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Role of Higher Education In Science and Technology Diplomacy Development (case: K.N.Toosi)

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Abstract – In recent years according to Iran planning, Science Diplomacy is developing foreign policy and the international relationship among nations. According to the major role of higher education in produce and dissemination of science and technology, providing a framework for diplomacy development through universities become important. This study has 2 main question that consists of dimensions and elements for Developing Science and Technology Diplomacy Development S&TDD and factors and criteria of the role of higher education to S&TDD. Also, the search method was the mix. The sample was the foreign policy and higher education specialists who participated in the interview. For qualitative part used questionnaires made by the researcher and Sample was faculty of K.N. TOOSI University. Sampling was the whole counting. The results indicates that the framework includes 3 dimensions and 30 elements for S&TDD and 5 factors and 21 criteria to improve the role of higher education

Keywords: Science and Technology Diplomacy, Science and Technology Diplomacy Development (S&TDD), Higher Education

1 Introduction

Over the past half century, significant advances in international development such as antibiotics, vaccines, cell phones, and mobile technologies have dramatically changed the trajectory of developing countries for the better. These powerful solutions were based in science and provided the most effective way to transcend traditional development barriers and spark revolutionary change. From small-scale irrigation to mobile-reading tools, from ultra-low-cost diagnostics without a laboratory to energy-from-waste, the exponential advances within science, technology, and data are allowing for the creation of novel approaches to traditionally sticky development problems. (Dehgan & Colglazier, 2012)

Diplomacy means foreign policy advance. The purpose of science and technology diplomacy is utilization of science and technology to achieve foreign policy goals. In many society, especially developing countries, to promote science and technology diplomacy there is no enough capacity, so universities and whole higher education system has great responsibility to attention. The role of higher education in Science and Technology Diplomacy development (S&TDD) sometimes retrieved from international mission of universities which requires planning and acting



well a process improvement in both higher education and diplomacy system in country. The main challenges to promote the role of higher education in science and technology are finding common aspect in tow system missions, localization science and technology dimensions in the country to conduct diplomacy correctly is another challenges, also finding and defining factors and criteria for promoting the role of higher education for that object is ambiguous. This importance and also facing to some issues in advancing scientific diplomacy such as limited cross boarder technology transfer by universities and weakness in international scientific communication, encourages the researcher to study about the role of universities and higher education in S&TDD.

Science and Technology Diplomacy Development and the role of Higher Education for (S&TD)

One of the important things that politicians should be considered is true understanding of science and technology development process. They should get all capacities of science and technology for political purposes and if science and technology are not tied to sustainable diplomatic sphere, country will be faced with many problems. As well as Efficient technology is not only as a political tool but also it should be wealth creation cycle. The small advanced economies initiative was established by the New Zealand Government through inaugural meeting held in Auckland in 2012 cooperating with higher education system. The initiative provides an opportunity for small nations, that face similar challenges and opportunities in an increasingly inter-connected and competitive global economy, to learn from each other. (Sweet, 2015)

Science diplomacy is relevant, effective, and potentially transformative. It can play a key role in responding to some of the most elemental challenges facing the international community. Despite of importance of Science and technology diplomacy, sometimes it is not necessarily the cause of peace

and development. For example, applying the princi-

ples of science and technology diplomacy by Pakistan and North Korea to develop nuclear weapons, a kind of global order is disorder. (Copeland, 2015)

In Germany are increasingly using factors that influx on science popularization, Such as improving the country's attitude towards new product, also this country has a long history to academic exchanges for improving science diplomacy. For example Germany Federal Ministry of Education and Research gave the commission to some expert institutes to evaluate all the indexes of the activities of Einstein Year. (Yanjun & etc., 2010) That Institute is the largest institution in science and technology field in Europe, so German and the Ministry of Education in coordination with the foreign policy of Germany attract foreign students and exchange deals. For example, in 2009 Iran can exchange students related to biotechnology fields in that country while from Afghanistan only 23 were accepted in political science.

