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The scientific contribution of Arab Scientists to the International research:

A Study of the Indicators for some Arab Countries

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Abstract:

Using SCOPUS database, the research productivity of Arab researchers in five countries has been investigated. The analysis included subject, geographical and time range indicators. The correlation between the most published journals and their quality was investigated. The results revealed the leadership of Egypt among the other countries studied and revealed a great gap between scientific contributions of Arab and developed countries.

Keywords:

Scientific productivity, Bibliometrics , SCOPUS Database

Introduction

Research productivity and its association with bibliometrics as well as scientometrics analysis is considered to be one of the important research fields of information science. This importance can be attributed to many factors such as the assistance of identifying countries positions on the world-wide scientific map. In addition such analysis helps in describing the most effective national research fields for each country and identifying fields that are in need for improvements. Also, this analysis helps in describing the scientific correlations among nations by identifying the co- scientific contributions either in one subject field or in multidisciplinary fields. In general, we can find a consensus among researchers in this field regarding the importance of identifying the scientific contributions of the Third World Countries (TWC) to the international scientific literature.

In general, there is a great gap or what can be describes as inequality in the international scientific productivity. This has been confirmed by the Robert May report in 1997 in which he mentioned the control of the U.S.A. over the third international scientific productivity and the majority of the productivity came from many rich countries (May, 1997as cited in Cole, Phelan, 1999).

In this context, many of social scientists proposed theories that can help in explaining the associated and the influential factors on the national research productivity. Cole and Phelan (1999) presented many theories such as the cultural theory of Merton that attributed the research productivity to the enhancements of scientific activities inside the society and the increments of those work in the scientific domain. Consequently, we should ask what factors might support or disallow the research productivity of scientists in general and for those affiliated with the Third World Countries in particular?. To answer such question, one can classify these factors into three main categories: Personal factors that are directly related to the researcher; factors that are related to the scientific institutions; and factors that are related to the society surrounding the researcher. The motivation considered to be one of the most important psychological factors that can affect the research productivity.

In the Arab world, this factor is related to the scientific promotion that might affect the research productivity in a negative way. In many cases we can find a negative correlation between research productivity and ranking as a professor. On the other hand, the availability and accessibility of electronic information resources forms an important factor that enhances the national research productivity. Although many studies have revealed the positive impact of the digital environment on the

research productivity, there are many threats that are related to scholarly communication- between researchers in TWC and those in developed countries- in this environment. Examples of these threats include the drawback in developing national research agenda for the TWC as the focus of their researchers will be directed to the hot topics in the developed countries. Also, such environment might increase the language obstacles for end users in TWC. On the contrary, the digital environment can positively help researchers in TWC who can contribute in modifying the scientific research priorities in different fields as a result of the selection of their researcher topics.

As mentioned before, there is a great dominance of the U.S.A. researchers on the international scientific literature in many subject fields. This might happen as a result of some factors that affect publishing of researches that have been done by non-American researchers in the international scientific journals. The domination of the English language as the main publication language in the high quality journals is the main reason. Another factor is related to the editorial boards of many journals that prefer to publish the American style papers - in different parts such as theory and research methods- which might not be the case for the research output in TWC including the Arab world (Horta &Veloso, 2007).

Moreover, there are some qualitative as well as quantitative indicators of the decline of the output of Arab research institutions. For example ,there is a shortage of manpower in the field of research and development (R&D) in the Arab world in general except in a few countries such as Jordan and Tunisia. The average number of employees range from 300 to 400 for each million which is considered very low percentage especially if we compare it with the similar manpower in the developed countries.

Objectives of the Study

The main goal of the current study is to identify the actual contributions of the Arab researchers to the international information resources. Based on that, the study tries to describe the contributions of Arab researchers from 1998 to 2007, and to define the major scientific productive fields in the Arab countries.

Research Questions

1. .What are the indicators of research productivity in the Arab world from 1998 to 2007?
2. What are the major productive scientific fields in the Arab world and how similar or different are they from the publication fields of the most productive scientists?
3. What is the correlation between the journals in which Arab scientists publish and their quality?

