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Gender, web presence and scientific productivity in nanoscience and nanotechnology

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Abstract Digital and scientific realms are commonly believed to be gendered. The wide pervasiveness of e-science may result in an interaction between the scientific and digital gender divides, increasing the disparities against women. Selecting web-presence as a manifestation of web activity, and applying a quasi-experimental scientometric method, the present study aims to investigate the effects of the interaction, if any, on web-present females and males compared to web-absent ones in Nanoscience and Nanotechnology. The results show that the web-present Nanoscientists are not necessarily superior in their scientific production, though they are higher in their recognition. The web-present females and males are equal in their numbers and productions. Although the female web-present are found to be equal in their recognition to their male counterparts, there is a significant difference between the web-present and web-absent males in this regard, signifying the higher impact of the web on males' recognition.

Keywords Nanoscience · Nanotechnology · Gender · Scientific productivity · Impact · Web presence

Introduction

Gender is among the important factors affecting scientists' scholarly productivity, as well as their approach to computing technologies and networks. Women are found to be not only inadequately active in the scientific realm, but also generally disinclined to use Internet, web and email in some societies (see e.g. Al-kahtani et al. 2007; Bimber and

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Barbara 2000; Duncan 2005), though they are found to enthusiastically adopt the social networks (Boland Abraham et al., 2010). The extents of the gender divide in digital and scientific worlds vary according to countries' levels of social and economic development, however, it is a global phenomenon involving all countries whether developed (Martines et al. 2007; Breimer and Leksell 2011; Trauth, et al. 2003; Ahuja 2002) or developing (Törenli 2006; Wangmo et al. 2004).

On the other hand, there is an association between technology adoption and scholarly performance level, so the more scientifically active the scholars are, the more inclined they are towards computer mediated communication (Cohen 1993; Walsh et al. 2000) and Computer Networks (Hesse et al. 1993), including the Internet (Barjak 2006a, b). Besides, we are witnessing a prevalent shift from science to e-science as reflected in for example, the publication and dissemination of digitally-born journals, as well as already-established journals via web, the wide acceptance of social scientific networks, and the development of web-based research evaluation metrics. Consequently, the gender divides in science and in the digital realm may interact, producing complex and invisible disparities against women. It is, therefore, necessary to study whether the position of women in science is changing with the new technologies (Kretschmer and Aguillo 2005).

In a recent research aimed to identify gender differences in scientific production in Nanoscience and Nanotechnology, Sotudeh and Khoshian (2013) revealed that although the field is mainly male-dominated, female Nanoscientists keep pace with men in their scientific productivity and recognition, signifying their capabilities and strengths in scientific competition and implying gender egalitarianism in the field. This gives rise to the question of whether web activity has any particular role in this regard. Consequently, it is helpful to investigate their web presence as one aspect of the web activities, in order to explore their web presence patterns and how it changes their effectiveness in science.

Female Nanoscientists presumably use computing technologies as part of their disciplinary work and hence would not conform to the gender divide in computing ability. However, one will doubt the expectation when recalling the under-representation of females in the field. Furthermore, they are expected to experience a higher citation impact than their web-absent peers, given the impact of the web on scholars' visibility and thereby their recognition (Barjak and Thelwall 2008; Barjak et al. 2007; Eysenbach 2006; Mc-Veigh 2004; Xia et al. 2011), and specifically the equal citation performance of male and female Nanoscientists (Sotudeh and Khoshian 2013). Nevertheless, female web-presents are not expected to outperform their male counterparts, given the general gender bias in science as regards females' lower scientific productivity and recognition levels, their scarcity in math and technology-intensive disciplines, the pipe-line effect hindering them from promoting to high academic degrees and ranks, and social factors such as anti-feminine biases in selection processes for employment or promotion and unequal distribution of research grants and incomes (Sotudeh and Khoshian 2013). In order to clarify the situation, the present communication endeavors to investigate the impact of web presence on male and female Nanoscientists by studying their scientific publications indexed in Web of Science during 2005–2007.

Literature review

The gender divide in Science, in brief

The gender impact on scholars' professional lives has been brought into focus by a substantive body of studies. Documenting the phenomenon, Sotudeh and Khoshian (2013) recently highlighted the existing trends. In brief, the literature reviewed showed that Women's contribution to science is affected by family engagements and maternity (Fox 2005; Abramoet al. 2008a; Martines et al. 2007; Ginther and Kahn 2006; Kyvik and Teigen 1996), and aggravated by anti-feminine social biases, e.g. in payment levels (Ginther 2003), promotion (Zinovyeva and Bagues 2010); and finding suitable jobs (Bornmann and Endres 2006). Their insufficient participation in scientific production was also revealed (Abramo et al. 2008a, b; Larivière et al. 2011; Prpic 2002; Mozaffarian and Jamali 2008).