India's diplomacy improves by science and technology, further development of computer science in the past few years. India is focused on knowledge-based economy and is looking for technology transfer from developed countries in the world. Taking into account India's population (second largest population in world), it is natural to expect that India improves upon computer science research, along with the industrial growth in the sector. (Singhal & etc., 2015)

Vaughan et al. (2014) define and explain all concepts related to diplomacy, science and technology. Science diplomacy in their idea is identification of many of today's global alternatives such as improving health systems and issues related to ecosystem. In terms of Bidabad (2012) diplomacy means Foreign policy advance. Diplomacy in its first meaning, is the guidelines about international political issues regarding to foreign states or different regions, and also concern about treats in international or regional fields. The second meaning of diplomacy is the skill or art of negotiation for reaching to a common understanding in international scene. Anyhow, it is "the conduct of rela-



tions and communication”, which makes both meanings to become comprehensible.

Turekian and Neureiter (2012) in his article examine the scientific and technological relations between America and Russia in the development of science diplomacy is important. Now America and Russia will work together at the international space station. International scientific cooperation, while strongly linked to the Cold War experience of the United States, also served as an important instrument in the wider global context. For example, after World War II had divided the European continent, collaboration on scientific endeavors served as a significant Ingredient in efforts to improve inter-state relations.

Systematic study of new knowledge about nature is a certain method can be achieved with the aim of establishing a fixed relation between phenomena. It is essential what science is empirical knowledge that terminate to create new technology. As he reported the developed world is so dominant because of its scientific and technological power. The contribution of the U.S. to the world’s annual economic output is about 30%, comparable to its share of scientific output on a global scale. (Zewail, 2010) Westcott’s study (2008) is about internet effect on complex international common issues. It also helps accelerate and advance the country’s foreign policy which requires benefit from the knowledge virtual networks and the Internet is foreign policy. The Internet is an inseparable part of global political change process. It affects what states do and how they do it, how they relate to each other and who is involved in that relationship. Among top universities that worked on scientific and technology development, Harvard and MIT can be mentioned that helped government foreign policy by some mechanisms. So the review activities of top universities in the world can accelerate obtain objectives and facilitate science and technology diplomacy development. Supporting consortiums development for international communication between countries especially developing countries is very crucial. (Ozdasli, 2015) Nowa-

days, International relations education provides common perception among faculty and other university’s society members. These programs have been organized under the names “International Relations skills”, “Political Science and International Relations”, “The higher education and International political Relations” and etc.

Capmbell (2012) considers founding and developing non-governmental organizations for developing communication between universities all over the world and recommend it as an advance factor for S&TDD. Founding and developing these kind of institutes by universities consist of politicians and academics is very necessary. (Neurieter & Cheetham, 2013)

For example cooperation between Syracuse and Kim Chaek universities in South Korea by non-governmental organizations is very significant for that aim. The Congress Research Service reports that a number of NGOs have been active in the Democratic People’s Republic of Korea since the mid of 1990s, primarily in humanitarian act, health system, communication, and education enlarged.

Arrove & Torres (2013) believe that despite of all pro and cons about globalization, this process is happening and developing and the main object is how can relate global thinking to regional performance? Universities duty for advancing foreign policy based on Miller’s study (2013) is considering the importance of international students role, exchange international scientific partners, international research cooperating, studying Abroad, develop fellowship, internationalization academic research and the develop cross-border projects, faculties sabbatical and involving at international research centers. He believe that Modern threats for science, learning, and academic freedom has many forms, including censorship, surveillance, imprisonment, and violence against academics. Also cooperating in pioneer projects especially about common difficulties should get a high priority. Science collaboration between India and the United States has already generated



tangible results, the number of U.S. technology startups led by immigrants from India. Most of these products is about robust and etc.

Universities financial support for research opportunities in developing countries helps science and technology diplomacy development. The strongest opportunities for science diplomacy occur when certain conditions are met. Specifically, scientific engagement efforts must be more than a public diplomacy function. Cooperation on science, technology, and engineering provides U.S. diplomats with a significant opportunity to leverage science as a tool of smart power. U.S. scientific expertise is highly regarded around the world, even in areas where U.S. popularity may be low. (Dehgan and Colglazier, 2012)

Mohd Shah & Hahim (2012) by considering Oceania scientific policy aspects shows the importance of co-operating New Zealand University (Canterbury) with continent's politicians to solve regional environmental issues. According to their survey, science diplomacy is using scientific co-operating to solve 21 century's main issues in international and national level. Science and technology diplomacy advances capacity making and foreign policy, develop global sustainability. Despite of limitation of Knowledge about climate development and biodiversity in the Antarctica, There are three main factors identified during research in Antarctic; its isolation, combined with the harshness of its climate is one of the major hindrances for conducting search.