In the light of these questions, we hypothesized that:

1. There are differences between the most productive fields for each country and the subject fields of publication by the most productive scientists.
2. Arab scientists tend to publish in low-impact factor journals.

Methodology

The current study used the bolometric method by colleting, describing, and analyzing the contributions of the Arab scientists to the international information resources. There are many reasons for this selection: SCOPUS is considered to be the largest international citations & abstracts database as it includes more than 15,000 journals. Also, the geographical diversity is one of the main features of the database as more than 50% of its contents are published in Europe, Latin America, and Asia. Finally, there is a relative balance in the subject coverage of the contents. According to the recent coverage distribution of SCOPUS, titles in the field of physical sciences constitute 32% of the contents, followed by health sciences with 31%, then the life sciences with 20%, and finally the social sciences with 17 % of the total coverage. On the other hand, the results of a new study revealed the advantage of the subject coverage of SCOPUS in the social sciences when compare with the coverage of Cambridge Scientific Abstract(CAS) and the Social Sciences Citation Index which forms a major part of the web of science(Norris& Oppenheim, 2007).

Out of 22 associated courtiers with the Arab league, the following five countries were selected: Egypt, Saudi Arabia, Morocco, Kuwait, Jordan). This selection was based on the results of some scientometrics studies of Arab countries in which these countries were ranked in the top five list for the number of published papers from 1990 to 1995, and for its contribution among the Islamic countries to the international scientific research (Nour, 2005, & Anwar, 1997).

Using the affiliation field in SCOPUS, the country name was entered as a search term for the time period from 1998 to 2007. Only Research articles that have been published in journals were included in the study. Other formats such as letters, editorials, and conference papers were excluded. In addition, published papers that were written in Arabic were excluded. Many steps were taken to identify the quality of the journals in which Arab scientists are most likely to publish their papers. This included the cancelation of non journal titles, cancelation of journal titles that are published in Arab countries. The number of these titles reaches 35. Although it is a small number, it affects the final results for each country as many of Arab scientists use it for publications. For example, the search for published works from 1998 to 2002 revealed 676 works that have been published in three Egyptian journals out the total of 10555 works, which constitutes 6.36% of the retrieved records. The science watch reports (indicators of science) were used to define the most productive countries world-wide. The journal citation report 2006 version was used to identify the impact factors of the most published journals.

Related Work

The related studies can be divided into two main groups. The first category includes the national scientometric studies that are concerned with describing and analyzing scientometric indicators based on the science citation index. In this context king (2204) analyzed the research productivity of the first 30 countries based on some variables such as published works, citations, and their Grass National Product (GDP). The results revealed starts of decrease in the U.S.A out put and increase in the European Union countries. Horta & Veloso (2007) compared the productivity and the quality of U.S.A and the European Union countries from 1986 to 2002. The researchers identify increase in the productivity of the European countries in the 1990s' as a result of their domination over many scientific fields. Along with the economic improvement, China became one of the top five countries in productivity in general and in nanotechnology in particular (Zhou, P.,& Leydesdorff, 2006.).

Other studies have focused on Arab and Islamic countries. For example, Bader (1999), analyzed the scientific productivity of Saudi Arabia that appears in King Abdul-Aziz city databases and the data that was driven from ISI regarding Egypt and Saudi Arabia. The study revealed the leadership of Egypt among Arab and Islamic countries. It indicated the sever decline of the scientific productivity of Islamic countries as it only contributed 2% to the international output. Similar results were ment in another study by Anwar (1997) in which both countries were ranked in the

top 50 worldwide list. In addition, Osareh & Wilson (1997) analyzed the reference citations of researchers in the TWC in seven scientific fields. The study ranked Egypt and Saudi Arabia in the top 12 countries.

In a recent study, Nour (2005) studied the major scientometric indicators in the Arab world based on geographical categorization of the countries to two groups. The Mediterranean Sea countries were more advanced than the Gulf countries in terms of the number of employees and scientific productivity.

