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Science and Technology Diplomacy and the Power of Students: The Case of Iranian Student in Malaysia

Seyed Abolhassan Riazi[1], Abbas Ghanbari Baghestan[2,3]*, Aini Ideris[4], Hadi Khaniki[5], Mehrnoosh Akhtari-Zavare[6] and Elaheh Farahmand[7]

[1]*Institute of Social and Cultural Studies, Ministry of Science, Research and Technology (MSRT), Iran*
[2]*Department of Communication, University of Tehran (UT), Iran*
[3]*Universiti Sains Malaysia (USM), Malaysia*
[4]*Universiti Putra Malaysia (UPM), Malaysia*
[5]*Department of Communication, Faculty of Communication, Allameh Tabatabi' University (ATU), Iran*
[6]*Department of Public Health, Tehran Medical Sciences Branch, Islamic Azad University (IAU), Iran*
[7]*Department of Educational Psychology and Counselling, Faculty of Education, University of Malaya (UM), Malaysia*

ABSTRACT

The world is witnessing a paradigm shift in international relations. Due to rapid changes in science and technology, "Science and Technology Diplomacy" (scientific diplomacy) has emerged as a new strategy for developing, shaping, and reshaping international relations across the world. In this paper, a scientometric approach is applied to study the trend and progress of "Scientific Diplomacy" in Iran's relationship with Malaysia during the last few years. The results of the study show that, with 5569 joint publications and as part of the 10,239 authors from both countries, Iranian students in Malaysia have contributed to 10.13% of Iran's international joint publications between 2012 and 2017. Additionally, Iranian students in Malaysia have contributed to 9.8% of all Malaysian international joint publications during the same period. This is equal to 2.06% and 3.6% of all scientific publications in Iran and Malaysia, respectively. Using Malaysia as a specific case, the study shows a significant relationship between the presence of Iranian students in Malaysia and the growth of scientific and academic collaboration between the two countries. The results of the study have many scientific, political, cultural, and social implications. Considering this study and applying its results to similar cases, "Scientific Diplomacy" seems to work successfully worldwide and plays a key role in future relations among nations. "Scientific Diplomacy" has great potential

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E-mail addresses:
riazi@iscs.ac.ir (Seyed Abolhassan Riazi)
ghanbari.abbas@ut.ac.ir) (Abbas Ghanbari Baghestan)
aiini@upm.my (Aini Ideris)
hadi.khaniki@gmail.com (Hadi Khaniki)
m.akhtari@iautmu.ac.ir (Mehrnoosh Akhtari-Zavare)
elaheh.farahmand@siswa.um.edu.my (Elaheh Farahmand)
* Corresponding author

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for furthering the development of relations between nations in very intelligent ways, and may help their states avoid possible disputes and conflicts.

Keywords: Iran, Malaysia, scientific diplomacy, smart power, students

INTRODUCTION

The world is witnessing a paradigm shift in international relations. Despite having many traditional types of diplomacy (such as political, cultural and media diplomacy), rapid changes in science, knowledge, and technology resulted in the development of a new strategy. "Science and Technology Diplomacy" (Scientific Diplomacy) has emerged as a new mechanism for developing, shaping, and reshaping international relations across the world (Lloyd & Patman, 2014). In "Scientific Diplomacy", science and knowledge are at the core of a country's power and the seductiveness of its ideas, and therefore who will shape and direct it is very important (Degelsegger & Blasy, 2011). In addition, the influence and effectiveness of diplomats and international civil servants is increasingly dependent upon the extent to which they can mobilize scientific and technical expertise in their work (United Nation, 2003). This is why many countries, world institutions, and research centres across the world have initiated measures to study this contemporary phenomenon. Examples of these measures include the United Nations' "Science-Technology Diplomacy Initiative" (United Nation, 2003) and AAAS Diplomacy[1].

[1] The American Association for the Advancement of Science.

As scientific and technological issues become increasingly dominant in global affairs, and in order to build and form a consensus on scientific issues, ways must be found to identify the key players in science and technology as well as how to mobilize them. This is where the roles of those key players, including students as a powerful engine for the progress and development of "Scientific Diplomacy", can be highlighted (Ghanbari & Ideris, 2018). Because of their nature and their abilities, students can be like "ambassadors" of their own countries. This tells a lot about their self-perception as elites of international science, and above all as improvised and spontaneous government representatives (Saint-Martin, 2011).