Universities are involving in international projects to promote specific and political knowledge and perform international role for foreign policy advances. (Beddington¹, 2010) Zewail (2010) believes nowadays there is new kind of communication between universities and academic institutes that is more than holding conferences and sporadic scientific exchanges. He considers founding development centers is crucial for all aspect countries develop-

¹Professor John Beddington FRS, Chief Scientific Advisor to the UK Government, 2010.

ment. Also his Commentary examines the important role of science in diplomacy and its soft-power in world's peace.

Universities role in "diplomacy for science" considers as a facilitator in international cooperating between universities and other institutions. The results of this approach can be categorized in three groups. These three are marketing, providing science and technology needs and supporting international competitions so we need scientists, engineers, and entrepreneurs to coach and teach until the world is truly flat. (Fedoroff, 2009)

Dimensions and elements of science and technology diplomacy development (S&TDD)

In scientific diplomacy three approaches is noticeable. The first is using science and technology as a diplomacy tool. In January 2010 the American Association for the Advancement of Science (AAAs) introduces three science and technology diplomacy dimensions which includes these:

1.1 Science in diplomacy

In this aspect, science and technology acts as a supporter of providing foreign policy goals. (AAAs, 2010) Founding and using capacities is other aspect of developing science in diplomacy. Communicating between scientists and diplomats relates to this aspect; For example, by exchanges between scientists and diplomats, USA and Russia acted in visa making and other facilities for scientific experts indirectly. The result of these actions helped the relation between these countries over last 25 years. (Turekian² Involving professors and experts in solving international issues is another aspect. Venezuela is pioneer in science in diplomacy. (Runde & Zargarian, 2014).

1.2 Diplomacy for science

This aspect made international science and technology cooperation easier. This approach means using diplomatic

²Vaughan Turekian, Director, Center for Science Diplomacy, American Association for the Advancement of Science (AAAS, 2012)



capacities to develop science and technology in the country. Scientific works in military field like military production in Argentina is an important result of its government policies. Economic problems have made Argentina more open to multilateral cooperative efforts for “diplomacy for science”. (Gamba-Stonehouse, 1992) making visa process easier for universities experts and professors by any country is another important act. Number and quality of international projects in other countries because of its risks and costs is another element.

1.3 Science for diplomacy

Improving international relations through science and technology is the original meaning of this dimension that called “Soft Power”. Soft power in all activities is related to leadership, management especially in military affairs and economic efficiency. (Armitage, 2007) In this dimension, the number and quality of relationship established non-governmental organizations is important. Also the number and quality of specialized consortium for international communication among countries, particularly developing countries to upgrade their skills and knowledge is needed. International commitments and contracts support political systems and improve mechanisms of higher education and research and developing scientific investment in the country. In past 20 years there was been some efforts in making capacity for developing science and technology globally. In year 2000 for the first time four scientists worked in US foreign embassy as scientific advisor and Fellowship programs now bring large number of scientists every year to developed country (Lempinen, 2012) that result to develop science and technology diplomacy as a tool for obtaining countries political goals (Dehgan & Colglazier, 2012).

2 Search Method

In this study use mix method as qualitative and quantitative. First by studying literature and theoretical principals, dimension and element of science and technology diplomacy development and factors and criteria of higher education role for S&TDD were identified. Then by interview (semi-structured with 5 fundamental open question) the opinion of experts who have sufficient experience about subject and above item collected. Web search was the second resource for data gathering. For analyze and confirm raw data, questionnaire was designed. It has 56 question with Likert spectrum for answers. (Appendix

1) Society members were 313 of K.N.Toosi’s faculties. Sampling was whole counting and 253 of society completed survey. The main method for data-analyzing were exploratory factor analysis and confirmatory factor analysis. For those operation edition 21 of SPSS was used.