The second category of studies focused on research productivity in specific scientific fields by using various data collection methods such as ISI databases or analyzing set of printed and electronic journals. For example, Falagas, Karavasious & Bliziotis, (2006) studied the productivity in tropical medicine. The study results revealed the leadership of the European countries followed by the African countries which enhanced the productivity of TWC. Another study by Gu (2002) analyzed the research productivity of Malaysian researchers in computer and information science from 1990 to 1999 based on the data driven from three web databases. The results showed an increase the in the number of major research fields as a consequence of many factors such as the number of researchers and the financial support for research projects in these fields. Ismail (2002) analyzed the contributions of Arab researchers in the field of library and information science based on the data driven from LISA, ISA, and Eric databases. The study revealed the dominance of the English language for the published papers.

Results, analysis, and discussion

Research productivity by subject fields from 1998 to 2007.

Scopus database divides scientific fields into four main groups. It is worth noting that we can not identify a clear cut differentiation among the published works under some of these categories as one paper might be classified in two categories. This section presents the data analysis based on subject, geography, and time series. As shown in Figure 1, Egypt has the leadership in the productivity in the all fields except the health sciences in which Saudi Arabia ranked number 1.

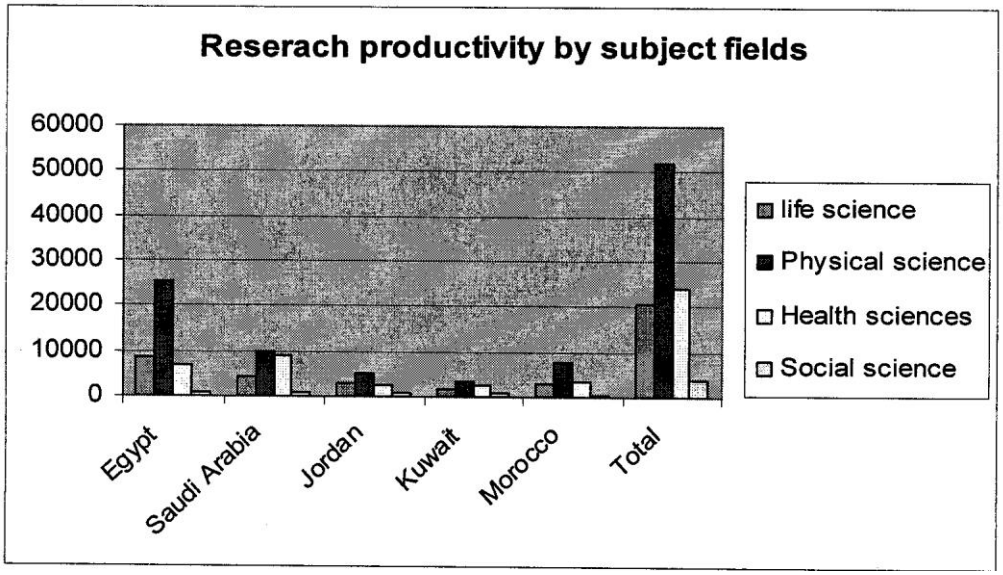

Fig1: Research productivity By subject fields (1998-2007)

A great gap between Egypt and the other countries was obvious in the case of the physical sciences. The Egyptian works reached 2,5475 works which constitutes 50 percent of the total published papers in this field. This result explains why the physical sciences field ranked as the core field of publications for these countries followed by the health sciences, life sciences, and finally the social sciences. One of the main reasons for having this result might be related to the nature of the included subjects under this category. The physical field encompasses major subjects that can have positive financial impact on these countries such as mineral sciences and environmental sciences. The total number of the published works in the life sciences reached 20,489 works, and 60% of it came from Egypt and Saudi Arabia.