During the last two decades, many academic and scientific inquiries have tried to understand, examine, and predict the nature of "Scientific Diplomacy" from different points of view using interdisciplinary and multidisciplinary approaches. Some of them highlighted the importance and urgency of implementing scientific diplomacy (Ahad, 1998). Others investigated a few "Scientific Diplomacy" cases, such as France (Raymond, 2014) and Iran (Pickett et al., 2014). Still others investigate the role of "scientific diplomacy on global relations" (Hupaylo, 2016) or the trend and prospect of "scientific diplomacy in the 21st century" (Fedoroff, 2009). The results of all of these efforts were published and appeared in both local and international academic and scientific journals, books, and other academic documents. However, there are few in-depth studies on how students play a role in scientific diplomacy.

Statistics show that in 2017, roughly five million students (more than double that of 2002 and more than triple that of 1990) were studying outside their home countries, including around 100,000 Iranian students pursuing tertiary education across the world. While some of the studies mainly focus on personal relations (Gbadamosi et al., 2014), media (Froget et al., 2013; Vegiayan et al., 2013), communication (Baghestan et al., 2009; Ghanbari-Baghestan et al., 2016) and health (Akhtari-Zavare et al., 2015) aspects of international students, it is very important to also investigate the role of international students in global relations, as well as to understand how they can play a role and what they can do in shaping and reshaping the international relations around the globe. Through this study, the authors use a scientometric approach to present a comprehensive study of the role of Iranian students on increasing the scientific and academic collaboration between Iran and other countries, using Malaysia as a case study.

METHODS

In this paper, a scientometric approach is applied to study the dynamic of Iran's "Scientific Diplomacy" across the world. Scientometrics can be defined as the "quantitative study of science, communications in science, and science policy" (Hess, 1997). Scientometric method is recognized as a novel instrument in the empirical study of the sciences (Leydesdorff & Milojević, 2015). It is used to measure scientific progress in many disciplines as well as to measure the progress and development of scientific productions. The timespan searched was from 2012 to the end of 2017. For further analysis, data for the four top destinations of Iranian students (US, Malaysia, Canada, and UK) was selected for qualitative content analysis, with specific focus on Malaysia. In this paper, total publications, citations, the average citation per document, and field weight citations were selected as key indicators for in-depth analysis. The average citation per document is more accurate and more scientific than total citations when identifying high impact documents (Chuang et al., 2011; Ho, 2014; Müller et al., 2016). For visualizing the results of the study, Elsevier's SciVal was used, which offers access to the research performance of 8500 research institutions and 220 nations worldwide. A summary table of data collection is illustrated in Table 1.

Table 1
A summary of data collection

1	Database/ Visualization	Scopus Database/ Elsevier's SciVal
2	Timespan	2012-2017

RESULT AND DISCUSSIONS

The Ministry of Science, Research, and Technology and the Ministry of Health Treatment and Medical Education are the main state ministries in Iran involved in higher education, science, research and technology. In addition, these two ministries pay particular attention to implementing science and technology diplomacy; traffic of academic collaborations; and developing,

strengthening, and improving national and international science and technology cooperation with its foreign partners, including overseas universities and science and technology institutions.

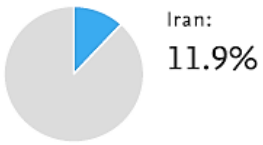
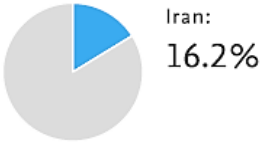
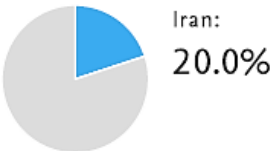
Iran currently has 154 main public universities, 58 public medical universities, an Islamic Azad University (IAU) with 567 branches, and over 2000 other private colleges, universities, and research centres. Additionally, Iran has more than 39 technology parks (with a total of 3650 companies inside them) as well as 3,032 knowledge based firms, which are leading the country in terms of higher education, science and technology.