For checking research tools validity use confirmatory factor analysis. Kaiser-Mayer test value was 0.869, Bartlett test amount of 7147.604 with DOF 528 is in reasonability level of 0.000. After analysis and performing Varimax rotation method of factors, it showed that items 13, 21, and 23 has stronger effect on two factors and with more than one factor overlaps that puts these items aside. Variance value indicated by these factors is 69.42 percent. Output of factor analyzes to analyze diplomacy science and technology development dimensions and elements also shows that model indexes were in allowed range for each one of models.

For determination validity of factors and criteria about higher education role in (S&TDD) questionnaire, Kaiser-Mayer test value is 0.901, Bartlett’s test value is 3631.712 with DOF 253 and reasonability level of 0.000. All was in reasonable level for both sections.

For assessing research tools reliability use Cronbach’s alpha coefficients. The result shows questionnaire’s Cronbach’s alpha value for dimensions and elements of science



Table 1: Factors promoting the role of higher education in science and technology diplomacy

	criteria	presenter
1	Systematic Education	Sadoq (2015)
2	Academic exchange process ease	Shirani (2015)
3	Non-profit organization improvement	Campell (2013)
4	Cooperating in international large project	Beddington (2010)
5	Cooperating in innovative international project	Moyzener (2013)
6	Funding in project in improving country especially at common challenges	Dehgan and Colglizier (2012)
7	Expansion scientific cooperation between neighboring country	Copeland (2015)
8	Establishing faculty consortiums for enhancing scientific relations	Ozdasly (2014)
9	Science and technology product marketing	Smith (2014)
10	Collaboration with diplomacy system to supply Science and technology requirement	Feddraf (2009)
11	Define science and technology attraction factors	Firozabadi (1390)
12	Developing relationship between scientific and politicians	Bernic lee (2010)
13	Negotiation for importing forbidden technology (in sanctions)	Barati (2011)
14	Make or improve capacity	Bernic lee (2010)
15	University collectivity for playing effective roll of science and technology	Craik (2007)
16	Attention to international roll of higher education	Jackson (2008)
17	Figure of universities for dependence of other country to our society	Barati (1390)
18	Validation of science and technology product efficiency	Mosavi (2012)

Table 2: Fitting indicators to assess the validity of science and technology diplomacy

	CFI	SRMR	NNFI	NFI	AGFI	GFI	RMSE A	d/ χ^2 _f	χ^2	
moderate	>0/09	<0/05	>0/09	>0/09	>0/09	>0/09	<0/08	<5	P>./0.5	result
Science in diplomacy	0/99	0/024	0/99	0/99	0/91	0/96	0/076	2.47	46/96 $\chi^2=$ df=19 P=../...	Acceptable
Diplomacy for science	0/99	0/03	0/98	0/98	0/91	0/95	0/065	2.07	68/26 $\chi^2=$ df=23 P=../...	Acceptable
Science for diplomacy	0/95	0/031	0/98	0/98	0/9	0/95	0/074	2.37	61/73 $\chi^2=$ df=26 P=../...	Acceptable

and technology diplomacy development is 0.911 and for factors and criteria of higher education role in S&TDD is 0.902. So they have good reliability.

3 Study Result, Discussion and Conclusion

Analyzing question 1 data: Which is dimensions and elements of science and technology diplomacy development?



Table 3: Fitting indicators validity of the factors and criteria promoting the role of higher education in science and technology diplomacy

moderate	CFI	SRMR	NNFI	NFI	AGFI	GFI	RMS EA	d/ χ^2 _f	χ^2	result
	>0/09	<0/05	>0/09	>0/09	>0/09	>0/09	<0/08	<5	P>0/05	
Infrastructure	1/00	0/004	1/00	1/00	1/00	1/00	0/000	0/16	=0/16 χ^2 df=1 P=-/69	Acceptable
International act	-	-	-	-	-	-	0/000	0/00	=0/00 χ^2 df=1 P=-/98	Perfect mode
Higher education and diplomacy system relationship	0/99	0/024	0/99	0/99	0/92	0/97	0/081	2.67	24/0 $\chi^2=1$ df=9 0/004 P=	Acceptable
Planning and management principal	-	-	-	-	-	-	0/000	0/00	=0/00 χ^2 df=- P=1/00	Perfect mode
Science and technology branding	-	-	-	-	-	-	0/000	0/00	=0/00 χ^2 df=- P=1/00	Perfect mode