On the other hand, Saudi Arabia ranked at the top of the health sciences productivity list. The affiliated works with Saudi Arabia reached 8,793 works which means more than 30% of the total published papers in this important field. However, as we will show later this was not the case in terms of increasing the number of works over a ten year period. Finally, the social sciences field was the lowest one as the total number of works only reached 3,953 works. This result might be explained by different assumptions. Main explanation can be attributed to the challenges that social scientists might face when they try to publish in other languages. Another reason might be related to the national ignorance at these countries to financially support research project in this field. This lack of support could be attributed to the problem of cost effectiveness of such studies from a national point of view. In other words the national systems might not highly appreciate the expected output as well as the outcome of these studies. Moreover, these results may reflect the inferior statues of

the social studies in the studied countries.

To better explain the research productivities of these countries, a time analysis was made. This analysis revealed few different results. For example, there was an improvement in the number of the published Egyptian works in the health sciences over the last ten years in comparison to the affiliated works with Saudi Arabia.

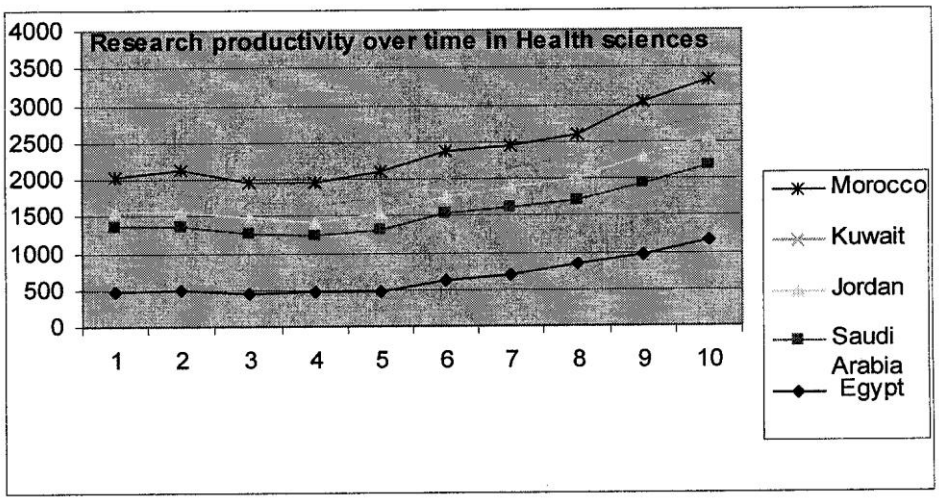

Fig 2: Research productivity over 10 years in health sciences.

As shown in Figure 2, the number of the Egyptian works increased from 478 in 2002 to 1,176 in 2007 with average of 138 yearly works. While the works of Saudi Arabia grew from 821 in year 2002 to 1,004 in 2007 with average of 36 works each year.

On the other hand, there was clear improvement in the number of the published social science works in the over the last 4 years.

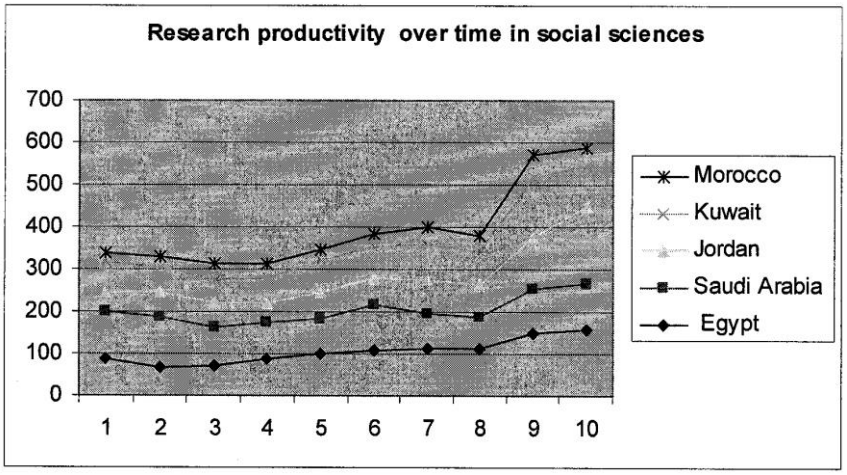

Fig 3: Research productivity over 10 years in social sciences.