Iran's contribution of scientific publications in the world has grown over the past two decades from 0.04% in 2005 to 1.5% in 2016 (ranked no. 16 in the globe). Likewise, its total contributions for regional scientific publications increased from 14.8% in 2005 to 28.6% in 2016 (ranked no. 1 in the region). Joint publications by Iranian authors and foreign collaborators accounted for around 20%. A major reason for these improvements is the increasing importance given to scientific publications and research. This has enabled the promotion of university professors through grants and created awards for graduate students pursuing admission at accredited universities. Iran's total exports for technology-based products were recorded at 12.1 billion US$ in 2014, adding to their total contributions to science and technology (The Science and Technology Department of the Iranian President's Office, 2017).

Overall Research and Scientific Performance of Iran

The results of the study show that overall, Iran had 274,919 indexed scientific outputs from 2012 to 2017 in which 239,880 authors were involved and contributed. Altogether, these outputs had 1,199,068

Table 2
Key indicators of research performance of Iran (2012-2017)

Outputs in Top Citation Percentiles Publications in top 10% most cited worldwide 	Publication in Top Journal Percentiles Publication in top 10% journals by CiteScore Percentile 
International Collaboration Publications co-authored with Institutions in other countries 	Academic-Corporate Collaboration Publications with both academic and corporate affiliations 

citations. In addition, the citation per publication is recorded as 4.4 and the Field Weighted Citation Impact as 0.93. Table 2 shows additional details of Iran's research performance from 2012 to 2017.

Top Active Academic and Scientific Institutions in Iran

Overall, 123 institutions (universities and research centres) were recorded as affiliates for the scientific outputs of Iran from 2012 to 2017. Figure 1 demonstrates the top 10 active institutions in Iran's scientific outputs within the period of study. Islamic Azad University, comprising of 567 branches inside and outside of the country, is ranked first at 54,544 scientific outputs. This is followed by Tehran University of Medical Science with 25,403 scientific outputs and University of Tehran with 23,729 scientific outputs.

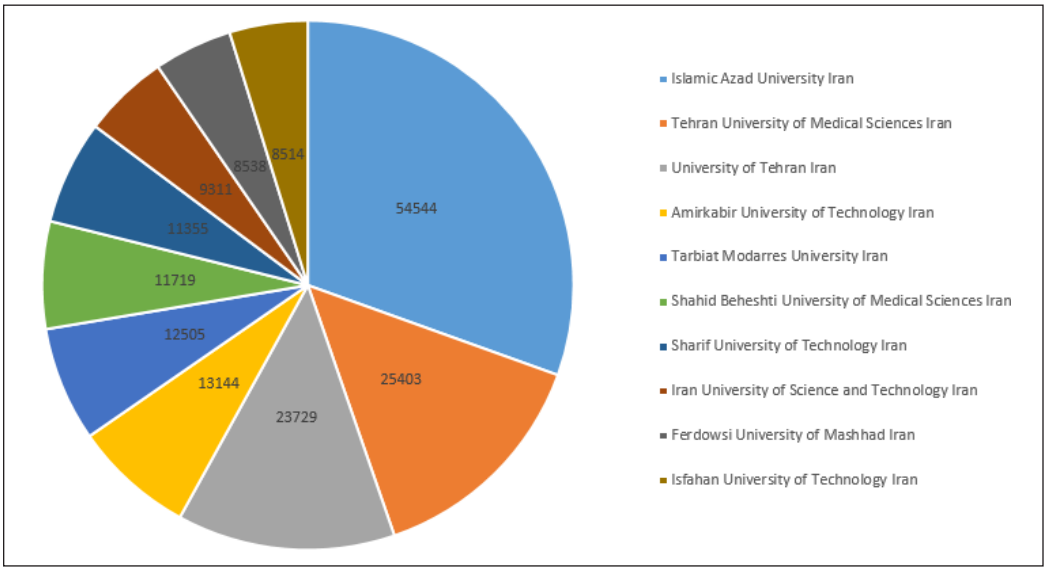


Figure 1. Top 10 active institutions in producing scientific outputs

International Collaboration on Research and Science Productions

The results of this study show that 182 countries around the globe collaborated with Iran between 2012-2017 in joint scientific publications. In fact, around 20% (54,835 documents) of Iran's scientific publications during this period were in collaboration with authors from those 182 countries. Table 3 illustrates the top 20 countries across the world that have the highest number of joint publications with Iran during this period. Based on this table, the top 20 countries alone contributed to 68,542 scientific documents, almost 25% of Iran's total publications between 2012-2017. Among the top 20 countries, the United States of America (12,999), Canada (5927), Malaysia (5569) and the United Kingdom (5158) are ranked as the four most collaborative

countries with Iran during this period. In fact, 10.7% (29,641 documents) of Iran's scientific outputs were in collaboration (co-authored) with these four countries.