Sexual inequality persists all over the world even in the highly developed, democratic countries like the USA (Martines et al. 2007), Denmark (Andersen 2001), Norway (Kyvik and Teigen 1996), and Sweden (Breimer and Leksell 2011). Fortunately, more recent research results imply early indications of a more gender-balanced scientific world (see e.g. Abramo et al. 2009; Breimer et al. 2010; Van Arensbergen et al. 2011; Mendlowicz et al. 2011; Kretschmer et al. 2012; Vela et al. 2012; Ceci and Williams 2011; Mutz et al. 2012). The improvement is also reflected in their recent progress compared with men regarding their recognition (Bordons et al. 2003; Borrego et al. 2008; Kretschmer et al. 2012; Mauleon and Bordons 2006), though this is not always the case (Aksnes et al. 2011; Breimer and Leksell 2011; Pudovkin et al. 2012).

The females' contribution is also characterized by a kind of technology reluctance notably remarkable in their low involvement in engineering (see e.g. Hobbs et al. n.d.; Boschini 2000; Glover 2002; Kulis et al. 2002; McMullen et al. 2010), technology (Mauleon and Bordons 2010), and math-intensive fields (Ceci and Williams 2010a, b).

The gender digital divide

The digital world has been experiencing an under-representation of women as internet users (Brayton 1999; Nachimas et al. 2000; Bimber and Barbara 2000), employees in digital industries (Crump et al. 2007; Clayton 2007, cited in Clayton 2012; Evans 2012), and students (James et al. 2006; Francis 2007; Mahatanankoon et al. 2012; Clayton et al. 2012). They also differ from males in their attitudes, usage pat-terns and purposes in social web (Huang et al. 2013; Zhang et al. 2013), social networks (Thelwall 2008; Mazman and Usluel 2011), internet (Muscanell and Guadagno 2012; Li and Kirkup 2007), web sites evaluation (Simon 2001) and web advertisements (Sun et al. 2010).

Women's reluctance towards or divergence in Internet, email or web usage is also reflected in their fewer experiences and lower skills (Potosky 2007; Al-kahtani et al. 2007), time spent (Akman and Mishra 2010; Madell and Muncer 2004; Schumacher and Morahan-Martin 2001), self-confidence about their computer skills (Li and Kirkup 2007; De Young and Spence 2004), interests (Brayton 1999; Al-Kahtani et al. 2007), and higher anxiety (De Young and Spence 2004; Madell and Muncer 2004; Bunz 2009; Huang et al. 2013). The gender digital divide is observed whether in developing nations (Törenli 2006; Wangmo et al. 2004) or developed countries (Trauth et al. 2003; Panteli et al. 1999; Ahuja 2002), although its extent varies according to the level of social and economic development of countries.

The gender digital divide is sometimes attributed to women's lower access to computers and networks (Bimber and Barbara 2000). However, they are believed to scarcely or differently approach the Internet, even when they are equal in their access (Li and Kirkup 2007), or in their number (Brayton 1999; Madell and Muncer 2004). Although the underlying causes of this feminine disinclination are not exactly known, it is evident that their performance in science and engineering is not intrinsically fragile (Sonnert and Fox 2012; Ceci and Williams 2011), but could be caused by some distinctive social, economical or cultural drivers, for instance, a lack of mentoring opportunities for women, a competitive work atmosphere where men are more aggressive in presenting themselves, difficulties in balancing work and family responsibilities, perceiving digital careers as solitary and isolating, as well as women's different computing skills, adaptive behaviors, attitudes and traits (Webb and Young 2005). These factors, which have a lot in common with those affecting women in science, inhibit or perhaps encourage career decisions among genders (Mahatanankoon et al. 2012), and produce complex and hidden inequalities (APC-WNSP 2002).

The gender divide is found to be removed or fading in some societies, whether in computers and networks usage in general (Husing and Selhofer 2002; Levy 2002; Jackson et al. 2008), or the Internet (Zhang 2005; Smith et al. 2008; Akman and Mishra 2010; Lin and Yu 2008), social networking, and e-commerce (Boland Abraham et al. 2010); web skills (Ryan 2003) and web-based learning (Astleitner and Steinberg 2005) specifically. However, the overall evidence provided by the literature seems to imply that the situation is still far from ideal and some consistent technology reluctance trends still exist among women, namely a more negative attitude, higher anxiety, lower usage and tendency, less inclination towards digital majors and careers. Consequently, the research results confirm the persistence of the 'masculine' demonstration of the digital sphere.

Research significance

Computers, Internet and web-based technologies are believed to have the potential to revolutionize women's lives by mobilizing and empowering them, either socially or economically (Arun and Arun 2002; Prasad and Sreedevi 2007; Wamala 2012; Huyer and Siloska 2003). Besides, they are revealed to leverage scholars' scientific achievements in that it is found to be correlated to scientific productivity (Barjak 2006b), academic levels and positions (Biradar et al. 2006; Parameshwar and Patil 2009), collaboration networks, particularly with R & D institutions (Barjak 2006a), and international collaborations (Soorymoorthy and Shrum 2007). Hence, the female reluctance towards the technologies may doubly retard them in their endeavors towards a socially, economically or scientifically impartial and fair world. Therefore, given the relationship between web presence and researchers empowerment, gender studies on the web could not only shed light on genders' achievements in exploiting web advantages as a result of their awareness, skills and willingness, but also explore its impact on their scientific performances.