This improvement might be an indicator of different assumptions. It might indicate the modifications that have affected the national research agendas and support at these countries during the last 4 years. Also, there might be increase in the number of

funded research projects that have been directed towards conducting social science research during that time.

The major productive scientific fields

To answer the second research question, the major scientific fields were identified for each country and followed by comparison to the fields of publications of the core authors at these countries. The Egyptian research output reached 3.6867 works and 80% of it was distributed over five major fields as it shows in table 1.

Table 1: Core scientific fields of Egypt

Subject field	1998 - 2002	Percentage Of the total production	2003 - 2007	Percentage Of the total production	1998 - 2007	Percentage Of the total Production
Chemistry	3305	22%	4179	19%	7484	20%
Engineering	2678	18%	3642	17%	6320	17%
Medicine	2069	13.7%	3842	17.5%	5917	16%
Material science	2071	13.7%	3004	14%	5075	14%
Physics & astronomy	1928	13%	2949	13.5%	4877	13%
Total	12051	80%	17622	81%	29673	80%

The table revealed an increase in the medical research output between the two time periods: (1998-2002) and (2003-2007) which leads to ranking the field as number three in the last ten years as it shows in the last column. Another main notice is the decrease in the improvement in the chemistry field from 22 % in the first five years to 19 % in the second period of time. This might requires research to find if there is any reason that causes such decrease. When the results were constrained to the top five researchers, changes in the core subject fields were founded. The subject field of the core authors included medicine with 310 works, followed by physics 109 works, engineering 107 works, computer sciences with 47 works and biochemistry with 44 works. Comparison of these numbers with the previous table indicates the exclusion of the chemistry- the main subject field in the last 10 years- as well as the material sciences fields from the major subject fields of the core authors. This means that core authors did not necessarily specialize in the core national subject fields.

The Saudi Arabian works over the last 10 years has reached 2,0298. As shown in table 2, 40% of these works fall in the subject field of medicine. This result might indicate the national support for research in this field.

Table 2 : Core scientific fields of Saudi Arabia

Subject field	1998 - 2002	Percentage Of the total production	2003 - 2007	Percentage Of the total production	1998 - 2007	Percentage of the total production
Medicine	3734	41%	4237	38%	7971	39%
Engineering	1507	16%	1679	15%	3186	15.5%
Chemistry	782	9%	956	8.5%	1738	8.5%
Biochemistry	690	7.5%	862	8%	1552	7.5%
Physics & astronomy	548	6%	849	7.5%	1397	7%
Total	7261	79.5%	7734	77%	15844	77.5%

The Comparison between the numbers in the previous table with the subject fields of the core five authors revealed the ranking of the engineering field as the first field while the medical field was ranked as the fourth major field for the core authors.

The Jordanian research productivity over the 10 years has reached 9,520 works with 21% of these works fall in the medical field. However, the comparison of these results with the major subject fields of the core Jordanian authors revealed the excluding of the medical field from the list of the major fields of these authors. The first field was chemistry followed by chemical engineering. In the meantime, the field of agriculture- ranked as the third field in table 3- was excluded from the interested fields for the core authors.

Table 3 : Core scientific fields of Jordon

Subject field	1998 - 2002	Percentage of the total production	2003 - 2007	Percentage of the total production	1998 - 2007	Percentage of the total production
Medicine	849	24%	1164	19%	2013	21%
Engineering	621	17.5%	1010	17%	1631	17%
Agriculture	426	12%	703	12%	1129	12%
Biochemistry	419	12%	688	11.5%	1107	11.6%
Chemistry	368	10%	574	10%	942	10%
Total	2683	75.5%	4139	69.5%	6822	71.6%

In addition, the total research productivity of Kuwaitis reached 6,998 works. As shown in table 4, the medical field was ranked as the first subject field followed by engineering.