Surprisingly, the growth rate for joint research and publications with Iran either was maintained or increased over 2012-2017. Figure 2 demonstrates the growth of co-authorship with Iran for these 20 countries. After the top four countries, who maintained or increased their level of co-authorship, the highest growth rate of co-authorship with Iran is seen in Poland, Sweden, South Korea, the Netherlands, and Belgium.

To evaluate the impact of co-authorship publications (research impact) between Iran and the top 20 countries, Table 4 illustrates the total number of citations received by joint publications based on each independent country. The highest citations were recorded for co-authored publications between Iran and United States (129,985 citations). This is followed by co-authored publications between Iran and the UK (79,188), and Iran and Germany (70,366). Even though Malaysia stands as the fourth ranked collaborative country, the total citations received by co-authored publications with Iran is only 46,975 (ranked as number 12 out of 20 collaborative countries).

Table 3
Top 20 collaborating countries with Iran (2012-2017)

Countries	Co-Authored Publications and Growth (%)		Co-authors	
			in Iran	in the other Country
United States	12999	61.6	17690	18758
Canada	5927	46.6	8716	5021
Malaysia	5569	32.3	5178	5035
UK	5158	35	7008	6046
Germany	4523	40.4	5746	6419
Australia	4240	50.4	6240	3874
Italy	3842	95.3	4492	6145
Turkey	2905	63.9	2934	2220
France	2784	26.5	3224	3803
Spain	2648	53.8	2828	3040
China	2624	126.5	2509	3322
India	2220	48.1	2391	2462
South Korea	2105	30.2	1941	1750
Netherlands	1866	39.5	2698	2599
Sweden	1731	60.4	2718	1878
Switzerland	1702	33.6	1971	5346
Belgium	1542	29.4	1552	1470
Poland	1406	112.3	1296	969
Saudi Arabia	1397	197.2	1255	637
Japan	1366	63.7	1902	2127

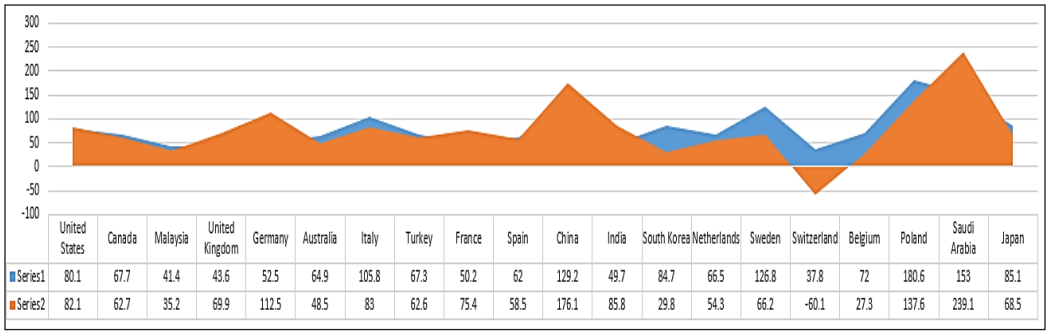


Figure 2. Growth of co-authorship with Iranian researchers between 2012-2017

Table 4
The impact of co-authored publications with Iran

Country	Co-authored publications	Citations	Institutions
United States	12999	129958	621
Canada	5927	60379	92
Malaysia	5557	46975	51
United Kingdom	5158	79188	261
Germany	4523	70366	227
Australia	4240	57175	119
Italy	3842	62195	139
Turkey	2905	45614	138
France	2784	58470	236
Spain	2648	58827	116
China	2624	59795	319
India	2220	57944	214
South Korea	2105	45822	89
Netherlands	1866	38422	59
Sweden	1731	39018	43
Switzerland	1702	48861	31
Belgium	1542	34779	28
Poland	1406	31510	76
Saudi Arabia	1397	32624	22
Japan	1366	35068	188