Research aims

The present study mainly aims to investigate and compare female and male Nanoscientists' approaches to the web and its impact on their mean citations, using the web-absent and web-present gender groups as the control and experimental groups, respectively.

To this aim, it is first necessary to investigate whether the control and experimental groups differ significantly in their scientific production and mean citation, in general, regardless of their genders:

1. The web-present Nanoscientists publish significantly more scientific papers compared to the web-absent ones.
2. The web-present Nanoscientists are significantly more cited compared to the web-absent ones.

An attempt was then made to compare the control and experimental gender groups by testing the following hypotheses inspired by the literature:

3. The Female Nanoscientists are significantly under-represented in the web-present group, however, over-represented in the web-absent one.
4. The Female Nanoscientists are statistically as productive as their male counterparts in the web-present group, while less productive in the web-absent group.
5. The Female Nanoscientists are statistically as recognized as their male counterparts in the web-present group, but less recognized in the web-absent group.

Research methodology

The research method

The present study applies a scientometric method with a quasi-experimental approach to compare web-present and web-absent women and men as regards their frequencies, scientific production and mean citation in the field of Nanoscience and Nanotechnology during 2005–2007.

The identification of Nanoscientists

The Nanoscientists identified in Sotudeh and Khoshian's study (2013) are used as the research population. In brief, they were identified using a list of 18 Nanoscience and Nanotechnology journals covered by the Journal Citation Report (JCR). The data were downloaded in September 2011 in a tab-delimited format. In order to remove casual contributors, the population studied was limited to 1,151 first authors consistently contributing to the field, i.e. having at least one paper in each year.

Searching Google, we attempted to determine the authors' genders, as well as their web presence in terms of having personal web sites or organizational web pages. As there may be several scientists having similar names, their names were combined with the titles of their papers in the search strategy, in order to obtain more precise search results. We also tried to control variations in names before and during the search. To get the most relevant search results, some other information like affiliations, co-authors, journal titles, e-mail addresses, etc. were used. The searches were carried out using the Latin transcription of the names as recorded in WoS. The gender information was extracted from photographs, masculine/feminine pronouns or other texts conveying sexuality. Finally, a short survey was carried out via questionnaire, in case of doubt or lack of information, asking for their genders and personal web site addresses.

It is noteworthy that 83 of the researchers remained unidentified with regard to their genders or web presence and did not enter the analyses. The total number of researchers thus amounted to 1,068, consisting of 148 women and 920 men (Table 2).

Data analysis tools and methods

Excel was used for parsing and preparing the downloaded data. The data were then analyzed by SPSS using descriptive statistics (including frequency, percentage and mean) and inferential statistics. As the Kolmogorov–Smirnov Tests rejected the normality of distributions for the evidence and experimental groups in general as well as in the gender ones, Non-parametric analyses including Kruskal–Wallis and Mann–Whitney *U* Tests were carried out to compare the groups.

Bibliometric data downloaded from online databases suffer from lack of citation time window control for papers published in different years. The solution is to manually check every single cited reference, which is time-consuming and labor-intensive for a large sample. Consequently, the present study selected a narrow publication time window to reduce the differences in citation time windows. Moreover, to further control any possible effects of time window on the results, the data were analyzed as a whole, as well as year by year. To be concise, the year by year analyses were not reported, unless they led to different results.

Research findings

Descriptive findings

Web presence situation of males and females in Nanoscience and Nanotechnology is illustrated in Table 1. According to the table, more than half of the researchers (59 percent), accounting for 8 percent for females and 51 percent for males are present in the web. However, this cannot be interpreted as an under-representation of the former, as the web-present females approximately equal men in terms of their web-presence percentage in their gender group (62 vs. 64 percent respectively).

A rough verification of the scientific productivity shows that the highest proportion of the papers is published by the web-present group, either in general (2916 contributions accounting for 59 percent of the total papers), or in each of the two gender groups (65.71 for females and 63 for males). However, the male web-absents are the most prolific group in terms of mean paper published (paper per researcher). According to the mean impact, the web present males and females are the most recognized groups (4.69 and 3.76 citation per paper, respectively).

The comparison of web-present and web-absent Nanoscientists' papers and impacts

The web-absent and web-present groups were compared in terms of their scientific productivity using a Mann–Whitney Test. According to the results, the web-absent researchers

Table 1 The web presence, productivity and recognition of the Nanoscientists

Web presence	Gender	Researchers			Papers				Mean impact
		No.	Percent		No.	Percent		Mean	
			In total	In the gender		In total	In the gender		
Present	Female	92	8	62	389	8	66	4.23	3.76
	Male	592	51	64	2,527	51	63	4.27	4.69
	Total	684	59	–	2,916	59	–	4.26	4.56
Absent	Female	56	5	38	203	4	34	3.63	2.59
	Male	328	28	36	1,502	30	37	4.58	3.01
	Total	384	33	–	1,705	35	–	4.24	2.95
NA		83	7	7	321	6	–	3.87	2.078
Total		1,151	100	100	4,942	100	–	4.33	3.98

(with Mean Rank = 540.66) are not significantly different from the web-present ones (with Mean Rank = 531.04) in terms of their production ($Z = -0.527$, Sig. = 0.598). However, the web-present group (with Mean Rank = 570.14) is seen to be higher in their citations, compared to the web-absent ones (with Mean Rank = 471.01) ($Z = -5.04$, Sig. = 0.000).