Table 4 : Core scientific fields of Kuwait

Subject field	1998 - 2002	Percentage of the total production	2003 - 2007	Percentage of the total production	1998 - 2007	Percentage of the total production
Medicine	944	30%	1249	32%	2193	31%
Engineering	529	17%	700	18%	1229	17.5%
Biochemistry	313	10%	399	10%	712	10%
Chemical engineering	287	9%	299	8%	586	8%
Chemistry	245	8%	270	7%	515	7%
Total	2318	74%	2971	75%	5235	74.8%

The subject fields of the core authors included the medical field at the top followed by the engineering and the chemical engineering fields. It does not include either the chemistry of the biochemistry fields. It included social sciences fields such as physiology. Finally, the total number of research output over ten years in Morocco reached 12,423.

Table 5: Core scientific fields of Morocco

Subject field	1998 - 2002	Percentage of the total production	2003 - 2007	Percentage of the total production	1998 - 2007	Percentage of the total production
Medicine	1382	24%	1749	26%	3131	25%
Physics & astronomy	1036	18%	1013	15%	2049	17%
Material sciences	860	15%	658	10%	1518	12%
Chemistry	849	15%	856	13%	1705	13.7%
Mathematics	563	9.7%	816	12%	1379	11%
Total	4690	81.7%	5092	76%	9782	78.7%

As shown in table 5, 25 % of the works fall in the medical field followed by papers in physics and astronomy. Although there was a 5% decrease in the number of research output in the material sciences in the last five years, it still ranked as the third core field. Also, Morocco ranked as the second country after Egypt in the field of material sciences. In the meantime, the comparison of these results to the major fields of the core authors indicated the heading of the chemistry field followed by the medical and chemical engineering fields. Although physics and astronomy ranked as the second core field, it was excluded from the top five fields of the core authors.

The above results revealed inconsistency of the core subject fields of the studied countries. Only 2 subject fields- medicine and chemistry- were common in all

of the five countries. The other fields were varied among the countries. Table 6 helps in identifying the uniqueness of the research output for each country.

Table 6: Core scientific fields of the studied countries.

Field Country	Egypt	Saudi Arabia	Jordan	Kuwait	Morocco	Total
Medicine	5917	7971	2013	2193	3131	21225
Engineering	6320	3186	1631	1229	1123	13489
Chemistry	7484	1738	942	515	1705	12384
Physics & astronomy	4877	1397	829	296	2049	9448
Material science	5075	1168	628	272	1518	8661
Biochemistry	3387	1552	1107	712	1090	7848
Agriculture & Biology	3413	1011	1129	341	1325	7219
Mathematics	2154	1269	692	476	1379	5970
Chemical engineering	2309	1174	671	586	585	5325

In terms of the subject field based productivity, the results indicated the lead of the medical field. Egypt ranked number one in all the fields except the medical one in which Saudi Arabia ranked first. To define the position of the studied countries on the international scientific map, the research productivity in chemistry was compared to the list of the top twenty countries worldwide from 1995 to 2005. This list was produced by the science watch database, (1) see appendix 1. The chemistry field was chosen as it was common subject field among the major productive fields in the studied countries. The comparison revealed the weakness of the research productivity at the Arab countries in the chemistry field. However the total number of Egyptian works reached 7,214 and it was the closest one to the research output of Israel which ranked as the 20th country on the list with a total number of 8,314 works. It is worth noting that Israel ranked as number 4 in the list based on the number of citations with the average of 11.30 citations per paper. This issue is more important and it requires conducting a study to define the citation rate of the Arab research output. In the meantime, the Belgium research output in chemistry-ranked as number 19 in the worldwide list- that reached 12,062 papers was about equal the total number of research output in the five studied countries which reached 12,384 works. These results give a negative indicator for the research output in the one of the most productive fields in the Arab countries.

