnitude of 150 or greater. Other items that are considered important in some fields and are subject to great variation between fields, but not considered here include the following: total number of pages published, citation intensity (citations/year), number of pages, and impact factor of journals and similar metrics being adjusted to reflect the number of authors or order of authors on each paper. Furthermore, presence of work in open access outlets, repositories, reports, and working papers are also overlooked by this approach. The implications of absence of additional sources of information from this study differ depending on the field under consideration. While it is not clear whether or not this in itself warrants further study in the future, it is clear that the insights from the use of this paper should be supplemented through consultation with academic field experts in the case of many decisions.

Having noted general limitations associated with the method of data collection, issues that are specific to *Scopus* are now briefly described. In addition to concerns regarding the possibility of transcription errors with such a large volume of data to be processed, information changes over time. While steps were taken during data collection and auditing to limit the effect of these concerns, the data are also included as a supplement, so it can be checked and appropriate corrections can be noted by interested parties. Throughout the data collection process a number of other factors were noted as possibly giving incomplete or misleading information: change in database formatting during the data collection process, incorrect spelling of author name in the database resulting in one person having two or more identities, or error in affiliation resulting in a university being credited/not credited for a researcher.

It has already been noted that inclusivity is a characteristic that made *Scopus* more attractive than *ISI Web of Science* for this study. While *Scopus* includes more journals than the *ISI Web of Science*, *Scopus* limits itself to 27 research categories. For finer grained consideration of differences between fields, the ability to consider a larger range of categories is attractive. However, the 27 categories offered in this study provide a substantial and suitable base. An alternative choice of database for this type of study is to utilize *Google Scholar* with or without Harzing's *Publish or Perish* engine (Dazey & Parks, 2010; Harzing & van derWal, 2008; Jacsó, 2009). While this engine is popular due to its inclusivity of sources, the authors have found that the engine has issues of consistency. While it should consistently provide higher citation results than either *Web of Science* or *Scopus*, the authors have found this is not always the case. In future studies, however, the use of this database may assist in overcoming the gaps that *Web of Science* and *Scopus* have in relation to books, book chapters, or influential non-academic publications. Having considered the results, their interpretation, and the strengths and weaknesses of the method utilized, the data supplement is now considered.

3.2. Consideration of Supplementary Data

The data utilized to produce the five summary tables is available at http://www.research.uottawa.ca/docs/researchexpectations.pdf. While full disclosure is a sufficient reason to provide this information, there are more practical uses for it. Prior to consideration of the uses of such data, it is worth offering some background information. The data for all 348 universities is provided in alphabetical order for all 27 academic fields. A sample of the data supplement is offered in Table 6. In addition to the metrics offered regarding publication number (department and most prolific researcher), citations, H-index, and number of coauthors; the name of the most prolific author is included. Such information is of great assistance when trying to make decisions regarding highly senior university-wide research positions such as institute or distinguished professors as one is able to compare the output metrics of a professor with the most prolific research professors at the top universities around the world in the same field. This can also offer guidance for awards that hold honor at a national level such a Tier I CRC chair or a Humboldt Fellowship. These values offer critical guidance and prevent hurdles from being set ridiculously high or undeservedly low through arguments that a certain field typically has very low publication and citation thresholds. If there is interest for a university to broaden its capabilities, such information is helpful in assisting in identifying what high performing faculty may look like in a field where the institution lacks local expertise. Of course there is more to excellence than the magnitude of numbers such as volume, citation and H-index, but access to such values from a neutral source such as the supplement is helpful.

Having discussed and considered the implications of the publishing data in both a summarized form (Tables 1–5) and its raw format (Table 6 and supplement), conclusions are now considered.