This is true for year-by year analyses of the impacts, with the exception of 2008, where the difference between the web-present scientists (with mean rank 262.09) is found to be insignificantly higher than that of their web-absent peers (with mean rank 243.22) ($Z = -1.35$, Sig. = 0.18). The shorter citation time window of the year may provide an explanation, so that the web present scientists increase their distance from the web-absents by the passing of time.

The comparison of female and male Nanoscientists' frequencies in the web

The results of the Chi Square tests conducted to compare the two genders' frequencies in the control and experimental groups reveal that there are no significant differences between males and females either in the control group ($\chi^2 = 168$; df = 1; Sig. = 0.682), or in the experimental one ($\chi^2 = 0.096$; df = 1; Sig. = 0.756). This signifies the two genders' equality in their approaches to the web, while significantly different in their numbers in the whole community ($\chi^2 = 558.037$; df = 1; Sig. = 0.00).

The comparison of female and male Nanoscientists' production and impact

The results of the Kruskal–Wallis tests revealed that the male and female web-present and web-absent Nanoscientists exhibit no significant difference in their scientific production ($\chi^2 = 3.665$; df = 3; Sig. = 0.3), although they are shown to be significantly different in their impacts ($\chi^2 = 27.569$; df = 3; Sig. = 0.00).

In order to discover the group(s) causing the significant difference, Mann–Whitney Tests were carried out as Post-Hoc test. According to the result, the difference is neither between the female and male web-absents (Z = −0.299, Sig. = 0.765) as the control groups, nor between the female and male web-presents ($Z = -1.505$, Sig. = 0.132) as the experimental one.

Further analyses showed that the female web-present and web-absent groups are not significantly different in this regard ($Z = -0.93$, Sig. = 0.353). However, male Nanoscientists in the web-absent and web-present groups experience significantly different impacts ($Z = -4.999$, Sig. = 0.00), favoring the latter (mean rank 401.68 vs. 493.09). This is confirmed via year-by-year analyses, except for the year 2008, where the difference between males in the web absent group (mean rank = 211) and the web-present group (mean rank = 223.54) is not significant ($Z = -0.97$, Sig. = 0.332).

The performance of the Nanoscientists with different academic characteristics

As previously mentioned, the gender-related literature confirms the effect of academic characteristics (e.g. positions, ranks and degrees), as well as personal characteristics (e.g. age and marital condition) on scientists' scientific production and impacts. As a result, the citation might equally be attributed to women and men's differences in their academic or personal characteristics. Given the population's large size, a sample of 290 (accounting for 42 percent) of the web-present Nanoscientists were selected to check any possible effects of the factors. The sample consisted of 42 females (14 percent) and 248 males (86 percent)

Table 2 The distribution of the academic characteristics of the web-present sample

	Female		Male	
	Frequency	Percent	Frequency	Percent
Degree				
MS	1	2	2	1
PhD	38	90	232	94
PostDoc	3	7	14	6
Sum	42	100	248	100
Position				
Faculty	30	71	203	82
Researcher	12	29	45	18
Sum	42	100	248	100
Rank				
Lecturer	2	5	11	4
Assistant Prof.	2	5	17	7
Associate Prof.	8	19	27	11
Professor	12	29	120	48
NA	18	43	73	29
Sum	42	100	248	100

similar to the gender distribution in the whole Nanocommunity, showing no significant differences in the genders' frequencies ($\chi^2 = 0.094$; df = 1; Sig. = 0.76).

Unfortunately, the websites were not informative enough to investigate the personal characteristics. The academic characteristics of the sample are summarized in Table 2. The frequencies of the two genders were compared using χ^2 test. The verification of the data showed that there are no significant differences between the two genders in terms of their degrees, including MS ($\chi^2 = 0.95$; df = 1; Sig. = 0.33), PhD ($\chi^2 = 0.010$; df = 1; Sig. = 0.92), and PostDoc ($\chi^2 = 0.20$; df = 1; Sig. = 0.65). The frequency of females and males was also found to be statistically equal in their academic positions, whether as faculty members ($\chi^2 = 0.094$; df = 1; Sig. = 0.76) or researchers ($\chi^2 = 0.094$; df = 1; Sig. = 0.76). The male and female faculty members also exhibited no differences in their numbers in different ranks, i.e. as lecturer ($\chi^2 = 0.025$; df = 1; Sig. = 0.87), assistant professor ($\chi^2 = 0.18$; df = 1; Sig. = 0.67), associate professor ($\chi^2 = 2.37$; df = 1; Sig. = 0.12), or professor ($\chi^2 = 2.5$; df = 1; Sig. = 0.11).