Figure 3 illustrates two key indicators for the impact of the co-authored publications between Iran and the top 20 collaborative countries. Switzerland is ranked first for the average citation per joint co-authored publication with Iran at 28.7, followed by India at 26.1 and Japan at 25.7. However, based on the Field Weighted Citation Impact (F.W.C.I) score, a more precise indicator, the figure shows that in all cases, the co-authored publications get at least 87% (in Malaysia's case with 1.87) more citations

than the normalized citation score of one. It is worth highlighting that the highest F.W.C.I score belongs to co-authored publications with Saudi Arabia (5.54), India (4.65), Japan (4.62), and Switzerland (4.54).

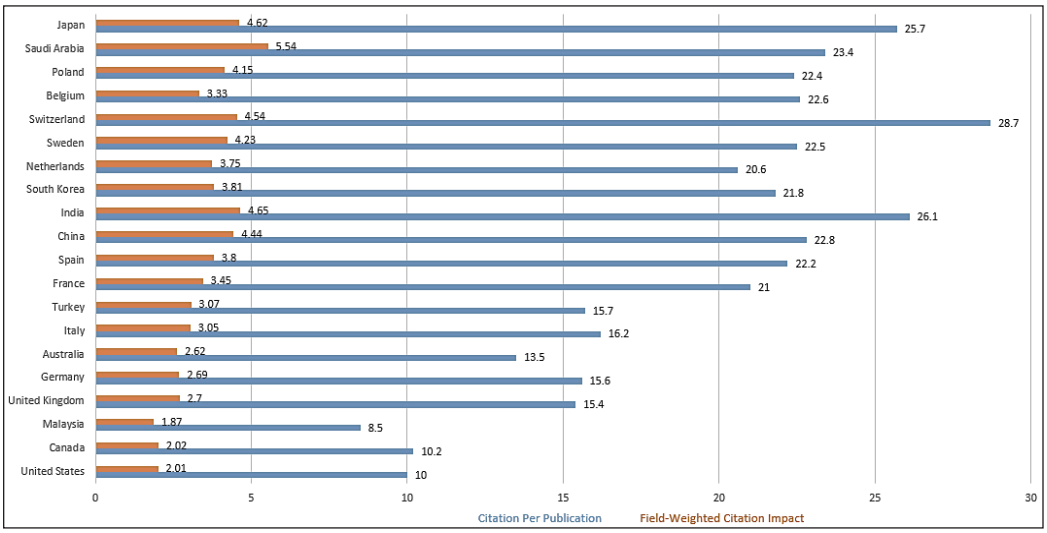


Figure 3. Citation per publication & field weighted citation impact between Iran and top 20 countries

The Role of Students in Iran's International Scientific Collaboration

In 2017, a total of 4,083,012 students were studying in Iranian universities, of whom 46% were women, showing a better gender balance in Iran than in other countries. Table 5 depicts the distribution of students and other related factors in Iran.

Based on the latest statistics, around 80 to 100 thousand Iranian students are studying overseas. Whereas historically the United States of America, Canada and the UK were the main destinations for Iranian students, Malaysia started receiving Iranian students in the early 21st century. This is mainly because of the introduction of Malaysian Research Universities (MRUs) in the country (Ministry of Higher Education [MoHE], 2015). The number of Iranian students in Malaysia increased dramatically from 2007, gradually reaching 13,800 students in 2012. This is the highest

Table 5
Some key statistic about students in Iran

Items	2005	2017	Items	2005	2017
No. of Students	2,389,867	4,083,012	Master Students	--	764,233
Graduates	340,264	738,260 **(2015)**	**Bachelor Students**	--	3,084,406
PhD Students	19,237	234,373	International Students	---	57,600
Students Distribution: 37% in Islamic Azad Unis, 16% Public Unis, 47% in other Unis.			**Total Academic Members:** 80.000 (out of this, 25% are women).		

number of international students in Malaysia (Mehrnoosh Akhtari-Zavare & ghanbari-baghestan, 2010). Overall, from 2000 to 2015, more than 20,000 students were studying in Malaysia, 11,000 of which were in Malaysian public universities, including five research universities. In terms of research and academic performance, students who graduated successfully from Malaysian universities have published three scientific publications (indexed and un-indexed) and five seminar/conference papers on average. Financially, based on the average expense of each international student in Malaysia, Iranian students have made contributions of more than 6 billion Malaysian Ringgit as of 2015 (Baghestan, 2016).