Implementation of exploratory factor analysis to confirm the advance of science and technology diplomacy development has revealed the following results:

As it can be seen at above table, KMO value is 0.753 which is close to 1. Also reasonability level of Bartlett's Test of Sphericity test characteristic is below 0.05 and it shows its statistically meaningful. So, based on both criteria it can be concluded that implementation of factor in second analysis based on the correlation matrix of the sample group, would be reasonable. The second output of is common table exploratory factor which shows determining variables coefficients. As this number be less than 0.4 in a variable it should get eliminated and explanatory factors should get redone. As common values be greater, extracted factors shows variables better.

According to above table, all dimensions common values was higher than 0.4 that is a confirmation of data and analysis reasonability. The third output is explaining

variance.

According to table above, all initial eigenvalues are higher than 1 and all of them prove 62.87 % of total variance. Factor loading of each dimensions is shown below:

3.1 Analyzing question 2 data: Which is factors and criteria for developing the role of higher education due to science and technology improvement?

Among all factors and criteria extracted from section two of this study and also evidences in web and data centers and interview process, the final questionnaire got done by 5 factors and 23 criteria as improving factors for developing academic education system role in science and technology diplomacy development that used explanatory factor analysis for checks. After explanatory factor analysis using SPSS the KMO value is 0.901 which is close to 1. Also reasonability level of Bartlett's test is zero which is bow 0.05 and indicates that it is statistically meaningful. So,



Table 5: Dimensions and elements identified by the analysis of the main elements

Science in diplomacy	Make or improve capacity
	Reinforcement relation between scientific and politicians
	Systematic education
	The role of science and technology for international division of labor
	Utilize scientific language in international exchange
	Introduce universities specialist for science and technology advisor in foreign policy system
	Study about other kind of diplomacy such as cultural, economic and . . .
	Collaborate with government to develop science and technology diplomacy
	Define science and technology attraction factors in diplomacy
Diplomacy for science	Facilitate issuance visa for faculty and other expert
	Collaborate in international project
	Upgrade scientific cooperation between neighbor country about common challenges
	Science and technology product marketing
	Absorb foreign fund for science and technology development
	Effective utilization of media for introduce science production
	Give technological present between official visit of politicians
	Branding of science and technology production
	Facilitate import pf new technology into country
	Reinforce science and technology diplomacy security
Science for diplomacy	Establish international faculty consortiums
	Establish or upgrade science and technology museums
	Reinforcement reward and punishment lever for sustainable politicalrelations between nations
	Student and faculty exchange in different courses
	Develop international scientific cooperation
	Develop scientific cooperation for political relation between nations
	The role of universities for dependence of other country
	Efficiency of technological product for easier export
	Localization import technology
	Assign fund for protecting science and technology diplomacy

it is reasonable based on both studies. The second output of explanatory factor analysis indicates that all items commons is higher than 0.4 which approves reasonability of used data and explanatory analysis. The third output is variance table. After analysis it showed that special value of 5 factors is greater than or equal one, and common variance coverage between these 5 is totally 69.43 percent of total variance of variables. In other words if 5 factors get

extracted based on above mentioned, it will be in amount of 69.43 percent of total variance. The forth output is related to Scree chart which showed that on chart slope there is 5 factors and other factors are close to each other too and according to special values table, does not clear much variance percentages. Next output is rotate structure factor which shows each item's effect after Varimax rotation. After performing factor analysis on two factors.