The genders were further compared in terms of their scientific production and impacts in different academic degrees, ranks and positions. The results showed that the Nanoscientists ranked as "professors" are the sole group showing significant differences in genders' impacts ($Z = -1.99$, Sig. = 0.047) favoring men (mean rank 71.36 vs. 49.80), though statistically similar in their papers ($Z = -1.89$, Sig. = 0.06). Consequently, the web brings about a citation advantage to men having earned a rank of "professor".

The performance of the Nanoscientists in different institutions

The authors' affiliations could be another factor affecting the scientific performances of scientists. To verify the possibility, affiliations were extracted from C1 and RP fields

Table 3 Universities and institutions' scientific performances in the control and experimental groups

Web Presence	Gender	No. of Univ./ Inst.	Paper		Impact	
			Mean	Mean rank	Mean	Mean rank
Absent	Female	54	1	152	2	163
	Male	271	2	165	8	163
Present	Female	80	2	201	9	226
	Male	386	2	240	10	235

devoted to authors' addresses. After controlling the name variations, 652 educational and research institutions were identified and categorized into the four control and experimental groups. The results are summarized in Table 3. The results of the Mann–Whitney U tests revealed that there are no differences between females and males across universities and institutions in the control group, in terms of their productions ($Z = -1.19$, Sig. $= 0.23$) or impacts ($Z = -0.021$, Sig. $= 0.98$). Nevertheless, in the experimental groups, the web-present males were found to have published significantly more papers than their female peers (mean rank 240.30 vs. 200.68) across universities and institutions ($Z = -2.7$, Sig. $= 0.007$); although this could not bring them a citation advantage as they are revealed to be statistically equal in their citations received ($Z = -0.55$, Sig. $= 0.59$). Consequently, the citation advantage of the web-present males and females cannot be attributed to the visibility or development level of the universities or institutions they are affiliated with.

The performance of the Nanoscientists in different scientific blocks

Nations with different scientific development levels show considerably different scientific performances, so they could be categorized into four scientific development classes, including scientifically developed, proficient, developing, and lagging countries, based on the classification proposed by the RAND group (Wagner 2001). This could also affect the citation performance of the studied scientists.

Verification of the contributing authors revealed that they come from 66 countries with different scientific levels, with the USA gaining the lion's share (942 accounting for 20 percent of the total contributions). The countries mostly belong to the scientifically developed block (20 comprising 30 percent of the contributing countries). The scientifically proficient nations occupy the second rank in terms of their frequency in Nanoscience and Nanotechnology (27 percent). The scientifically developing and lagging nations constitute the less frequent groups (20 percent each).

Table 4 summarizes the countries scientific performances in Nanoscience and Nanotechnology. As seen, the researchers' numbers and papers decline as the scientific development levels decrease, so that the authors from the scientifically developed block in all four groups gain the highest values, and those from the lagging block the least. In all the country groups, the female Nanoscientists are shown to be less frequent and less productive compared to their male peers from the same scientific development level, to the extent that no female authors come from the lagging countries, whether in the web-present or the web-absent group. According to the mean impact values, women appear to be relatively less recognized in the developed and proficient groups, unlike the developing category, in which they seemingly outperform their male counterparts in this regard.

Table 4 Countries' scientific performances in Nano S&T

	Web presence	Gender	Scientific development blocks								NA[e]		Total	
			Developed[a]		Proficient[b]		Developing[c]		Lagging[d]					
			NO	Percent	NO	Percent	NO	Percent	NO	Percent	NO	Percent	NO	Percent
Researchers	Absent	Female	39	70	14	25	2	4	0	0	1	2	56	100
		Male	207	63	74	23	30	9	14	4	3	1	328	100
	Present	Female	60	65	24	26	8	9	0	0	0	0	92	100
		Male	407	69	130	22	29	5	26	4	0	0	592	100
	Sum		713		242		69		40		4		1,068	
Papers	Absent	Female	139	68	53	26	8	4	0	0	3	1	203	100
		Male	906	60	357	24	133	9	92	6	14	1	1,502	100
	Present	Female	258	66	96	25	35	9	0	0	0	0	389	100
		Male	1,771	70	517	20	139	6	100	4	0	0	2,527	100
	Sum		3,074		1,023		315		192		17		4,621	
Mean Impact	Absent	Female	2.67		1.66		2.13		–					
		Male	3.26		2.61		1.05		1.58					
	Present	Female	2.73		2.42		3.44		–					
		Male	3.84		3.50		2.03		1.45					

[a] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Japan, Netherlands, Norway, Russia, Sweden, Switzerland, Taiwan, UK, USA

[b] Brazil, China, Croatia, Czech Republic, Estonia, Greece, Hungary, India, Lithuania, New Zealand, Poland, Portugal, Romania, Singapore, Slovakia, Slovenia, Spain, Ukraine

[c] Argentina, Armenia, Chile, Colombia, Costa Rica, Egypt, Iran, Kuwait, Macedonia, Mexico, Pakistan, Turkey, Venezuela

[d] Algeria, Georgia, Iraq, Jordan, Kazakhstan, Malaysia, Morocco, Nigeria, Oman, South Korea, Thailand, Tunisia, UAE

[e] Bahrain , Serbia

Table 5 The χ^2 tests results for the comparison of genders frequencies in the country groups