In recent years, like elsewhere (Fedoroff, 2009), due to the presence of Iranian students in Malaysia, both countries experienced very progressive development and collaboration in terms of joint research. There is increased development in academic and scientific co-authored publications as a result (Figure 4). As presented in Table 3, Malaysia ranks third among the top countries in collaboration with Iran that had the highest number of co-authored publications. Conversely, Iran ranked fourth for the number of co-authored publications in the top 20 collaborative countries with Malaysia, following the UK, Australia, and the United States (MoHE, 2017).

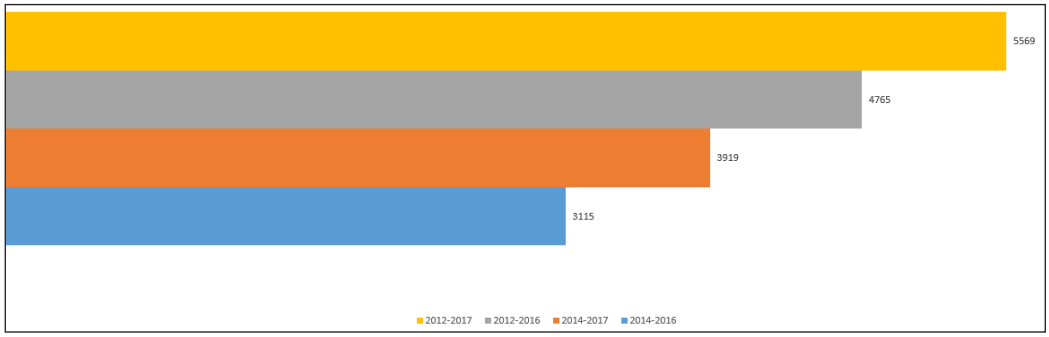


Figure 4. Trend of co-authored publications between Iran and Malaysia

As can be seen in Figure 4, the total number of co-authored publications between Iran and Malaysia reached 5569 scientific documents at the end of 2017. This is equal to 2.06% of Iran's total scientific publications and 10.13% of Iran's total international joint publications between 2012 to 2017. In comparison, the 5569 scientific publications are equal to 3.6% of all Malaysian scientific publications and 9.8% of Malaysia's total international joint publications during the same period. In other words, 10.13% of Iran's international joint publications and 9.8% of Malaysia's international joint publications were mainly due to the presence of Iranian students in Malaysia. Interestingly, a total of 10,239 researchers/scholars (5,045 authors from Malaysia and 5,194 authors from Iran) contributed to these publications. Regarding

the impact, which is normally measured by citations (Etemadifard, 2018), these scientific co-authored publications received 46,976 citations in total (each paper received an average of 8.4 citations with a field weight citation of 1.87). This is equal to 7.9% and 3.9% of all citations received by Malaysia's and Iran's scientific publications, respectively. It is worth highlighting that the Field-Weighted Citation Impact score of the joint publications between the two countries is almost 2 times higher than the overall field weight citation for each country. In addition, the citation per publication of the joint publications between the two countries is 2.2 times and 1.9 times higher than Malaysia's and Iran's overall citation per publications, respectively (Table 6).

Table 6
Comparison between impact of overall performance of each countries and joint publications between Iran and Malaysia

No.	Scholarly Outputs	Authors involved	Citation Count	**Field Weight Citation**	**Citation Per Publication**
Malaysia (Overall)	158,573	130,177	598,681	0.90	3.8
Iran (overall)	274,819	239,880	1,199,068	0.93	4.4
Between Iran & Malaysia	5,569	10,239	46976	1.87	8.5

Due to the scientific backgrounds and profiles of the 10,239 researchers and scientists from both countries, it is unsurprising that they (universities, research centres, technology parks, scholars, and researchers) know each other's counter parts as well as ways to move forward. It is proposed that "strategic planning" be considered at higher levels, in order to provide a more technical and detailed roadmap for quality enhancement of current scientific collaborations.