Table 4: Added elements resulted from interview

Added criteria by interview	Main factor
Systematic Education	Science in diplomacy
Recognition other shape of diplomacy such as cultural, economic and	Science in diplomacy
Collaborate with government to improve science and technology diplomacy	Science in diplomacy
Perfect Utilization of media for introducing science and technology product	Diplomacy for Science
Facilitate importing new technology into country	Diplomacy for Science
Reinforcement science and technology diplomacy security	Diplomacy for Science
Establishment or upgrading science and technology museum	Science for diplomacy
Student and faculty exchange in different courses	Science for diplomacy
Localization transitive technology	Science for diplomacy
Assigned independent fund to protect S&D	Science for diplomacy

Table 6: KMO and Bartlett's Test for S&TDD

Kaiser-Meyer-Olkin Measurement of Sampling Adequacy		0.753
Bartlett's Test of Sphericity	Approx. Chi-Square	141.076
	df	3
	sig.	0.000

It means that it has overlap with more than one factor that those items can get put aside. So varimax rotation method result indicates that after 7 rotations, the best solution has 5 factors. It means that among all, 23 items and 5 factors identified as main and got named properly.

After performing to confirm Factors and criteria of higher education's role for science and technology (elementary 5 factors and 23 criteria), Explanatory Factor Analysis is used.

It showed that KMO value is 0.901 and it is close to 1.

Science in diplomacy	1.000	0.0549
Diplomacy for science	1.000	0.701
Science for diplomacy	1.000	0.637

Table 7: Tab 6.Total variance explained

component	Initial eigenvalues			Extraction sums of squared loadings		
	total	%variance	Cumulative %	total	% of variance	Cumulative %
Science in diplomacy	1.886	62.871	62.871	1.886	62.871	62.871
Diplomacy for science	0.649	21.640	84.511			
Science for diplomacy	0.465	15.489	100.000			

Also reasonability level of Bartlett's test characteristic is zero which is less than 0.05 and it shows that it is statistically meaningful. The second output of explanatory factor is common table which shows determining variable coefficient. All common values are higher than 0.4 that approves reasonability of data and analysis. After factor analyzing and performing varimax rotation method to simplifying factors, it showed that items 9 and 10 has strong effect on the two factors. It means that with more than one factor of overlap, items can get put away. So the result of factor analyze using varimax rotation method shows that after 7 rotations, the best solution has three factors. It means that among 23 items, 5 factors identified as main factors and get named related to its subject and 21 criteria accepted and classified into those factors. It worth to notice that some elements and criteria as same together because of similarity in concepts and their application.

Table 8: Tab 7. Factor analyzing matrix

dimensions	Factor loading
Diplomacy for science	0/817
Science for diplomacy	0.758
Science in diplomacy	0.511



Table 11: Factors and Criteria about role of higher education in S&TDD

Infrastructure Requirement	Systematic education in university and upgrading culture about the subject
	Cooperation in giving visa easier with foreign policy system
	Non-profit academic sections improvement
	International relation improvement
Act in global level	Launch huge international projects
	Cooperation in innovative project globally
	More investment on running project in developing country
	Expansion scientific cooperation between neighboring country
Relationship between higher education and diplomacy system	Collaborate with government to improve science and technology diplomacy
	Obviate science and technology needs with help of diplomatic system
	Intercommunity for protect science and technology from spy
	Define science and technology attraction factors in diplomacy
	Reinforcement relation between scientific and politicians
	Negotiation for new or forbidden technology import
	Make or improve capacity
Planning and managing	Higher education participation for effective role of science and technology
	Protect and develop executive scientific acts such as conferences, workshop and ...
	Reinforcing reward and punishment lever
Science and technology branding	International mission of higher education
	Make other country Independent about our science-based product
	Improvement efficiency of technology for easier export

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Table 9: Factors and criteria of higher education's role for science and technology development identified and added by interview

Main factors	Added criteria
Upgrade universities skills for international relationship	Act in global level
Improvement scientific and technological exchange between universities	Act in global level
Intercommunity for protect science and technology from spy	Relationship between higher education and diplomacy system
Protect and develop executive scientific acts such as conferences, workshop and ...	Planning and managing
Reinforcing reward and punishment lever	Planning and managing

Table 10: KMO and Bartlett's Test for the role of higher education to S&TDD

Kaiser-Meyer-Olkin Measurement of Sampling Adequacy		0.901
Bartlett's Test of Sphericity	Approx. Chi-Square	3631.712
	df	253
	sig.	0.000

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