Country groups	Control group		Experimental group		The whole community	
	χ^2	Sig.	χ^2	Sig.	χ^2	Sig.
Developed	0.79	0.38	0.43	0.51	371.99	0.000
Proficient	0.003	0.96	0.002	0.97	34.8	0.000
Developing	1.76	0.19	1.51	0.22	113.87	0.000

Table 6 *T* tests results for the comparison of Control and experimental groups' productions and impacts in the scientific blocks

	Country block	Gender	Web-absent			Web-present			The whole community		
			Mean	T	Sig.	Mean	T	Sig.	Mean	T	Sig.
Paper	Developed	Female	6.95	−2.68	0.008	12.90	−2.39	0.03	19.85	−2.61	0.02
		Male	45.30			88.55			133.85		
	Proficient	Female	2.94	−1.88	0.077	5.33	−1.64	0.12	8.28	−1.82	0.86
		Male	19.83			28.72			48.56		
	Developing	Female	0.62	−2.75	0.017	2.69	−1.74	0.10	3.31	−2.28	0.04
		Male	10.23			10.69			20.92		
Impact	Developed	Female	2.67	−0.77	0.45	2.73	−1.61	0.12	2.81	−1.26	0.22
		Male	3.26			3.84			3.57		
	Proficient	Female	1.66	−0.79	0.44	2.42	−0.73	0.48	2.16	−0.89	0.04
		Male	2.61			3.50			3.08		
	Developing	Female	2.13	−0.77	0.58	3.44	0.88	0.40	2.57	1.19	0.25
		Male	1.05			2.03			1.56		

The results of the Chi Square tests conducted to compare gender frequencies in the control and experimental groups reveal that none of the country groups experience significant differences between the male and female numbers, either in the control groups or in the experimental ones, in spite of the significant differences in their frequencies observed in the whole communities (Table 5).

The control and experimental groups were also compared in terms of their scientific production and recognition, in each of the scientific blocks (Table 6). According to the results, the female Nanoscientists from the developed block produce significantly fewer scientific papers compared to the males of the same block, whether in the control group, the experimental group or the whole developed community. This is true for the developing block, too; however, the developing web-present females reduced their productivity distance from their male counterparts so that the difference appears to be insignificant. As a result, the most and the least prolific blocks in Nanoscience and Nanotechnology seem to experience gender disparities in the scientific production. This signifies that the scientific development level and sexuality may interact, negatively affecting the females.

However, the genders are shown to be equally recognized in all the blocks, whether in the whole community or in the control or experimental groups. The sole exception is the proficient group, exhibiting gender difference in mean citation in favor of men in the whole community, though experiencing gender equality in its control and experimental groups.

Table 7 ANOVA results for the comparison of the scientific blocks' impacts

Web presence	Scientific block	Gender						The whole community		
		Male			Female					
		Mean	*F*	Sig.	Mean	*F*	Sig.	Mean	*F*	Sig.
Web-absent	Developed	2.73	2.83	0.07	2.67	0.80	0.47	3.02	3.08	0.05
	Proficient	2.42			1.66			2.30		
	Developing	3.44			2.13			1.24		
Web-present	Developed	3.84	1.19	0.32	3.26	0.30	0.75	3.37	0.38	0.68
	Proficient	3.50			2.61			3.01		
	Developing	2.03			1.05			2.63		

The findings imply that the scientific development level does not play an important role in genders recognition, although it does affect their productivity levels.

The results give rise to another question: does the scientific development level interact with web presence, affecting their impacts? To answer this question, the scientific blocks' impacts were compared in the genders and web presents groups. The results of the ANOVA tests summarized in Table 7 show that the scientific blocks in the web-absent group significantly differ in terms of their mean citations. According to Tukey Post Hoc test, it is the developed block which significantly outperforms the developing one (mean difference = 1.77, Sig = 0.047). However, the proficient group does not significantly differ from the two other groups. The web-present groups experience increases in their citation means. Nevertheless, there are no significant differences between the blocks in this regard. The finding signifies that the web has a rather equal influence on countries at different scientific levels, as a whole.

Furthermore, the three scientific blocks show no impact differences, whether in the web-absent or the web-present gender groups. This may imply that no matter how scientifically developed a country is, the web has a rather equal influence on authors of the same sex. Overall, the finding signifies that the web brings on a rather equal advantage for countries at different scientific levels, as a whole or as gender groups.

The performance of the Nanoscientists in different disciplines

The citation equality of men and women seems to be caused by their different contributions in disciplines with diverse citation and publication behavior. To investigate any effects caused by the disciplines, the citation and production performances of the scientists in different subjects of the related journals were studied. As Nanoscience and Nanotechnology is a multi-disciplinary field, the journals are categorized into 18 subject categories in the SCI.[1] The subject categories were classified into 6 broader subject fields derived

[1] Biophysics; Biotechnology & Applied Microbiology; Chemistry, Analytical; Chemistry, Inorganic & Nuclear; Chemistry, Multidisciplinary; Chemistry, Physical; Electrochemistry; Engineering, Electrical & Electronic; Instruments & Instrumentation; Materials Science, Multidisciplinary; Mechanics; Medicine, Research & Experimental; Metallurgy & Metallurgical Engineering; Optics; Physics, Applied; Physics, Atomic, Molecular & Chemical; Physics, Condensed Matter; Physics, Fluids & Plasmas.

from ESI. They include Chemistry; Clinical Medicine (2 papers); Engineering; Materials Science; Microbiology; Molecular Biology & Genetics; and Physics.[2]

Given the non-normality of the impact and paper distributions in the disciplines, the Kruskall Wallis tests were used to compare the females and males' productions and impacts in the control and experimental groups in each subject.