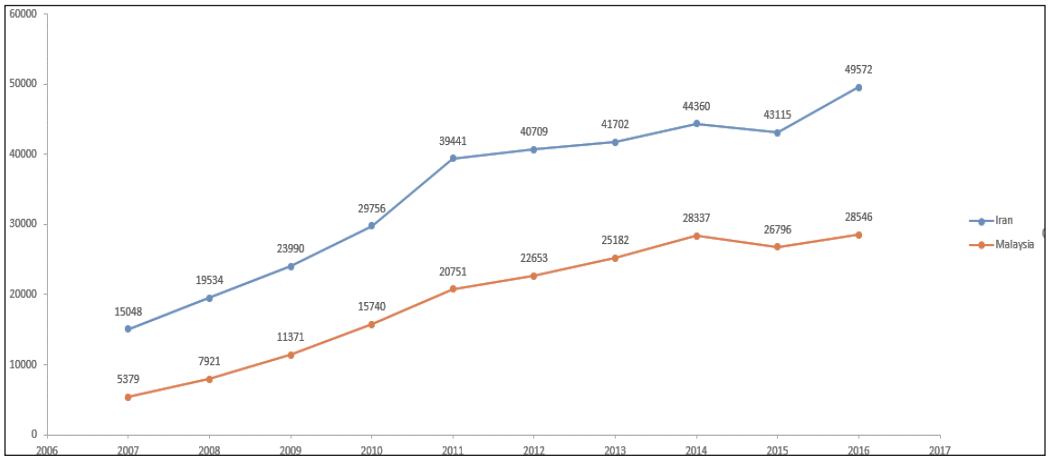


Figure 5. Trends of scientific productions of Iran and Malaysia

Both countries continue to increase the quantity of their annual scientific publications (Figure 5). In the latest version of the Scimago country ranking (2016), Iran and Malaysia ranked number 16 and 23 respectively for science and knowledge production at the global scale. In Malaysia's case, it is obvious that the number of Iranian students impacts not only joint scientific publications between the two countries, but also the total number of scientific publications in Malaysia. The number of students also effects the amount of citations received over the past 10 years. To prove this hypothesis, the Pearson correlation coefficient was applied to evaluate the relationship between the total number of Iranian students during 2008 to 2016 and the total number of publications, total citations, and average number of citations per publication. According to the results (Table 7), there was a positive and significant relationship in Malaysia between the number of Iranian students and the total number of citations. Furthermore, there was a significant relationship between the number of Iranian students and average number of citations per publication.

The total number of citations is only one of the notable achievements that is due to the presence of Iranian students in Malaysia. Many other achievements can be highlighted in terms of the quantity and quality of collaborations that currently exist between the academic and scientific bodies of both countries. The impact on the two countries' overall political, cultural and economic relations can also be discussed. In other words, there is still much to be desired if both countries' relevant organizations use their potential power in intelligent ways, such as working on a joint researchers' network, joint research sharing repositories, joint research programs, etc. For example, a look at the overall research impact shows both countries' performance in receiving citations has decreased in recent years (Figure 6). It is known that citations have major contributions to all global rankings (ranging from 20% to 100%). Strategic planning in this factor may increase both university and country rankings for Malaysia and Iran between 9% to 30% (PeerJ, 2013), desirable for both countries.