(١) http://www.in-cites.com/countries/top20che.html

Quality of the most published journals

The study aimed to investigate the correlation between the journals in which Arab scientists publish and their quality. In other words it was hypothesized that Arab scientists intended to publish in low impact factor journals. To answer such a question, we have identified the top twenty journals in which researchers published their papers. The procedures were followed for each of the studied countries. These journals were distributed based on the three main subject fields. As a result of the low rate of the research productivity, titles in the social sciences were excluded. In addition, the journals that were published in the Arab countries were excluded. The top twenty journals were chosen to overcome the problem of not having the Impact Factor for some of the journals. In such a case, the following title was used instead of the title with no IF. The Journal Citation Report- Science 2006 edition was used to define the IF for each journal. The total number of analyzed titles reaches 140.

Table 7: Correlations between research productivity and the quality of the most published journals.

Field / Country	Egypt	IF Average	Saudi Arabia	If Average	Jordan	If Average	Kuwait	If Average	Morocco	If Average
Life sciences	-.163	-.424	-.424	1.068	-.228	2.552	-.141	1.463	.113	1.108
Physical sciences	.185	-.441	-.441	1.046	.219	.707	-.197	1.252	.169	1.195
Medical Sciences	.500	-.288	-.288	1.413	-.271	2.095	-.419	1.439	-.276	.499

As shown in table 7, the study found negative correlations between the most published journals and their impact factors. Only 5 out of 15 cases were exceptions. That means there are negative correlations in 67% of the analyzed cases with the availability of one moderate correlation for the Egyptian papers in the medical field. In the mean time, Egypt and Morocco were the best countries with low positive correlations. These results affirmed the second hypothesis of the study and indicated that Arab researchers intend to publish most likely in journals with low IF.

Conclusion*:*

Researching the scholarly publishing in the international information resources consider to be one of the supportive factors that aids to the national scientific rank. It

helps countries to enhance their existence on the international scientific map. Although there are many reasons that lead to the decrease of the international publications of research, the English language is considered the major factor among others in having this phenomenon. The results of the study indicated the leading position of Egypt among other Arab countries in many of the subject fields. This might be attributed to the high number of those who work at the research centers as well as universities-close to 65,000 researchers- compared to the number of their fellow researchers in the other Arab countries.

Also, it was indicated that there were negative correlations between density of publications in some of the journals and their quality. So that, we can't consider the quantitative improvement of research output at the studied countries as an indicator of their scientific enhancements. In fact, this result might be considered as a negative indicator for the use of this output. Finally, the study revealed the increased gap between the research productivity of some developed countries and the Arab countries in chemistry which consider being a major publication field. These results affirm the importance of the future investigation of research productivity in the rest of the Arab countries and tracking the new procedures that have been taken in some countries to enhance the international publications. Along with that, the reasons that negatively affect the international publications of the Arab researchers should be investigated. In additions, it seems important to study the impact of the research output of the Arab countries on the international researches.

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Appendix 1: Top twenty countries in chemistry

RANK	COUNTRY	PAPERS	CITATIONS	CITATIONS PER PAPER
1	USA	219,333	2,939,674	13.40
2	JAPAN	118,048	961,876	8.15
3	GERMANY	96,779	938,684	9.70
4	ENGLAND	58,002	612.975	10.57
5	FRANCE	64,420	580,417	9.01
6	ITALY	38,818	350,278	9.02
7	SPAIN	39,200	327,734	8.36
8	CANADA	30,764	325,054	10.57
9	PEOPLES R CHINA	89,485	320,700	3.58
10	NETHERLANDS	18,784	239,730	12.76
11	SWITZERLAND	17,051	221,086	12.97
12	INDIA	45,945	199,857	4.35
13	RUSSIA	63,065	169,824	2.69
14	SWEDEN	14,162	158,332	11.18
15	AUSTRALIA	16,638	152,888	9.19
16	SOUTH KOREA	26,056	138,719	5.32
17	POLAND	25,436	124,653	4.90
18	BELGIUM	12,062	111,701	9.26
19	ISRAEL	8,314	93,943	11.30
20	TAIWAN	15,196	87,319	5.75

SOURCE: Essential Science Indicators from the January 1, 2006 update covering a ten-year + ten- month period, January 1995 - October 31, 2005. Available at: http://www.in-cites.com/countries/top20che.html