The results show that the male and female web-absent and web-presents are not significantly different in terms of their papers in Chemistry ($\chi^2 = 2.03$, df = 3, Sig. = 0.57), Engineering ($\chi^2 = 6.68$, df = 3, Sig. = 0.83), Microbiology ($\chi^2 = 0.934$, df = 3, Sig. = 0.817), Molecular Biology & Genetics ($\chi^2 = 1.1$, df = 3, Sig. = 0.78), or in Physics ($\chi^2 = 5.4$, df = 3, Sig. = 0.15). Materials Science is the sole field experiencing a significant difference ($\chi^2 = 10.97$, df = 3, Sig. = 0.012).

Furthermore, the results of the Kruskal–Wallis tests revealed that the four groups do not significantly differ in their impacts in Chemistry ($\chi^2 = 3.63$, df = 3, Sig. = 0.31), Engineering ($\chi^2 = 4.4$, df = 3, Sig. = 0.22), Microbiology ($\chi^2 = 1.94$, df = 3, Sig. = 0.59), and Molecular Biology & Genetics ($\chi^2 = 1.94$, df = 3, Sig. = 0.59). However, Materials Science ($\chi^2 = 26.46$, df = 3, Sig. = 0.000) and Physics ($\chi^2 = 8.67$, df = 3, Sig. = 0.034) experience significant differences in the groups' impacts.

Mann–Whitney *U* carried out as Post Hoc tests, revealed that none of the control or experimental groups in the studied disciplines experienced significant differences in their papers or impacts. Based on the findings, one may notice that the specialty of the Nanoscientists, as far as it is defined based on the related journals subject classes, is not associated with their impacts.

Discussion

The Web-present Nanoscientists publish significantly more scientific papers compared to the Web-absent ones

The Mann–Whitney Test result for the comparison of scientific production of Web-present and Web-absent Nanoscientists revealed no significant difference between the two groups. Therefore, the null hypothesis of equality of the two genders' productions is confirmed. This is not in accordance with previous studies emphasizing the superiority of internet-inclined scholars and researchers in their scientific productivity (Biradar et al. 2006; Parameshwar and Patil 2009; Barjak 2006a, b; Soorymoorthy and Shrum 2007; Mahajan 2006; Bansode and Pujar 2008; Kantkhari et al. 2007). The general shortage of the scientific publications of the researchers in Nanoscience and Nanotechnology compared to other disciplines (Sotudeh &and Khoshian 2013) may play a role in the resemblance.

Besides, one would wonder if the obligatory nature of web presence is at the root of the phenomenon, as an increasing number of universities and institutions prescribe their research and academic staff to introduce their resumes via universities' official web sites. This, too, might possibly overshadow the distinction expected between the two groups' productivities. However, the studied groups should be homogeneous in other dimensions for their unintentional presence to be validated. Nevertheless, as will be shown later in this communication, there is a significant difference between the four groups in terms of their productivity levels, challenging the justification (see the next section on the hypothesis 4).

[2] Clinical Medicine with just 2 papers is the least frequent subject and excluded from the analyses.

The web-present Nanoscientists are significantly more cited compared to the Web-absent ones

The result of the Mann–Whitney Test discovered a significant difference between the two groups in terms of their mean impacts (citation per paper), favoring the web-present one. Given the equality of the web-present and absent groups in the number of scientific publications, they are shown to achieve citation superiority for equal amounts of publications.

One may wonder whether the web presence leads to a higher level of influence, or if the impact superiority is due to a wider approach of highly prestigious Nanoscientists to the web. According to the previous literature, the web improves scholars' visibility and thereby their recognition. This is especially proven for open access publications (e.g. Antelman 2004; Eysenbach 2006; Mc-Veigh 2004; Xia et al. 2011). However, it is noteworthy that the web presence cannot per se bestow prestige on the researchers; but the wider readership brought about by the web helps realize the citation potentials of their papers, otherwise less known to their target audience. In other words, a less prestigious work cannot considerably enhance its recognition even though it may be available on the web.

The female Nanoscientists are significantly under-represented in the web-present group, while over-represented in the web-absent one

Given the general technology reluctance of women, it is expected that they would be under-represented in the web. However, the χ^2 test for comparison of males and females frequencies in the web shows that they are equal in their numbers, both in the control group and in the experimental one. Thus, the hypothesis of inferiority of female Nanoscientists in their web presence is rejected.