4. Conclusions

This study of 348 universities found that in almost all cases there are statistically significant differences in what constitutes research activity when comparing 27 separate fields of study. Consequently, one must be very careful when utilizing knowledge from one academic field to make decisions regarding research activity and quality in another academic field. Librarians can offer guidance to administrators and university committees on the estimated equivalent levels of publications, citations, and H-indices using information provided by this study. While consulting with academic field experts is still advised, information comparing two separate areas provides a more complete picture to personnel at their university. This information can be used either in the absence of an academic field expert or to ensure that an academic field expert is not overly generous or stingy in how they assess high performance in their stated field of academic field expertise. By comparing quartiles or median on dimensions such as departmental publications, author papers, author citations, author H-index, or co-authors; one can at least partially calibrate the quality of researchers and departments in different areas of study. Such information assists in consideration of the most appropriate acquisitions,

Table 6
Sample of supplement data listing medical publications data for 31 universities by alphabetical order—both number and rank are provided.

Medical publications data	Department publications	Rang	Most prolific author	Published	Rank	Cited	Rank	H-index	Rank	# of coauthors
Aalto University	761	305	R. Hari	301	193	7,650	108	48	73	150
Aarhus University	19,494	70	H.T. Sorensen	537	76	8,413	96	40	128	150
Arizona State University	3,774	223	J. He	132	293	501	316	12	304	150
Ateneo de Manila University	13	347	U.M. Carajal	29	345	20	345	0	347	5
Auburn University	1,917	257	C.J. Diskin	1,578	2	304	327	8	324	64
Australian National University	5,952	199	A.F. Jorm	377	143	9,729	84	47	80	150
Boston College	1,026	290	J.J. Paris	78	323	227	330	6	330	60
Boston University	26,336	36	R.B. D' Gostino	645	50	47,024	3	91	3	150
Brandeis University	1,509	272	J.C. Hall	195	253	3,134	202	44	101	150
Brigham Young University	1,739	262	E.D. Bigler	224	237	2,421	233	26	225	150
Brown University	12,873	124	V. Mor	314	180	7,278	113	46	89	150
California Institute of Technology (Caltech)	2,196	248	E.H. Davidson	314	180	5,324	141	47	80	150
Cardiff University	18,205	80	M.J. Owen	732	29	25,019	20	17	17	150
Carnegie Mellon University	1,530	270	S. Cohen	162	273	10,566	75	36	160	150
Case Western Reserve University	20,639	65	G. Perry	507	87	964	298	65	24	150
Chalmers University of Technology	639	311	S. Nillson	110	305	1,611	268	27	216	150
Charles University	12,250	127	M. Michal	365	147	1,887	249	25	238	150
Chinese University of Hong Kong	7,296	183	T.B. Ng	409	124	2,912	209	38	143	150
Chulalongkorn University	4,569	213	V. Wimanitkit	645	50	733	303	9	319	120
City University of Hong Kong	578	313	P.K.N. Yu	87	317	459	319	15	288	51
City University of New York	7,683	178	T. Raphan	135	291	1,224	288	21	259	105
Colorado State University	4,136	215	I.M. Orme	255	219	5,468	135	42	116	150
Columbia University	44,637	9	H.C. Neu	514	84	4,740	160	4	334	150
Cornell University	30,207	25	R.B. Devereoux	722	32	700	304	68	20	150
Curtin University of Technology	2,125	249	A.H. Lee	205	250	1,003	296	17	283	15
Dalhousie University	9,394	162	K. Rockwood	299	196	5,230	143	44	101	150
Dartmouth College	10,196	152	J.A. Baron	321	173	12,099	61	52	61	150
Delft University of Technology	1,229	280	J. Dankelman	82	319	350	324	10	313	120
Drexel University	10,488	147	D. Kaye	79	322	1,739	262	25	238	150
Duke University	42,208	11	R.M. Califf	1,084	8	57,461	1	100	2	150
Durham University	1,523	271	A. Unsworth	149	279	847	301	15	288	109

cancelations, and formats. The relative dependence on journals helps determine and justify the balance of journals between different fields and also between journals and books. In other words fields that place a strong emphasis on journal articles warrant extensive access to serials, if the university wishes to maintain or grow research activities in this field. In fields that consider journal articles to be of a lower importance, the focus should be more on book acquisition and less on journals.

It is important to note that universities' reputations are developed in different ways. Consequently, highly ranked universities may lack certain specialties and have differing levels of research performance in the specialties that they do have. There is substantial room for further consideration of this topic; this paper is intended as a starting point for a dialog about how research activity differs across different areas of study.

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