Table 7
Relationship between number of Iranian students and the total number of citations in Malaysia

Years	2008	2009	2010	2011	2012	2013	2014	2015	2016
No. of Iranian Students in Malaysia	8000	9700	11823	12500	13800	9750	6228	5304	4182
						NO of Student			
NO of Publication						-0.377			
Citation						0.899**(0.05)			
RATIO (average of citation per publication)						0.634* (0.01)			

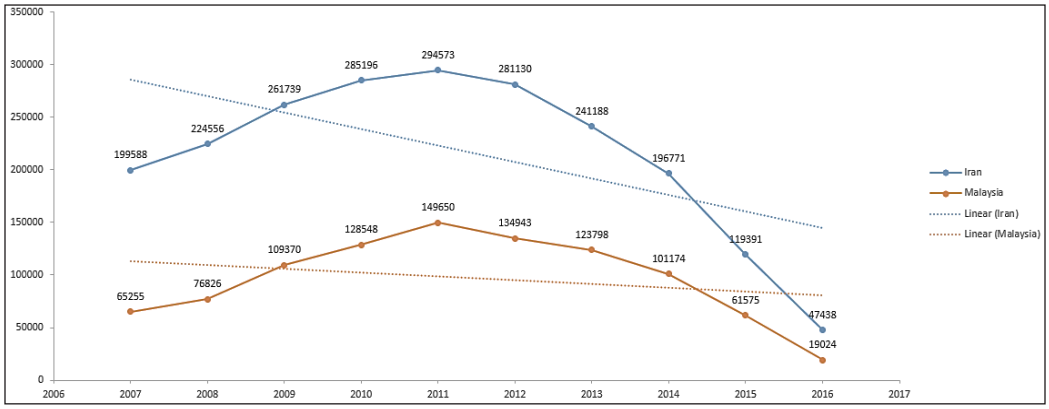
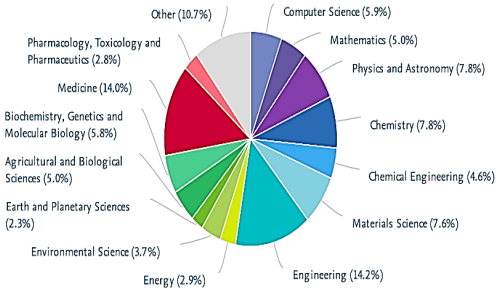
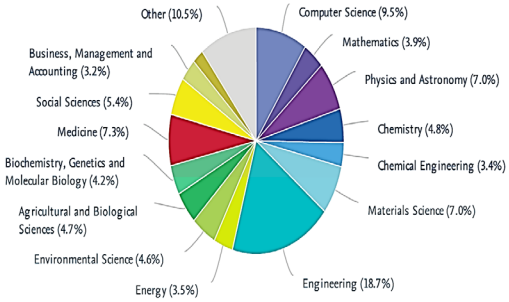


Figure 6. Trend of research impact of Iran and Malaysia scientific publications based on citation

Another area that might be considered for further strategic planning on academic and scientific collaborations between Iran and Malaysia is the identification of strengths for each country and mainly focusing on those areas for enhancement. *Table 8* presents the strongest research areas for each country. For example, Iran seems to be strong in areas such as Pharmacology, Toxicology, and Pharmaceutics and Earth and Planetary Science. In contrast, Malaysia is strong in areas such as Social Sciences and Business, Managements and Accounting. Even in existing overall performance, Iran appears to be very strong in Medicine and Engineering, while Malaysia appears to be strong in Engineering and Computer Sciences. Through the current Iranian students and by mapping and crosschecking the weakest and strongest points of each country, both countries can help each other more purposefully. This would create a pre-planned strategy for further enhancement of their scientific and academic collaborations. Of course, this also will require more researchers and scholars, as well as more institutions belonging to both countries, to be involved.

Table 8
Area of research of total scientific publications (2012-2017)

Iran	Malaysia
	

CONCLUSION

The results of the study, which were mapped and discussed in detail with Malaysia as a case study, have many scientific, political, cultural and social implications. These results can be generalized to other countries with confidence, especially the top destination countries of Iranian students, namely the US, Canada, the UK, and Germany. As presented in this study, the more researchers/scholars integrated with each other through research and scientific publications in both countries, the better common understanding and consistency there will be in the ties and relations between the two countries. Using the roles of Iranian students during the last 10 years as an example, with Iran and Malaysia as one of most dynamic and successful cases, "Scientific Diplomacy" seems to work successfully and will play a key role in the future relationship of the authors' countries. Using "Scientific Diplomacy" in intelligent ways has great potential to enhance the quality and quantity of the relations, not only in scientific and academic areas, but in all other areas as well. Finally, scientific diplomacy has the potential to help nations remain secure and avoid any possible type of disputes or conflicts.

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