The equal presence of female and male Nanoscientists in the web is not in line with some previous studies emphasizing technology-disinclined behavior of women (Akman and Mishra 2010; Schumacher and Morahan-Martin 2001; Madell and Muncer 2004; De Young and Spence 2004), though it is in accordance with some other investigations rejecting the effect of sexuality in users' approach to internet and web (Zhang 2005; Smith et al. 2008; Jackson et al. 2008; Levy 2002; Husing and Selhofer 2002).

The web presence of the studied researchers could mainly be achieved via organizational web sites having a rather obligatory nature. This might give one pause in inferring from the result the female Nanoscientists' intentional inclination towards the web. However, as mentioned before, the significant difference between the four groups in terms of their productivity levels rejects the casualty of the grouping and hence the role of the mandatory policy prescribed by their organizations; as, if so, all the four groups would have been homogeneous in their paper amounts (see the discussion on the hypothesis 4).

The female Nanoscientists are statistically as productive as their male counterparts in the Web-present group, while less productive in the Web-absent group

The result of the Kruskal–Wallis test proved that the studied groups do not significantly differ in their mean scientific productions. As a result, the scientific production does not seem to be a differentiating factor among scientists neither in the experimental nor the control gender groups. Consequently, although the female web-absents apparently have the lowest scientific publication level (Table 1), the difference is not revealed to be determining. Therefore, the result confirms the hypothesis postulating similar productivity levels for female and male web-presents.

The non-significant inferiority of female web-absents to their male counterparts in their scientific production reveals that their approach to the web is not significantly affected by the interaction of sexuality and scientific performance, inferred from the previous literature confirming women's technology-disinclined behaviors and attitudes (Akman and Mishra 2010; Schumacher and Morahan-Martin 2001; Madell and Muncer 2004), their generally lower productivity level (Abramo et al. 2008a, b; Larivière et al., 2011; Prpic 2002; Mozaffarian and Jamali 2008), as well as the higher tendency of scientifically prolific scholars towards the web (Barjak 2006b).

The female Nanoscientists are statistically as recognized as their male counterparts in the Web-present group, while less recognized in the web-absent group

The result of the Kruskal–Wallis test discloses a significant difference between the four groups studied in terms of their mean citations. However, as the Mann–Whitney Tests reveal, the difference is just caused by the web-present and web-absent males, favoring the former. Accordingly, although the experimental group is found to be significantly more recognized than the control (see the section on the hypothesis 2), the difference exists neither between the two control gender groups, nor between the female groups in the control and experimental ones. Further analyses carried out to control the effects of different factors revealed that the citation equality is not caused by countries' scientific development levels, disciplines or universities. Furthermore, web-present women were found to exhibit a citation performance similar to their counterparts with the same academic degrees and positions. However, males ranked as "professor" were found to be more recognized, compared to their female peers.

As a result, the first part of the hypothesis assuming mean citation equality of men and women on the web is confirmed. This is in accordance with Kretschmer and Aguillo (2005) demonstrating gender equality among COLLNET authors in their web visibility, i.e. the frequencies of websites mentioning bibliographic publications.

As the web-present males were the highest recognized group, especially those ranked as professors, the web is found to considerably increase the males' impacts. Given their insignificant difference with their female peers in terms of the citations received, the web seems to improve citation to the females, too, though not sufficiently enough to make them outperform the web-absent groups. The higher impact of the web-present male scholars cannot be attributed to their abundance, as their gender group is found to be equal in production and impact, in spite of their higher frequency compared to their female counterparts in the whole community studied (Sotudeh and Khoshian 2013).

The finding gives rise to another question of whether the web can aggravate the "Matthew phenomenon" in the form of "gender discrimination"?: Males, who have a greater chance to be cited, get even more citations than they deserve and females, who are relatively less likely to be recognized, are even less cited. However, as Morgan et al. (2004) argue, taking just one perspective in studying the gender dimensions of digital divide obscures the multilayered and versatile nature of gendered experience. Consequently, in order to have a comprehensive image of women's performance on the web, further studies are required to definitely judge the web effect on the "gender inequality". It is, therefore, suggested to study other aspects of web-presence including genders' contribution to Open Access and its impact on their recognition, web-visibility as counted based on the web citations or URL citations, web impact on genders' collaboration networks, gender interlinking on the web, the genders performances in scientific social networks and social bookmarking services.

Concluding remarks

To summarize:

1. The scientific productivity of the web-absent and present Nanoscientists being similar in general is not found to be associated with the web presence.
2. The web-present Nanoscientists are better recognized compared to their web-absent peers. The finding reinforces the constructive impact of the web on the visibility and thereby recognition levels of scholars.
3. The web-present female and male Nanoscientists are more frequent in their numbers compared to their web-absent peers in the respective sexual group. The two genders are, therefore, found to be similarly inclined to the web.
4. The web-present female Nanoscholars are also found to be equal to males in terms of their scientific productivity. Thus, they are not seen to be negatively affected by the interaction of scientific productivity and web-tendency.
5. However, they are not significantly higher in their citations, unlike their male counterparts. So, the web is found to be considerably more effective in improving males' recognition levels than the females', in spite of their equal tendencies towards the web.

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